

Pepperdine University

Pepperdine Digital Commons

Theses and Dissertations

2019

Stories in the making: a phenomenological study of persistent women techmakers in co-ed community makerspaces

Stacey Shinnick

Follow this and additional works at: <https://digitalcommons.pepperdine.edu/etd>

Recommended Citation

Shinnick, Stacey, "Stories in the making: a phenomenological study of persistent women techmakers in co-ed community makerspaces" (2019). *Theses and Dissertations*. 1060.

<https://digitalcommons.pepperdine.edu/etd/1060>

This Dissertation is brought to you for free and open access by Pepperdine Digital Commons. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of Pepperdine Digital Commons. For more information, please contact josias.bartram@pepperdine.edu , anna.speth@pepperdine.edu.

Pepperdine University
Graduate School of Education and Psychology

STORIES IN THE MAKING: A PHENOMENOLOGICAL STUDY OF PERSISTENT
WOMEN TECHMAKERS IN CO-ED COMMUNITY MAKERSPACES

A dissertation proposal submitted in partial satisfaction
of the requirements for the degree of
Doctor of Education in Leadership, Administration, and Policy

by

Stacey Shinnick

June, 2019

Linda Purrington, Ed.D. – Dissertation Chairperson

This dissertation, written by

Stacey Shinnick

under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Doctoral Committee:

Linda Purrington, Ed.D., Chairperson

Molly McCabe, Ed.D.

Dawn Hendricks, Ed.D.

© Copyright by Stacey Shinnick (2019)

All Rights Reserved

TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	vii
DEDICATION	viii
ACKNOWLEDGEMENTS	ix
VITA	x
ABSTRACT	xii
Chapter 1: Introduction	1
Background of the Study	1
Problem Statement	7
Statement of the Purpose	7
Importance of the Study	7
Definition of Terms	8
Theoretical Framework	9
Research Questions	10
Delimitations	10
Limitations	11
Assumptions	11
Organization of the Study	11
Chapter 2: Review of the Literature	13
Organization of the Chapter	13
Theoretical Framework	14
Historical Background	18
Attraction to Making	42
Barriers and Challenges	46
Strategies and Supports	50
Chapter 3: Methodology	55
Study Purpose	55
Research Questions	55
Research Methodology and Rationale	56
Setting	57
Population, Sample, and Sampling Procedures	57
Human Subject Protections	59
Design Validity	60
Instrumentation	60

	Page
Data Collection Procedures and Data Management	66
Data Analysis	69
Chapter 4: Results	70
Restatement of the Purpose.....	70
Research Questions.....	70
Research Design.....	70
Participants' Demographic Information	71
Participant Profiles.....	71
Research Question 1 Findings	104
Research Question 2 Findings	106
Research Question 3 Findings	108
Summary.....	111
Chapter 5: Discussion, Recommendations, and Conclusion	113
Purpose.....	114
Research Questions.....	114
Research Design Overview.....	115
Discussion of Key Findings	115
Discussion of Key Findings as Related to Theoretical Framework.....	123
Conclusions.....	129
Implications for Practice.....	134
Recommendations for Further Research.....	135
Summary.....	137
REFERENCES	139
APPENDIX A: Informed Consent for Participation.....	149
APPENDIX B: Interview Instrument	152
APPENDIX C: Expert Review and Pilot Interviews	154
APPENDIX D: Participant Recruitment Email	157
APPENDIX E: Recruitment Advertisement.....	158
APPENDIX F: Follow-Up Email	159
APPENDIX G: Email Declining Potential Participant.....	160
APPENDIX H: Pepperdine IRB Approval.....	161

LIST OF TABLES

	Page
Table 1. Relationship among Research Question, Interview Questions, and Literature	63
Table 2. Demographic Information.....	72
Table 3. Research Question 1 Key Themes	104
Table 4. Research Question 2 Key Themes	106
Table 5. Research Question 3 Key Themes	109

LIST OF FIGURES

	Page
Figure 1. Mansplaining flow chart.....	128

DEDICATION

To my adorable, loving husband, Sean, who has always kept me laughing. Without your support and encouragement, I could not have finished this doctoral journey in 3 years. I love you.

To Shay, thank you for your support. I do not tell you enough how much our relationship means to me or how proud of you I am. Also, thank you for all the laughs we shared along our educational journeys the past few years.

To Laurie O'Keefe, thank you for inspiring me to become an educator and for your mentorship along the way. Your talent and expertise made it look easy. It is anything but easy, but it is so rewarding.

To Buddy, Baby, and Biggie, thank you for the much-needed hugs and play breaks during this arduous marathon.

ACKNOWLEDGEMENTS

This dissertation was masterfully guided by the incredibly attentive and patient Dr. Linda Purrington. She is a consummate professional and leader who truly leads by example. It was an honor and pleasure to work with her on this research. Additionally, I would like to thank Dr. Dawn Hendricks and Dr. Molly McCabe for their thoughtful and meaningful input.

I would like to express gratitude toward the six unique and amazing women who shared their stories with me. They are true pioneers, and their intelligence, determination, and selflessness will inspire me for a lifetime. The world is definitely a better place with them in it.

I want to thank the nine other members of my Pepperdine University cohort: Kelli, Emma, Simone, Will, Sharet, Daisey, Tisha, Jay, and Nate. Together we were the perfect 10! Thank you for making doctoral work fun. Of course, I must give special thanks to Kelli. Your friendship since kindergarten has meant more than you know. Thank you for being there for me. I will always love you unconditionally.

Thank you to Marcus Konantz, Wendy Blais, and Sandra Hall for your support at work and for letting me bounce ideas off of you. Your many insights have inspired this research. The opportunity to work alongside such outstanding colleagues has been a great gift.

Thank you Faith MacDonald for taking the time to help test my interview instrument and for being so candid and forthcoming. I thoroughly enjoyed learning more about you. You are a beautiful genius inside and out.

Lastly, thank you to Dr. Sarah Davies and Katherine Kersten for your willingness to review my interview instrument. Moreover, thank you Dr. Davies for your wonderful book on hackerspaces and Katherine Kersten for your brilliant and brave conservative writings.

VITA

EDUCATION:

Pepperdine University Malibu, CA Doctor of Education in Educational Leadership, Administration, Policy	2019
Google for Education Training Center Online Google Educator Certification	2014
Fresno Pacific University: Computer Using Educators (CUE) Online Innovative Educator Advanced Studies Certification Leading Edge Online and Blended Teaching Certification	2013
Clear California Special Education Credential Autism and English Language Learner Authorizations- Highly Qualified	2012
California State University, Northridge, CA ACT-R Special Education Mild/Moderate Master of Arts	2012
Vista Center for Behavior Analysis, Vista, CA Behavior Intervention Training	2009
San Diego State University, San Diego, CA Bachelor of Arts in Psychology	1989

EXPERIENCE:

LAUSD District Office of Transition Services, Los Angeles, CA Transition Teacher/Career Coach- California Career Innovations Project	8/2016-Present
Superior Street Elementary Resource Specialist Program Teacher Mentor/teacher support provider for District Intern Program	2013-2014
Santana Arts Academy Resource Specialist Program Teacher	2014-2015
Hart Street Elementary, Canoga Park, CA Resource Specialist Program Teacher	2014-2015
CUE Android Project Team Reviewer of Android Apps for Google Play for Education Store	2014-2016

Napa Street Elementary, Reseda, CA Resource Specialist Program Teacher	2013-2014
Calahan Community Charter, Northridge, CA Resource Specialist Program Teacher	2012-2013
Millikan Middle School Teacher Special Day Class for 6th-8th grade students with autism	2011-2012
Urban Teacher Residency Program, Mt. Gleason Middle School Co-taught Algebra, Physical Science, Life Science, U.S History, World History	2010-2011
Better Golf Academy Instructor Golf coach for elementary students in after-school enrichment programs.	2008
Callaway Golf Staff Professional Taught golf clinics and performed long drive exhibitions.	2000-2005
All-Star Photography, San Diego & Los Angeles, CA Owned and operated high-volume youth sports photography service and lab.	1995-2010

ABSTRACT

Technology shapes the world, and collaborative learning environments known as makerspaces offer tremendous opportunity for innovation and invention. Co-ed community makerspaces lack female membership and participation. If women do not participate, they are being left behind; therefore, there is a need to understand female techmakers who persist in co-ed community makerspaces. This study was viewed through the socio-political conservative feminist framework. It aimed to explore why the participants were attracted to co-ed makerspaces; challenges and barriers they encountered and how they overcame them; and supports and strategies used to persist in co-ed community makerspaces. This study may interest current and future female techmakers and anyone seeking increased female participation in co-ed makerspaces.

This study utilized a qualitative existential-phenomenal research design. The researcher interviewed 6 persistent women techmakers who were long-term members of co-ed community makerspaces. The interviews were conducted both face-to-face and virtually using a semi-structured interview protocol consisting of 3 primary questions and 10 as-needed follow-up questions to elicit candid accounts of their lived experiences as female techmakers in co-ed community makerspaces.

Five conclusions resulted from this study. First, natural tendencies such as extraordinary curiosity and natural attraction to electronic technology played an important role in the participants' attraction to techmaking. Second, the participants were attracted to their makerspaces because they offered meaningful personal connections. Third, inadvertent sexism existed in the participant's makerspaces but not oppression. Fourth, the participants were self-

determined. Fifth, early supports and role models inspired or helped the participants in their techmaking pursuits.

This study's findings yielded three recommendations. First, the researcher recommends that adults encourage and support extraordinarily curious children. Second, educational policy and curriculum around makerspaces should include talking points to highlight meaningful social interactions as an attraction point. Finally, the conservative feminist framework has value when unpacking male and female social relations in male-dominated fields and should be taught more widely in the area of technology.

Chapter 1: Introduction

This study focused on the persistence of six women techmakers in the United States. The chapter commences with the background of the study, followed by the statement of the purpose, importance of the study, definition of terms, and theoretical framework of the study. Then, the research questions, delimitations, limitations, and assumptions are established. Lastly, the organization of the remainder of the study is presented.

Background of the Study

In order to understand this study, one must have a basic understanding of making, techmaking, makerspaces (aka hackerspaces), and the importance of the Maker Movement.

Making is an iterative process of tinkering and problem solving that draws on a do-it-yourself (DIY) mindset. Making is collaborative and allows for self-expression through the creation of a personally meaningful artifact that is shared with a larger community.

(Allen et al., 2016, p.1)

In its simplest form, techmaking, which is the focus of this study, is using electronic technology to make (Faulkner & McClard, 2014). Makerspaces are collaborative learning environments where people come together to share materials and information and learn new skills (Anderson, 2012; Hatch, 2018); however, makerspaces are not defined by a specific set of materials or tools but the mindset of the communities they serve (Davies, 2017; "Makerspace," n.d.). Digital connectivity is important to the Maker Movement, but online participation is not the center of makerspace participation (Davies, 2017). The culture of makerspaces and the Maker Movement emphasizes learning-through-doing in a social environment (Davies, 2017; Dougherty, 2012).

Techmaking is not a new concept, but what is exciting is that it is becoming easier to accomplish (Anderson, 2012; Dougherty, 2016a; Hatch, 2018). For example, there is now cheap,

often free, and relatively simple to use software that can help anyone fabricate complex objects. Easier techmaking, coupled with the fact that factories are increasingly willing to work with the public, opens doors for exciting entrepreneurial opportunities that never existed before (Anderson, 2012; Davies, 2017; Hatch, 2018). Individual makers can now use the Internet and a credit card to get robots in factories to take their prototypes to mass production. Processes to move a product from idea to market that used to cost \$100,000 are now reduced to around \$2,000 (Anderson, 2012; Hatch, 2014). This phenomenon has huge implications for start-ups and jobs because Hatch (2014) predicted that the majority of innovations and products will come from individual makers in the future. Additionally, because science and technology are important for U.S. growth and competitiveness, individuals with science, technology, engineering, and mathematics (STEM) backgrounds will continue to be sought after by high-tech firms because of their ability to increase capacity for innovation (Bilimoria & Liang, 2015).

The Maker Movement has grown exponentially since its inception (Davies, 2017). It is widely acknowledged that the Maker Movement officially began in 2005 with the launch of Make Magazine, the go-to magazine for makers (Hatch, 2018). The first Maker Faire, held in the San Francisco Bay area in 2006, was so successful that by 2013 there were 60 Maker Faires and Mini Maker Faires across the globe (Pepler & Bender, 2013). In 2014, President Obama hosted the first-ever White House Maker Faire and issued a call to action for every college, company, community, and citizen embrace and empower U.S. makers (Kalil & Santoso, 2015). In 2016, the U.S. Census Bureau listed more than 400 makerspaces in the U.S., with California hosting 56 (almost twice the number of the second most prolific state, New York); worldwide, the number of makerspaces had gone up 14 times since 2006 (Lou & Peek, 2016). The movement has also

grown globally. In 2016, there were 1,233 active spaces worldwide and over 500 in development (Davies, 2017).

The Maker Movement is gaining momentum because of cheaper, more powerful and shared tools, and free and shared software, but it is also the result of a new appreciation for open innovation, which is essentially collaboration in innovation. In the Maker Movement, making and inventing are no longer done by tinkerers in secret in their garages trying to protect their ideas (Anderson, 2012). Instead, they are done in the open, with makers helping each other refine products and ideas (Anderson, 2012). Also, one does not need to have an original invention to participate fully; makers can devote themselves solely to collaborative efforts to improve designs and ideas (Anderson, 2012). In fact, the Maker Movement is now often referred to as the *new industrial revolution* (Anderson, 2012; Davies, 2017). In 2017, Maker Media reported that makers are leaders in innovation: They have added more than \$29 billion to the U.S. economy, and \$150 million dollars has been invested by individuals to maker projects on Kickstarter (Make, 2017).

In their qualitative study of values and expectations of 39 makers worldwide, Unterfrauner, Voigt, Schrammel, and Menichinelli (2018) found that the opportunity to customize and personalize products was one of the biggest advantages makers saw in making. The makers in the study believed people will demand more customized and personalized products in the future. One maker predicted, “They won’t settle for the same glasses [as] their neighbors, they want their glasses, which fit them perfectly and have the right shape for their ears. Every single product that they will want will have to be personalized” (Unterfrauner et al., 2018, p. 120). The makers believed customers will also be willing to pay more due to knowing how the product was made, as well as where and by whom.

In the Unterfrauner et al. (2018) study, makers cited other advantages to making, including recycling, upcycling, and the disruption of the current consumer-producer relationship. Lifespans of products can be increased because one no longer has to throw away industrially produced goods whose replacement parts are no longer manufactured by the original manufacturers (Unterfrauner et al., 2018). As one maker noted, “There is much value behind the 3D printer because you can replace the world around you and you can improve it and create your own parts” (Unterfrauner et al., 2018, p. 121). Upcycling, the process of taking something old and transforming it to something new through reconfiguration, is also an advantage makers in the study saw as having a lot of implications for innovation in the future (Unterfrauner et al., 2018). Many of the makers appeared to be anti-consumerist because of their drive to understand how things are made as well as to be in charge of producing their own products. One maker suggested that makers will continue to disrupt the relationship between consumer and producer, but it will take time “because you have to start with a new generation and teach them it doesn’t have to be like this (that you purchase things), and they can be picky, and they can influence their design and be a designer” (Unterfrauner et al., 2018, p. 122).

Makerspaces are important in the Maker Movement because product development costs can be kept down by 98% through the shared tools, spaces, and expertise found in makerspaces. Fast prototyping is one of the biggest advantages makerspaces offer to makers (Unterfrauner et al., 2018). However, the power of the makerspace lies in its ability to serve as a platform for anyone to innovate, make, connect, collaborate, and change the world (Anderson, 2012; Davies, 2017; Hatch, 2014, 2018). Hatch (2014) believes the Maker Movement needs millions to join in, and that the movement can lend itself to “liberating the oppressed” (p. 9) because collectively, it has the power to solve the world’s largest problems and meet people’s most pressing needs.

Also, the open hardware and software at makerspaces, as well as exponential increases in participation, offer unlimited potential for innovation across many industries (Hatch, 2014).

It has been estimated that over 80% of all makers are male, which is similar to the gender representation in major tech companies (Karlin Associates, 2012). Additionally, males make up the overwhelming majority of members of co-ed community makerspaces (Davies, 2017; Faulkner & McClard, 2014). Dale Dougherty (2016a), CEO of Maker Media and often referred to as the father of the Maker Movement, emphasized that “the power of ‘maker’ as a new term lies in its sense of inclusiveness, and its lack of close alignment with a particular field or interest area, so people are free to claim the identity for themselves” (p. xv). Although Dougherty asserted everyone is invited to claim the identity of maker, the lack of female participation in makerspaces belies that assertion.

One reason for the lack of female representation in makerspaces may be that maker culture is not as welcoming of diversity as Dougherty claims. For example, at the end of 2017, Dougherty called out Naomi Wu, a successful female techmaker, on Twitter (Koslow, 2017). In his tweets, he questioned Wu’s very existence as a techmaker (Koslow, 2017). After the Twitter battle between Wu and Dougherty escalated, he apologized to Wu and offered to feature her on the cover of Make Magazine along with a full-length story about her techmaking (Dougherty, 2017). He also promised to publish a diversity audit of Make, prioritizing goals related to issues of diversity, and he invited Wu to serve on Maker Faire advisory boards in China (Dougherty, 2017). He admitted that his tweets “reflected my unconscious biases; and the negative impact of my tweets was amplified by the fact that I, a white, Western, male CEO of a key company in the Maker community publicly questioned a young, female, self-employed Chinese maker” (Dougherty, 2017, para. 1).

Some women techmakers have rejected co-ed community makerspaces in favor of women only makerspaces they call *safe spaces*. Safe spaces are devoted to the safety of oppressed groups and are based on the belief that shared values empower those groups to thrive (Toupin, n.d.). Henry (2014), outspoken and often-quoted founder of Double Union, a feminist hackerspace, has claimed that women are not participating in co-ed community makerspaces not because they do not make things, code, or possess skills with the requisite technology. Rather, “It’s because men act like the space is theirs. Women face harassment ranging from assault to much milder, but more constant, come-ons and innuendos. Our geek cred is constantly challenged or belittled” (Henry, 2014, p. 5). According to Henry (2014), she and others with similar experiences started a movement toward creating feminist spaces after they grew tired of the struggle to be taken seriously as techmakers. “We’re pissed off. What if we weren’t always fighting bad behavior, having to justify our hacker-ness, feeling like unicorns, being tokenized, having to be armored up against harassment?” (Henry, 2014, p. 7).

Bean, Farmer, and Kerr (2015) believe more exploration is needed to find ways to close the gender gap in the Maker Movement and to ensure female makers have enriching and supportive environments in which to work. Today’s world is constructed by technology; therefore, attracting and supporting more women in science and technology is not only an issue of equal opportunity, but also critical to ensuring that female voices are heard in the design and shaping of the world (Wajcman, 2009). Feminist makers are taking matters into their own hands to establish spaces of mutual support away from male counterparts who participate in co-ed community makerspaces, yet these feminist spaces are inherently exclusionary (Henry, 2014). If collaborative, inclusive cultures are the ideal in community makerspaces, it is also important to

hear from women who have been navigating these spaces successfully to learn how and why they have persisted.

Problem Statement

It is well-known that community makerspaces lack female membership and participation (Davies, 2017; Faulkner & McClard, 2014). However, little is known about how female techmakers persist in co-ed community makerspaces. Bean et al. (2015) encouraged more exploration of ways to close the gender gap in the Maker Movement. Therefore, there is a need to study the experiences and perspectives of women who are long-term, active techmakers in co-ed community makerspaces to learn about what attracted them, any barriers/challenges they have experienced, and support they have received.

Statement of the Purpose

The purpose of this qualitative, phenomenological study was to investigate the experiences and perspectives of female members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. The researcher selected six women techmakers to interview and explored their lived experiences of how they thrive in a predominantly male culture within the makerspace community.

Importance of the Study

This study could encourage more women to explore techmaking through an understanding of the practices and strategies used by those who overcame obstacles to persist in co-ed community makerspaces. Current and future techmakers may be able to benefit by implementing the practices of persistent women techmakers. This study may offer women

techmakers strategies to use when dealing with adverse conditions in co-ed community makerspaces. This study had the potential to yield information to help community makerspaces increase female membership and participation. It may provide insights that help to close the gender gap in computer-science related fields, and it may provide insights to why many girls and women lose interest in STEM. Moreover, this study may add to feminist theory regarding women and their relationship with men, technology, and innovation.

Little formal research has been conducted on variables that contribute to the persistence of women techmakers who are long-term participants in techmaking in co-ed community makerspaces (Bean et al., 2015). This study may add to that body of knowledge. Therefore, there is a need to study the lived experiences of these pioneering women who are paving the way in the new industrial revolution.

Definition of Terms

Active Techmaker: Based upon the Intel (2014) definition of techmaker, for this study, active techmakers were defined as:

Those who have done one or more of the following within the past year: made an object that has parts that can move on their own, light up or make a sound; made clothing or jewelry that lights up, created or built a robot, or used a 3D printer or laser cutter to make something. (p. 58)

In this study, participants were considered active techmakers if they had met these criteria in the past 6 months. Additionally, they can have used a computer numerical control machine to make products.

Arduino: “Arduino is an open-source electronics platform based upon easy-to-use hardware and software” (Arduino, n.d., para. 1).

3D Printer: A printer that can produce three-dimensional objects. Most 3D printers use plastic, but higher-end 3D printers can print rubber, mixtures of plastic, and metal (Hatch, 2014).

Makerspace: “A place in which people with shared interests, especially in computing or technology, can gather to work on projects while sharing ideas, equipment, and knowledge (“Makerspace,” n.d., para. 1).

Microcontroller: “A silicon chip that can be programmed to control things like sensors, switches, and other devices” (Hatch, 2014, p. 121).

Safer Spaces: “Space that is explicitly committed to the safety of individuals or communities that are targets of oppression” (Toupin, n.d., p. 4).

Techmakers: “People who make physical objects with electronic tools for their own purposes or with their own designs, as opposed to including every type of maker – weavers, knitters, woodworkers, welders – regardless of their use of technology” (Faulkner & McClard, 2014, p. 189).

Theoretical Framework

This study of women techmakers was viewed through the socio-political conservative feminist perspective. Conservative feminism is based upon three assertions: unvarying standards of justice and equality must apply to both sexes; women have and still do suffer from injustice; and the problems women face can best be addressed by improving upon, rather than discarding, the institutions and principles of Western culture (Kersten, 1991). Kersten (1991) asserted that a merging of conservative and feminist principles can help to motivate and support women in the modern era. The aim is “to help women judge when change and which change is desirable and to recognize the circumstances under which change is likely to make matters worse, rather than better” (Kersten, 1991, p. 9).

Conservative feminism is concerned with individual rights to justice and equality, whereas other feminisms tend to focus on group rights (Kersten, 1991). Women should be free to make their own decisions about workplace relationships and propriety (Schreiber, 2012). Conservative feminists believe that gender equality exists as long as women and men are judged by the same standards, and women are free to choose whatever occupation is desirable to them (Kersten, 1991). Moreover, women should value men as partners, not condemn them as foes or oppressors (Bruce, 2014; Paglia, 2017). For the purposes of this study, conservative feminism offered an appropriate framework to address the challenges and barriers women techmakers face in sustaining in co-ed community makerspaces.

Research Questions

Through this study of female techmakers who have persisted in co-ed community makerspaces for over 1 year, the researcher sought answers to the following research questions:

1. What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces?
2. What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them?
3. What supports, if any, have long-term active female techmakers accessed/received to persist in co-ed community makerspaces?

Delimitations

This study had three delimitations. These include: (a) the researcher conducted interviews with women techmakers in the U.S; (b) partially modeled after the Intel (2014) study, the female techmakers needed to have been a member of a co-ed community makerspace for more than 1

year, and they must have used one of these tools within a co-ed community makerspace within the past 6 months: microcontroller, laser cutter, computer numerical control machine (CNC), computer development board, open source robotics, 3D manufacturing tools, or a 3D printer; and (c) participants also had to be actively pursuing tech making projects.

Limitations

This study was delimited to a select group of women techmakers in the U.S. This geographic constraint may affect the findings of the study because biases may occur within the confines of one country or particular region within a country. These biases may include unique perspectives and attitudes toward women. This study may also be limited by the small sample size and non-random sampling procedures. Data were self-reported, not observed or triangulated. Additionally, the interview instrument, although reviewed by experts, was used for the first time in this study.

Assumptions

The researcher made four assumptions in this study. These include the following: (a) gender is essential to understanding the experiences of women who are long-term techmakers in co-ed community makerspaces, (b) long-term women techmakers in co-ed community makerspaces will be willing to participate in the study and complete the interviews, (c) participants will answer interview questions honestly, and (d) the data and the interpretation of the data will accurately reflect the perceptions of long-term women techmakers in co-ed community makerspaces.

Organization of the Study

This phenomenological qualitative study will be presented in five chapters. Chapter 1 provided the rationale for conducting such a study, the importance of the study, and key terms

used in the study. Additionally, Chapter 1 presented the research questions, delimitations, limitations, assumptions, and theoretical framework of the study, in addition to the value of studying persistent women techmakers in the U.S.. Chapter 2 presents a review of the literature related to (a) how conservative feminist theory might relate to the variables relative to female's persistence in techmaking in co-ed community makerspaces in the U.S., (b) historical background of events leading to the Maker Movement, (c) women's versus men's attraction to techmaking, (d) the barriers and challenges persistent female techmakers have faced in male-dominated spaces, and (e) the strategies and supports women techmakers have used to persist. Chapter 3 presents the methodology utilized for this qualitative, phenomenological study. Chapter 4 provides profiles based on the personal stories of successful women techmakers, with the goal of getting to know the subjects and investigating their unique paths to persistent techmaking. Lastly, Chapter 5 offers a discussion of the results of the study, conclusions, and recommendations for future study.

Chapter 2: Review of the Literature

Organization of the Chapter

This chapter presents the literature on the subject of women techmakers in regard to participating and persisting in techmaking and successfully navigating co-ed community makerspaces. The focus of this study was to better understand the personal stories of persistent women techmakers, delving into how they began as techmakers and strategies they use to overcome barriers associated with persistence in techmaking in co-ed community makerspaces.

There is sparse literature on female techmakers who are members of co-ed community makerspaces; however, there are numerous relevant studies on the underrepresentation of women in male-dominated computer science-related fields. The literature on female techmakers continues to evolve as the Maker Movement and makerspaces grow in popularity, and this study focused on current trends in research regarding makerspace environments and women techmakers. Although the Maker Movement is currently gaining traction worldwide, the scope of this literature review is confined to the context of the U.S. and the factors that are unique to women navigating co-ed community makerspaces within the boundaries of the U.S.

The literature review begins with the presentation of the theoretical lens. This phenomenological study of U.S. women techmakers was analyzed through the socio-political conservative feminist theoretical perspective. Next, this literature review will outline the history behind the Maker Movement and research on women's evolving participation in techmaking and participation in male-dominated computer science-related fields. The literature aligns with the research questions identified in Chapter 1 by examining the independent variables associated with active techmaking and persistent techmaking. Specifically, it aligns with attraction to techmaking, barriers women techmakers face, and research on the strategies women techmakers

implement to help them persist in male-dominated spaces. Finally, the chapter concludes with a call to action for more research of women techmakers and inclusion strategies for increasing women's representation in techmaking in the Maker Movement and co-ed community makerspaces.

Theoretical Framework

Although it is universally acknowledged that feminism played a role in ensuring that U.S. women now have the same rights and opportunities as men, there is a divide among feminist groups as to the direction feminism itself should take in regard to women's underrepresentation in science and engineering. Most contemporary feminist thought leaders seek social egalitarianism, and they see power hierarchies as a result of male hegemony and something to be eradicated (Chafetz, 1992; Sommers, 2013). Wajcman (2009) believes women are relatively absent in scientific and technological fields and institutions because of marginalization due to sex stereotyping in education, sexual discrimination in the workforce, and the perception that technology is masculine. Wajcman (2009) also asserts that we are in a global age dominated by science and technology that is dominated by men, and by being absent in male-dominated computer science related fields, women are losing the power struggle over who controls the future. Haraway (2009) asserted that with advances in technology and science moving everyone closer to identifying as cyborgs, women can and should use technology as a source of power to destroy power hierarchies. Chafetz (1992) suggests equal valuation for women will only occur when organizations have equal representation by women and men in elite roles, and that a tactic to gain access to elite roles is to boycott businesses and organizations that do not meet quotas of female elites.

Conversely, conservative thought leaders do not view underrepresentation of women in the workforce as the result of oppression or in need of quotas, boycotts, and other radical tactics. Sowell (2015a) argued that competition in the American capitalist economy ensures that it is extremely difficult for businesses that discriminate against women to succeed in the long run (Sowell, 2015a). Businesses that pay men more compared to women who have the same experience and track records of performance are subjecting themselves to unnecessarily higher production costs than those who do not (Sowell, 2015a). For example, if businesses pay women 25% less than men, the effect should manifest itself in overrepresentation of women because those businesses could hire four women for the same price of three comparable men (Sowell, 2015a).

Capitalism levels the playing field for women because it rewards profitable practices rather than oppressive ones (Kersten, 1991). Guha (as cited in Devlin & Hearn, 2017), a female leader of a tech incubator, argues that companies with an all-male workforce make less money and inferior products. Additionally, although a woman is 86% less likely to be funded for a tech start-up than a man, companies with leadership that is gender diverse can expect to make approximately 34% more return on investment (Devlin & Hearn, 2017). Guha stated, “It’s not about ‘corporate social responsibility’: a diverse range of thinking will bring better value for the company” (as cited in Devlin & Hearn, 2017, p. 5). Increased diversity in the Maker Movement will stimulate competition and promote economic progress (Intel, 2014).

Conservative feminism opposes efforts to assign stereotypical gender roles, but it also acknowledges that men and women will choose to express their equal freedoms in different ways. In other words, underrepresentation occurs because of personal choices (Fox-Genovese, 2004; Kersten, 1991; Pavlich, 2015; Sommers, 2013; Sowell, 2015b). Men typically choose

higher paying careers and education leading to higher financial rewards than women, women tend to take more time off work for family than men and prioritize the needs of the family when considering work options, and men work more hours as well as more years consecutively than women (Pavlich, 2015; Sommers, 2013; Sowell, 2015a). Occupations that allow women to take a few years off for motherhood are also more attractive to American women who want to become mothers than occupations in such domains as the rapidly changing computer engineering field, where taking a few years off may be detrimental (Sowell, 2015a). Moreover, men show much stronger interest in working with things, whereas women prefer to work with people (Su, Rounds, & Armstrong, 2009). Men also show a stronger interest in STEM areas, whereas women tend to prefer conventional, artistic, and social pursuits (Su, Rounds, & Armstrong, 2009). The implication is that women choose careers outside of fields such as engineering not because those environments are oppressive, but because their career choices are a manifestation of females' tendency to want to work in people-oriented careers (Su, Rounds, & Armstrong, 2009).

Conservatives believe it is illogical to be angry with a society that has not been able to provide everything for everyone (Kersten, 1991). Conservative feminism contends that assigning blame to men for society's failure to achieve expectations that can never be met condemns women to despair and commits them to perpetual "victimhood" (Kersten, 1991, p. 8). Instead, American women should acknowledge that they are among the most privileged, wealthy, educated, and politically powerful groups in the world (Fox-Genovese, 2004; Sommers, 1995).

Conservative feminists believe men are partners, not adversaries (Kersten, 1991). For example, although women have played an important role in the modern economy, it has been primarily men who have chosen to enter professions that involve extreme hours and physical exertion (Sowell, 2015b). Additionally, men are much more likely than women to lose their lives

on the job (U.S. Department of Labor, 2017). In 2016, there were 4,803 fatal occupational injuries involving men compared to 387 fatal occupational injuries involving women (U.S. Department of Labor, 2017). It is men who deserve the credit for the enormous production and distribution systems and infrastructures benefitting both men and women today (Paglia, 2017). It was also men who created birth control and many of the modern appliances that have freed up American women to pursue endeavors outside of homemaking, should they choose to do so (Bruce, 2014). Conservative feminists believe women and men complement each other and should seek to identify universal human interests that can mediate the power struggles between them (Kersten, 1991).

Although conservative feminism is not concerned with social engineering or attempting to free women from femininity, it is still concerned with the protection of women as a unique class because of physical and social differences that inherently place women in more vulnerable positions (Kersten, 1991). Women struggle more than men in balancing work and family responsibilities (Sommers, 2013; Sowell, 2015a). Misogyny in popular culture and violence against women need to be addressed (Kersten, 1991). However, conservative feminism accepts as an inevitable facet of human experience that there will be ongoing negotiations among men and women about social boundaries and sexual relations (Fox-Genovese, 2004; Sommers, 2013). Conservative feminism seeks to distinguish between needs and wants and to discern real injustices from irritations that can be handled without the involvement of political or legal systems (Kersten, 1991; Paglia, 2017).

Conservative feminists believe it is time to widen the narrow focus on oppression in America into which other feminist groups appear to be locked and examine practical issues such as the realities of trying to balance career and family (Kersten, 1991). Conservative feminism

does not condemn capitalism or seek socialist solutions to try to eradicate inequities in the American workforce, nor does it forget that the West was solely responsible for the evolution of the standards of justice, equality, and individual self-determination enjoyed in the U.S. today (Fox-Genovese, 2004; Kersten, 1991; Sommers, 2013). As the conservative feminist carves out her future, she:

regards adversity as an inevitable component of human life, rather than an aberration afflicting primarily her and her sex. When hard times come, she strives to face them with courage, dignity, and good humor—qualities often in short supply in the feminist camp. And when her own shortcomings lead to failure, she resists the temptation to blame a hostile “system.” (Kersten, 1991, p. 15)

Historical Background

To understand the history of the Maker Movement and why techmakers believe there is a third industrial revolution called the Maker Revolution, one must have a fundamental understanding of the ingredients and events that led to the first two industrial revolutions. An industrial revolution, at its most basic level, is about inventions and technologies that exponentially magnify the productivity of people (Anderson, 2012). In the late 1700s, the First Industrial Revolution came about in Western Europe and North America because of technologies such as the spinning jenny and the steam engine that ultimately transformed how people lived: improving quality of life, increasing life expectancy, increasing sizes of families, and providing more options for where people could live (Anderson, 2012). The machines enabled the exportation of agricultural commodities, which enabled nations to command power using trade instead of violence (Anderson, 2012). Also, by helping people do more in less time, the new

machines afforded innovators the time necessary to invent and produce even more new technologies to make things even better for civilization (Anderson, 2012).

The Second Industrial Revolution was more worldwide and was the result of factories joining with steam-powered ships and railroads (Anderson, 2012). In the 1860s, steel and metal goods were being produced in large quantities, and the assembly line was created (Anderson, 2012). This included Henry Ford's Model-T line, which was innovative in that workers produced products by working on single tasks using interchangeable parts delivered to them by conveyor belt (Anderson, 2012). These advances—along with the development of the internal combustion engine, advances in electrification, petroleum refining, and the rise of chemical industries—continued until the end of World War I (Anderson, 2012). The Second Industrial Revolution “elevated our species from one that was less about what we could do and more about what we knew. We became more valuable for our brains than for our muscles” (Anderson, 2012, p. 39).

Some believe the Information Age is the Third Industrial Revolution; however, thought leaders in the making community argue that although Information Age is certainly a revolution, digital computing is insufficient on its own to be considered an industrial revolution (Anderson, 2012; Hatch, 2014). The Information Age started around 1950 and continued through the 1990s, beginning with the personal computer and evolving to include the Internet and Web (Anderson, 2012). Digital computing transformed how some jobs were done, but by definition, digital computing in and of itself could not be considered an industrial revolution until it transformed how actual things were made (Anderson, 2012). Anderson (2012) claimed that the economy of bits (i.e., the dematerialized world of information trade) helps people perform tasks better and faster than before, but the digital economy it is a mere fraction of the economy of atoms (i.e., the world of tangible goods). Regardless, digital computing is an essential and powerful ingredient

in the Third Industrial Revolution because of its ability to amplify and transform manufacturing by democratizing it (Anderson, 2012; Dougherty, 2016a). Hence, this is why Anderson (2012) believes the Third Industrial Revolution (i.e., the combination of personal and digital manufacturing) will soon have worldwide effects.

Because of cheaper tools and production costs, individual makers now have the opportunity to play a major role in manufacturing (Anderson, 2012; Dougherty, 2016a; Hatch, 2014). In the United States, as many large manufacturing plants have moved overseas, big manufacturing has been replaced by small manufacturing. This is why Dougherty (2016a) believes the Maker Movement has the potential to revitalize manufacturing, as opposed to previous failed initiatives driven by Democratic funding policies that attempted to bring large manufacturing back to America. For example, in 2009, the Obama administration and the state of Michigan devoted nearly \$1.5 billion in stimulus grants and tax credits to develop plants in Michigan to produce new types of batteries (Dougherty, 2016a). After 5 years, the plants had a few hundred employees but were not thriving (Dougherty, 2016a). Instead of spending huge amounts of taxpayer dollars on public-private partnership ideas that produce little to no return on investment, cities like Detroit could be revitalized through connecting small manufacturing firms with makers, thereby increasing work opportunities as well as avenues for getting things made (Dougherty, 2016a). According to Dougherty (2016a), if individual makers had the ability to make small batches (i.e., from one to 5,000) of a product easily by using online networking, that could be a practical way to increase manufacturing in America.

The digital transformation of making things enables existing manufacturing processes to be more efficient, but it is also affording never before seen entrepreneurial opportunities (Anderson, 2012). During the First Industrial Revolution, there was a rise in cottage industries.

Individuals and families worked from home as outsourced factory labor; their products were made in small batches and typically involved skilled hand-made craftsmanship such as lacework that was difficult for machines to produce (Anderson, 2012). As a result of the cottage industry model, small businesses outnumbered large ones by a significant number (Anderson, 2012). Anderson (2012) links this historical cottage worker-manufacturing industry relationship to what is now emerging in what he calls the “Maker-driven New Industrial Revolution” (p. 49). However, the difference is that makers in this new revolution no longer have to sell to factories to get their products to consumers (Anderson, 2012). Manufacturing is now something anyone can do without being controlled by industrialists (Anderson, 2012). “As a hybrid between traditional manufacturing companies and Web startups, Maker companies also have the potential to be the next big thing, combining the growth rates of software with the money-making ability of hardware” (Anderson, 2012, p. 19).

According to Anderson (2012), today’s makers resemble the cottage workers in the First Industrial Revolution in a number of ways; many makers work from home or in their own workshops, use the labor of family members, and typically make items big factories are not making. In contrast to the cottage industry workers in the past, entrepreneurial makers are likely to sell their products directly to consumers, often using their own websites, eBay, or niche marketplaces (Anderson, 2012). “Today’s cottage industry is more typically an Etsy marketplace seller with a computer-controlled vinyl cutter making cool stickers for Macbooks or making and selling perfect replacement parts for vintage cars” (Anderson, 2012, p. 50). Entrepreneurial makers seek to build their own products and brands (Anderson, 2012). Anderson (2012) asserted that most makers do not compete in a market that is dependent upon cheap labor because competition in the world of making is based on innovation and personalization, not mass

production. Therefore, makers can demand higher prices because their customers realize they will be charged a premium for the unique products they are seeking (Anderson, 2012).

The relatively new concept of crowdfunding provides much-needed capital for many entrepreneurial makers in the Maker Revolution (Anderson, 2012; Hatch, 2018). They can now take advantage of services like Kickstarter to fund projects that would historically take bank loans or venture capital, which imposed serious financial risks and required entrepreneurs to give up a great deal of control (Anderson, 2012). Kickstarter is a website people use to post their ideas or descriptions of their products on and ask others to contribute financially (Anderson, 2012). Most financial contributors choose to preorder the product through their contributions, but some simply donate because they want to help (Anderson, 2012). On Kickstarter, those who post projects must complete them if they raise a target amount agreed upon as a minimum (Anderson, 2012). If projects are not funded at the minimum level, entrepreneurs must look elsewhere for funding and there is no charge to investors (Anderson, 2012).

Kickstarter is especially attractive to entrepreneurial makers and those who support the Maker Movement because it is a financial problem-solver (Anderson, 2012). It turns sales for which an entrepreneur would historically have to wait into pre-sales, providing much-needed financial resources up front (Anderson, 2012). It also serves as a catalyst for community-building around a product (Anderson, 2012). Makers and investors participate as a team; investors get progress reports and are invited to offer suggestions in discussion forums on how to improve the product (Anderson, 2012). Investors' participation in product development may also help projects go viral because they can be committed to creating buzz around the product (Anderson, 2012). As Anderson (2012) noted, "Making in public is an incredibly effective form of advertising, but rather than having to pay for the promotion, you can actually get paid instead" (p. 173).

Kickstarter also provides crucial market feedback, whereas an entrepreneur who cannot hit his/her target may realize the product would fail in the marketplace before incurring huge production costs (Anderson, 2012).

MAKE Magazine and Maker Faires. It is generally accepted that the Maker Movement began with the launch of MAKE Magazine and Maker Faires (Hatch, 2018). Dougherty (2016a) created MAKE because he thought there was a need to have a magazine that focused on the contemporary technology-infused DIY culture. He presented the idea to Tim O'Reilly, founder of O'Reilly Media, as “Martha Stewart for Geeks” (Dougherty, 2016a, p. 15). He said, “It would be a magazine with recipes for projects you could do, with new technology on the ingredients list” (p. 15). O'Reilly encouraged Dougherty to pursue the idea and MAKE became a reality (Dougherty, 2016a). On a side note, Dougherty initially wanted to call the magazine HACK because hacking is a unique type of problem-solving process; however, his children could not relate to the word *hack*, so Dougherty named it MAKE because he felt that was a more universally understood word (Dougherty, 2016a). Now, MAKE “features instructions on how to make anything from bamboo hors-d’oeuvre trays to handcrafted drones” (Davies, 2017, p. 34). It also features stories about inspirational and influential makers and reviews of products.

MAKE is a bridge between the new world of hackers and the older world of traditional craftspeople, tinkerers, and hobbyists alongside the punks, crafters, and DIYers. All these people share a DIY mindset, a determination to remake the world and adopt it to their own ideas, with the assumption that this will make the world a better place. (Dougherty, 2016a, p. 15)

The magazine coined the term *maker* to represent these people, and the popularity of the magazine led to the development of Maker Faires, which started in the San Francisco Bay area

(Dougherty, 2016a). Today the Maker Faire Bay Area attracts over 100,000 people, with around 1,500 exhibitors (Dougherty, 2016a). Moreover, Maker Faires are now produced globally.

Dale Dougherty (2016a) decided to create Maker Faire after realizing that the makers he met through the magazine might enjoy such a venue to meet each other and share ideas. The makers bring a variety of projects that come from many different disciplines, and at its heart, it is a giant weekend-long “show and tell” celebration of makers and creativity (Dougherty, 2016a). According to Dougherty, Maker Faires have a vibe that is hopeful and easy to experience.

It is the feeling that anything is possible, as we revel in experiencing the talent in our community. Everybody brings their best self to Maker Faire, and indeed, they are creating something together that none of us could do by ourselves. Everyone is happy; there is a sense that we all play well together. It makes us feel optimistic about our society and our future. (Dougherty, 2016a, p. 37)

Although Maker Faires are fun and designed to appeal to all, the experience is more in the vein of Burning Man than Disneyland (Dougherty, 2016a). According to Dougherty (2016a), Disneyland is comfortable, attractive, and predictable, whereas Maker Faire and Burning Man can be unfamiliar and unpolished. The experience at Maker Faire is not about fairy tales and happy endings (Dougherty, 2016a). Rather, it is what one desires it to be. “Such experiences can inspire us to tell our own story, sing our own song, build our own scrap-metal robot, or make your own experiences” (Dougherty, 2016a, p. 269).

Makerspaces. The history of makerspaces is somewhat cloudy in the literature, and the differences between some of the labels given to them (e.g., hacklabs, makerspaces, DIY labs, Fab Labs, community-based DIY shops) can be equally difficult to discern (Davies, 2017). The term *hacker*, at its most fundamental level, is often associated with pioneers in the world of the

personal computer who used skills to take apart and tinker with computers, as well as hack with computers (Dougherty, 2016a). In the early 1960s, the first group to meet the later-defined term hacker were identified (Dougherty, 2016a). They were the subgroup of members of MIT's Tech Model Railway Club who were fascinated by the switches in model trains and felt they needed to learn more about how to use computers for their own purposes (Dougherty, 2016a). They also believed strongly that computers should be accessible and information about them should be free, not just available through the paid services of a central bureaucracy (Dougherty, 2016a). Another important collective in the history of hackerspaces was the Homebrew Computer Club formed in 1975, in Menlo Park, California (Dougherty, 2016a). This was an informal subversive hobbyist group whose members enjoyed playing pranks, sharing information, and pirating and swapping computer parts to help each other build computers (Dougherty 2016a). The Homebrew Computer Club famously included Steve Wozniak and Steve Jobs. Wozniack (as cited in Dougherty, 2016a) later reflected, "I just loved going down to the HomeBrew Computer Club, showing off my ideas and designing neat computers. I was willing to do that for free for the rest of my life" (as cited in Dougherty, 2016a, p. 11).

The term hacker also has a history associated with European counter-culture. According to Davies (2017), European hackerspace history is traced to the Chaos Computer Club, a German hackerspace founded in the 1980s. The Chaos Computer Club and other European hackerspace offshoots were rooted in anti-authoritarian values and politics where members could come together to work with like-minded people to solve technical issues, as well as work against social injustices (Davies, 2017). One of the main concerns in European hackerspaces today is Internet freedom and a relentless belief in free information and open-source software, but members of

most maker communities are not as committed to social justice activism as they once were (Davies, 2017).

The first universally recognized formal U.S. hackerspaces were inspired by the Chaos Computer Club (Davies, 2017). In 2007, a group of 35 U.S hackers flew from the DefCom Convention, an annual computer hackers' convention, to the Chaos Computer Club (Davies, 2017). According to Mitch Altman (as cited in Davies, 2017), founder of Noisebridge hackerspace in San Francisco, they were so amazed by the “cool projects, beautiful art, wonderful crafts, creating community, serving community, helping each other, teaching, learning, and sharing” (p. 33) that many decided to open their own spaces. The success of these early spaces resulted in the current explosion of hackerspaces and makerspaces across the country (Davies, 2017). The terms makerspace and hackerspace are often used interchangeably, but some believe the term makerspace implies more openness to commercial structures and capitalistic ideals; moreover, it holds more appeal across a broader spectrum of people, as most makerspaces in America are shops that can be rented by any type of maker to pursue whatever making activity they wish (Davies, 2017).

Many spaces offer month to month memberships that include the use of any tool at the space, sometimes for as little as a few dollars a day (Hatch, 2014).

Access to a complete innovation lab like a fully equipped makerspace has dropped by four orders of magnitude. With the development of pay-by-the month makerspaces, access to these tools is 1/10,000 of what it would have cost just 10 to 15 years. (Hatch, 2014, p. 86)

Also, according to Hatch (2014), having access to tools offered in makerspaces can be life changing. “Yes, people do cry when you tell them they can have access to the tools, information, and community they need to pursue and achieve their dreams” (Hatch, 2014, p. 121).

Many makerspaces are host to a plethora of traditional making tools, from welding torches to sewing machines; however, some newer digital making tools have also become standard in most makerspaces, and to understand this study better, one needs a rudimentary understanding of these tools. All digital design needs software, so techmakers typically may have some understanding of Computer-Aided Design (CAD), which can be thought of as the “word processor of fabrication” (Anderson, 2012, p. 232). CAD can be a 3D drawing program to help sculpt a 3D object on the computer that can be 3D printed into material form (Anderson, 2012). CAD also draws lines and shapes to be interpreted by laser cutters and Computer Numerical Control (CNC) routers, directing them where to cut. High-powered lasers and drills simply trace along the lines, cutting through plastic, wood, and metal (Hatch, 2014). The laser cutter is currently one of the most useful digital fabrication tools available (Hatch, 2014). The minimum requirement for using a laser cutter and CNC machine is a 2D image in a CAD program (Hatch, 2014).

Microcontroller boards are also commonly used in makerspaces because a large part of making culture is making physical objects more useful by attaching sensors, making them programmable, and creating connections to the Web (Anderson, 2012). Arduino (n.d.) is a popular microcontroller platform makers use to add electronic elements to their products. “Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online” (Arduino, n.d., para. 1).

The 3D printer is considered one of the premier prototyping tools in many makerspaces (Anderson, 2012; Hatch, 2014). 3D printers operate much like laser and inkjet printers; however, they work to print solid objects (Hatch, 2014). The 3D printer turns out entire objects by using materials (usually plastic) to print thousands of small slices from the bottom up (Hatch, 2014). Now, with 3D printers, sales-ready prototypes that used to take 6 months and cost tens of thousands of dollars can be made in a fraction of the amount of time and with an investment of just a few hundred dollars (Hatch, 2014). It has been predicted that like laser and inkjet printers, 3D printers will become commonplace in the average home in the not too distant future, and just as the masses can now press *publish* on their computers to submit their ideas for world to read, the masses will be able to press *make* on their computers to turn their ideas into objects for the world to see and experience (Anderson, 2012). In fact, the market for 3D printing and services was approximately \$2.2 billion in 2012 and is expected to skyrocket to \$8.41 billion in 2020 (Bajarin, 2014).

Although tools are an attractive reason for makers to join makerspaces, more is often expected of members than simply paying dues to use tools (Davies, 2017). In 2002, Davies visited 12 hackerspaces across the U.S. and held more than 30 interviews with members. To varying degrees, just as in the Maker Movement itself, all spaces relied on grassroots efforts in their management (Davies, 2017). Members are usually expected to participate in decision-making and maintaining the environment (Davies, 2017). Although some of the spaces were non-profit organizations tied to regulations, members were usually unhappy with leaders who were not participating fully in the culture. There was a sense that a hackerspace is a “do-ocracy” which is the ethos of giving full support to the person or people who take it upon themselves to step up and act on issues (Davies, 2017, p. 55). Members who act on ideas are respected, and

others who complain but do nothing are frowned upon (Davies, 2017). Rules other than those involving safety were sparse (Davies, 2017). For example, Noisebridge had the only rule of “be excellent to each other” (Davies, 2017, p. 55), and a New York space simply asked members not to sleep there or make it their day job.

Almost all the spaces visited in the Davies (2017) study were interested in increasing membership and most held workshops and trainings in various making techniques and technologies that were open to non-members. In a sense, the trainings and workshops were seen as a “gateway drug into hacking” (Davies, 2017, p. 53). The current members expected that the trainings and workshops would enlighten those who had little to no knowledge about hackerspaces to want to become part of such an enthusiastic, creative community (Davies, 2017). Although the spaces were interested in expanding, many of the members claimed there were certain people who were not a match to their community, and they were not allowed to join (Davies, 2017). The types of people often deemed inappropriate for membership included those who only wanted to capitalize on the expertise and efforts of existing makers (e.g., those who expected that their membership fee entitled them to use existing makers to perform all of their work to prototype or market an idea), those who appeared lazy or unfriendly, and those who did not fit into the specific culture of the particular makerspace (Davies, 2017). However, many members explained that the direction and ideals of their makerspace could change at any time because they were dependent solely on the passions of those who were participating actively in the space at the moment (Davies, 2017).

Outspoken women in making. In the past few years, several high-profile women techmakers have publicly alleged that men have been outrageously oppressive to women in the world of making. Two of the women at the forefront of these accusations are Liz Henry and

Naomi Wu. These women have received much attention in maker culture through online magazine articles, blogs, wikis, and other forms of social media. Henry is also quoted in scholarly literature.

Henry (2014), co-founder of one of the first feminist hackerspaces in San Francisco, Double Union, promotes her space as a harassment-free, supportive environment for anyone who identifies as non-male to make without “having to worry about jerks” (p. 3). According to Henry (2014), the members support feminist activism, intersectional feminism, and personal boundaries. She is adamant that women are not participating in co-ed hackerspaces because when they do go there, it may be

kind of dirty and cluttered and there’s no toilet paper, and there is some creepy guy who won’t stop talking to you about how he wants to teach you things you already know, while he backs you into a corner. There’s that level of harassment. (p. 5)

Henry (2014) laments that women’s capabilities are undermined because when they do have knowledge in male-dominated fields or areas of expertise, they are classified as inauthentic. Women in these spaces also feel extra pressure to prove themselves. She stated, “The message is there’s this cool culture of invention, making and learning, but we aren’t expected to be a part of it” (Henry, 2014, p. 5).

Henry (2014) has also insisted that the hacker principle of open source often works in favor of White males and against underprivileged females in co-ed makerspaces. She believes men exploit women’s labor in makerspaces and that the sharing culture also spills over into sexual expectations, with male makers expecting women to share their bodies. She stated,

Openness, that’s great, right? Except oddly, openness can mean we get rape and death threats while at the same time, the only thing we can’t be “open” about is publicly

naming a person who raped us. The “adhocracy” form of informal organizing sometimes look to us like the tyranny of structurelessness, where already-strong power structures and dynamics define our field, so already-powerful elites get stronger. (p. 14)

Along with promoting her feminist hackerspace at the expense of co-ed hackerspaces, Henry is a contributor to a public wiki, Timeline of Incidents (n.d.), documenting events she feels are harmful to women in tech culture (Henry, 2014). She and others police the Internet for anything they find offensive, including jokes about grandmothers who are inept with technology and photographs of women in bikinis at tech conferences (Henry, 2014). She believes this documentation helps women see the systemic misogyny clearer. The wiki is kept current and documents incidents from 1963 to 2018.

For this literature review, the researcher ran the search words *makerspace* and *hackerspace* on the Timeline of Incidents (n.d.) wiki to find documentation to support Henry’s serious allegations about the behavior of men in these spaces. Based upon Henry’s claims, one may expect to find a slew of incidents. The search produced three results, but only one alleged possible inappropriate behavior by a male member inside of a makerspace. However, the evidence posted on the wiki was inconclusive as to the nature of the behavior: In March 2013, an entry was made that a member of the Noisebridge hackerspace, Shawn L, was expelled from the space for his alleged former criminal offense record and for bad behavior with 10 members. The entry did not describe the behavior or whether the members were female or male (“Shawn L’s Expulsion from Hackerspaces,” 2013).

As stated previously, the other two entries were not related to sexual harassment inside of a makerspace. The second entry, posted in March 2013, was about Martin Pohlman, co-founder of Portland hackerspace BrainSilo. Pohlman pled guilty to charges that he drugged and raped

two women (Terry, 2013). He met one of the women in a bar and the other at a party (Terry, 2013). There was no evidence that these women were ever associated with his makerspace (Terry, 2013). The researcher also performed a search for customer reviews of Noisebridge and BrainSilo, the makerspaces mentioned in the wiki, expecting to find poor ratings from women based on Henry's allegations. BrainSilo closed in 2015 but Noisebridge received an overall rating of 4.5 from 32 reviewers (Noisebridge, 2018), and most female reviewers were very impressed and satisfied with Noisebridge. For example, in 2011, Lisa Q wrote,

This place is the garden of Eden for creators and it's free. You can come anytime you'd like and build anything you want. It's amazing--- everyone might be quietly working on their own project but they'll be really open to helping you out. We come here often to solder, attend free classes, and toy with their laser cutter and 3D printer. (Lisa Q., 2018, para. 1)

The third entry found on the wiki was a link to a hackerspace discussion thread started by David Powell, an owner of a Baltimore makerspace with 19 male members and one female member (Timeline of Incidents, n.d.). In his post, Powell discussed how difficult it is to keep a makerspace running, urging females who want to increase female membership in co-ed makerspaces to seek out other women and bring them in (Powell, 2013). He included many strong arguments on how to achieve gender equality in co-ed spaces, giving explicit examples of what he considers the welcoming, encouraging, and chivalrous behavior of the male members in his space. He encouraged people of all genders to participate fully and claim the space for themselves. He also suggested women could "host a class about e-textiles or whatever it is females like to talk about" (Powell, 2013, para. 1.). According to Henry (2014), this suggestion, along with others on the thread, was so harmful it culminated in the collective alienation of

Henry's members from the co-ed makerspace community. Subsequently, Henry claimed that all of her members who code express interest in learning to craft and all members who craft would like to learn more technology (Henry, 2014).

Naomi Wu, a Chinese techmaker with over 70,000 followers on Twitter and videos with millions of views on YouTube, has been referred to as a feminist heroine in the media because of the tactics she uses to gain notoriety in the maker community (Gaudette, 2017). In 2016, she wanted to influence the policies of MAKE Magazine after apparently combing through the archives of MAKE magazine to find it had not published a picture of a woman with an exposed midriff in 8 years (Wu, 2016). It is the researcher's opinion this may have been a source of personal distress for Wu because she is often photographed with an exposed midriff.

In 2016, Wu began ranting on social media platform that Dale Dougherty (who is often referred to as the father of the Maker Movement because he is the CEO of MAKE Magazine and producer of Maker Faire) was responsible for policies that are oppressive to women at MAKE Magazine (SexyCyborg, 2016). Because the events are so recent and the researcher could find no articles in the media that did not include out-of-context quotes that aimed to portray Wu as an innocent victim of Dougherty, the researcher felt it was important to include newly uncovered information that may shed new light on the story.

After becoming aware of Wu's accusations, Dougherty reached out to Wu on Twitter, stating that he would like to know more about that problems she was having and that MAKE should be "helpful and supportive" (Dougherty, 2016b, para. 1) of her work. Instead of engaging in a dialogue with Dougherty, Wu accused him of blacklisting her from events because of an article she posted on Pastebin back on October 26, 2016 (Wu, 2017a). In the Pastebin article, she

claimed MAKE Magazine had a policy of not featuring makers who did not follow the “dress code in conservative American school districts” (SexyCyborg, 2016, para. 10).

Although Wu was adamant that Dougherty had already used the Pastebin article to blacklist her, she emailed Dougherty directly to ask him to read it on April 16, 2017 (Dougherty, 2017c). Dougherty replied courteously to her email. He asked Wu privately for evidence of blacklisting, assured her there was no such policy, and promised to take action if he ever found out there was (Dalepd, 2017). He also told her MAKE did not cater to conservative American school values and, in fact, he felt MAKE and Maker Faires actually challenged them (Dalepd, 2017). He further assured Wu that he wanted to help her, that he wanted to learn more about what she was doing, and that he would love to show more women in the magazine who are assertive and innovative (Dalepd, 2017; Dougherty, 2017b). He concluded by asking if she would pen an article as a guest editor and by telling her he would like to do something online immediately and plan a future section for the magazine (Dalepd, 2017).

Wu then began to claim Dougherty was a Donald Trump supporter (Wu, 2017b), and she continued to accuse Dougherty of having her blacklisted (Wu, 2017c), to which Dougherty responded “Not true. How to refute your many falsehoods that build on your previous lies?” (Dougherty, 2017a, para. 1). On the same day, Wu also tweeted, “I want my kids to grow up in this magical White lady fantasy land where they can delude themselves that everyone has the same opportunities” (Wu, 2017d, para. 1). On May 26, 2017, Wu alleged that Dougherty’s only reply to her email was to thank her for writing to him (Wu, 2017e), to which Dougherty’s response was to post his actual reply on Pastebin in its entirety for anyone to see (Dalepd, 2017).

According to Dougherty, he started to question Wu’s identity because there were sources in Shenzhen telling him she was a front for others in the making community there (Cho, 2017).

There was also an anonymous Reddit blog that made strong claims supporting this argument (R/Skeptic, 2018). On November 3, 2017, Wu (2017f) tweeted a message indicating, once again, that Dougherty was a Donald Trump supporter because he had co-written an article suggesting ideas for President Trump's administration. On November 4, 2017, Dougherty replied by posting the actual article, in which he simply promotes the Maker Movement by suggesting that the new administration look at makers when thinking of ways to revitalize manufacturing in America (Dougherty, 2017c).

On November 5, 2017, Dougherty tweeted (since deleted), "I am questioning who she really is. Naomi is a persona, not a real person. She is several or many people" (Cho, 2017, para. 1), and in reaction to one of Wu's supporters who suggested that Tim O'Reilly, CEO of O'Reilly Media and owner of MAKE Magazine and Maker Faire, oust Dougherty from the magazine, Wu tweeted, "Nothing will happen. Old white men like @timoreilly don't hold men like Dale accountable for what they do to yellow women in the 2nd world" (Wu, 2017g, para. 1).

On November 17, 2017, Dougherty apologized for questioning Wu's identity, and he promised to make the situation better for her (Dougherty, 2017). He made good on his promises, and Wu was featured on the cover of the January/February 2018 issue of MAKE Magazine. Later, he stated that he had been intending to question Wu's false accusations and attacks more than her identity, but it came out wrong. Dougherty (as cited in Cho, 2017) said,

I wanted to be supportive and helpful, but she continued to find ways to say that she was excluded. When we offered to help on those things, she didn't want that help. I was very frustrated and never seemed to get anything back except hostility. (p. 9)

Although Wu and Henry use different tactics to promote themselves, it is the opinion of the researcher their narratives regarding the culture of making share a common contemporary

feminist theme: perceived male oppression of females. Conservative feminists do not follow contemporary feminist's propensity for blaming social institutions instead of human shortcomings as the "root of all evil" (Kersten, 1991, p. 13). It is the opinion of the researcher that conservative feminists would argue that Henry is making a mistake by classifying so many behaviors and comments as sexual harassment that are, at most, politically incorrect. Additionally, Henry may be doing more harm than good by publicly and repeatedly claiming that harassment in co-ed makerspaces is widespread and out of control. The lack of evidence to support her claims on the Timeline of Incidents (n.d.) bolsters this argument.

Wu appears to believe women are entitled to more exposure from MAKE (SexyCyborg, 2016); however, the conservative feminist advocates for policies that reward merit, and "sees little value in mere diversity of gender" (Kersten, 1991, p. 11). Wu is the first to admit she has "middle school level DIY/shop skills" (Gaudette, 2017, p. 6); therefore, conservative feminists may question the decision to feature her on the cover of MAKE. Furthermore, it is the opinion of the researcher that conservative feminists would question Wu's strategy of spewing racist, and ageist comments toward White Americans (Wu 2017d; Wu, 2017g) while at the same time trying to appeal to a White American (i.e., Dougherty) to help her. Conservative feminists stand firmly against letting other feminists who do not feel gratitude toward the American political and social systems make claim to moral authority or the feminist agenda (Kersten, 1991).

Progressive reform to redesign perceived discriminatory practices should not involve the demonization of men because that strategy is unnecessary and often counterproductive (Paglia, 2017). Paglia (2016) condemns what she considers modern feminism for this overarching theme of male-bashing.

It's an absolute poison that has spread worldwide. A feminism based on denigrating men — trivializing what men have done, defining men as oppressors and tyrants through history — okay? It is an absolute lie. There have been crimes against women. Where they have occurred, we must condemn them, all right? But men throughout history have given their lives, okay, and their labor for the support of women and children. This is an element of second-wave feminism that, to me, is an extrapolation of neuroticism on the part of these fanatics, okay, who have been attracted to this movement. (1:23)

The tactics used by Wu and Henry have possibly helped them boost their own statuses in the American maker community but questions remain for the researcher: Do the ends justify the means? Do these types of radical feminist tactics really work to bring men onboard to help reconstruct social processes that may be unfair to women? Or, do they simply ensure that men run away in fear when they think they may be called upon to support feminist causes? In the case of Wu, Dougherty regrets questioning her identity (Dougherty, 2017d), but the researcher cannot help but wonder if he now regrets responding to her in the first place. If so, the researcher wonders what are the implications for women who reach out to him and other influential men following this story and others like it in the future?

When the media or feminist scholars seek stories about gender politics in the tech world, it appears to the researcher they usually seek out women such as Wu and Henry. However, there are other women in making who do not feel oppression is an issue (Bean et al. 2015; Davies, 2017; Hollingsworth, 2017; Maric, 2018). For example, another high-profile Shenzhen female maker, Guan Chunlin, aka Dolphin, believes male makers have been unfairly demonized (Hollingsworth, 2017). She believes female underrepresentation in the tech industry has more to do with the freedoms women and men have to choose what interests them (Hollingsworth, 2017).

In her experience, women are more attracted to the fashion element of making, as opposed to robotics type projects (Hollingsworth, 2017).

Safer spaces. Feminist makerspaces cater to women, non-binary, trans, and femme-identifying people who identify as feminists (Reed, 2018). Feminist makerspaces are places where people of similar backgrounds and interests can network and work on projects they find meaningful, with the ultimate goal being achieving equality with their White male counterparts (Reed, 2018). According to Reed (2018), feminist makerspaces also lessen the barriers to entry into STEM because they are places that help to build confidence in making in an otherwise male-dominated space. Toupin (n.d.) argued that feminist spaces provide safe havens for women and people of color to hack and socialize away from oppressive White “dudecore” (p. 3) culture, while at the same time creating a separate form of hacking with feminist-queer emphasis, one that she calls “feminist hacktivism” (p. 5).

Fox (2015) argued that safe spaces support women and other marginalized populations by giving them a place to explore technology without being subjected to abuse. Fox designs and facilitates workshops in these spaces, and asserted the workshop design agenda “could extend members’ personal and collective concerns, recognizing their organization of space as a productive act, enacting particular values and ideas in relation to a broader technology cultures” (p. 342). Fox’s workshops and values appear to be in alignment with the typical leftist feminist college classroom.

The feminist classroom is the place to use what we know as women to appropriate and transform, totally, a domain which has been men’s ... Let us welcome the intrusion/infusion of emotionality- love, rage, anxiety, eroticism - into intellect as a step

toward healing the fragmentation capitalism and patriarchy have demanded from us.

(Cully, Diamond, Edwards, Lennox & Portuges, as cited in Sommers, 1995, p. 87)

In one of Fox's (2015) workshops, members and guests were asked to redesign tools they found problematic. The members and guests were expected to spend a week prior to the workshop taking pictures of spaces and tools for which they would want to produce low-fidelity design proposals. One of the problematic tools the members and guests decided to re-imagine was "dick pics" on Tinder (p. 342). Fox (2015) argued that these workshops are transformational because through reciprocal action, feminism and design can change each other. On the surface, this type of workshop may appear to be empowering; however, the conservative feminist argument suggests that these types of workshops or classes may actually be counterproductive to achieving the goal of lessening the barriers to STEM and achieving equality with men because they isolate and corner women into a world in which they are hanging around being safe and honoring feelings while males are busy studying "vertical" (Sommers, 1995, p. 91) subjects such as engineering (Sommers, 1995). They also are marginal at best in their ability to prepare women for the real world of culture and work, as safe spaces are inherently intolerant to opposing ideas (Sommers, 1995).

Terry Norbrock, a female maker and board member from a makerspace in Tucson, Arizona, appears to agree with Toupin and Fox (Reed, 2018). Norbrock hosts a WTF Night (i.e., Women, Trans, Femme) for trans, women, and femme-identifying people to work without the distraction of male members offering "demeaning" help (Reed, 2018, p. 3). Devi Peacock, executive director of a collective that houses Liberating Ourselves Locally, a makerspace for queer and trans people of color, also appears to agree with Toupin. Peacock (as cited in Reed, 2018) stated, "What we're thinking about is what it's like to actually thrive, and how to dream

and prototype trans liberation, and how to practice that, and what is it like to 3D model that” (p. 5). Trans and queer people also use Peacock’s space to create signs with LED lights for night protests and learn to design social justice video games (Reed, 2018).

Although sharing and helping are integral parts of the fabric of the makerspace community, a common theme found in the feminist literature regarding makerspaces is that male members offend female makers when they offer unsolicited help (Henry, 2014; Reed, 2018) . This unsolicited help is perceived as demeaning, oppressive, and exclusionary (Henry, 2014; Reed, 2018). It is also sometimes perceived as threatening and harassing (Henry, 2014; Intel, 2014). The researcher could find very little literature written from a male perspective on this issue other than the discussion post mentioned in the last section by Powell (2013), in which he claims male members in his makerspace simply go out of their way to help female members in order to make them feel more welcome. The personal attacks Powell received on the thread from angry feminists for expressing his opinion were hateful and numerous (Powell, 2013). Powell was also vilified and mocked on the Timeline of Incidents (n.d.), and he and his comments continued to be a target for anti-male feminist propaganda and rhetoric by Henry during multiple interviews regarding gender disparity in makerspaces (Davies, 2017; Henry, 2014).

After witnessing what happened to Powell, it may be difficult for some to understand why any male-identifying person would want to put their neck on the chopping block by offering to help women, trans, or femme-identifying members in co-ed spaces. Nevertheless, it is the opinion of the researcher that if male members of co-ed spaces really do put themselves out there to help as much as has been suggested, it would seem a good opportunity for makers such as Peacock to engage them with their projects and possibly recruit them into helping with their social justice campaigns. Feminist makers say they believe diversity is important in the tech

scene (Reed, 2018); however, it is the opinion of the researcher their own discriminatory actions appear to contradict that assertion, as their spaces welcome and value input from all but those identifying as White, heterosexual males.

Another common theme in the feminist literature regarding safe spaces for making is fear of technology (Reed, 2018). According to Norbrock (as cited in Reed, 2018), there are “unspoken rules that assign gender to the use of tools or the ability to make and design things” (p. 3); however, what the researcher finds problematic is that when males respond to these unspoken rules with offers of support, feminists vehemently reject their help, often classifying it as harassment, and run to other gender feminists for support in safe spaces. Women need to be more honest about the contributions and critical value of men (Paglia, 2017). There is a lot to gain from partnering with men, as men have done great things in science and technology, and they have actually made feminism possible (Paglia, 2017). The researcher questions the fairness of attributing the need for safe spaces to male barbarism.

The future of making and makerspaces. Dale Dougherty (as cited in Corcoran, 2015), believes that as generations of makers grow older and more skilled, they will be able to make important changes in the world in order to make things better for other people because the maker culture’s core values are kindness, generosity, and problem-solving. Although makerspaces are popping up in schools and libraries across the country, Dougherty worries that making a formal curriculum around it may “kill the magic” (as cited in Corcoran, 2015, p. 5) because he believes making should come from the heart and not be forced upon people by an institution. He also believes those involved in Maker Movement have a moral obligation to insist on a sense of freedom (Corcoran, 2015). Once, on the way to a meeting at the Department of Education in Washington, DC, a man told Dougherty he wanted to know if there was a project all American

seventh graders could accomplish, and Dougherty instinctively told him there wasn't (Corcoran, 2015). He later regretted not telling him all the students should have their own project (Corcoran, 2015).

Although he is fearful about the possibility of the standardization of making in schools, Dougherty is hopeful that the lasting impact of making may turn out to be the transformation of education from a top-down system to a grassroots one, in which students are in charge of their own learning and standardized curriculum and testing is replaced by experiential learning (Corcoran, 2015). When asked if money were no object what Dougherty's perfect makerspace would look like, he stated,

It would look like a village where you had all kinds of people who knew how to make all kinds of things, and you could spend time learning from them, having them show you how they use their tools or work with materials. Some would be scientists and engineers; architects and designers; artists and craftsmen. I'd also have people who knit and weld, those who love model trains or Legos. I'd like to see all those people with their own interests and personalities working on their own and working together. What makes a makerspace awesome are the people who know how to do things and love what they do. The more of them the merrier. (Corcoran, 2015, p. 2)

Attraction to Making

Demographics of makers. In 2014, Intel conducted surveys in the U.S., China, and Mexico to gather information on demographics and experiences of makers, surveying 963 makers in total. In the United States, there were 106 female and 241 male participants. According to the study, the median age of adult female makers in China, the United States, and Mexico is 28. In the U.S., male makers, on average, are 9 years older than female makers. In all

countries, the majority (63%) of female makers have been making for less than 2 years, whereas the majority of males (56%) have been making for 4 years or more, with most of the difference in experience coming from the United States (Intel, 2014). In Mexico and China, both males and females are relatively new to making. Men were shown to be significantly more likely than women to become makers through physical science and engineering backgrounds (Intel, 2014). American female makers were more likely to have engineering or information and computer science degrees than other degrees, but they typically come to making through the arts (Intel, 2014). In other words, American women primarily use technology for making in the arts and identify more strongly than men with the terms such as *designer*, *artist*, and *creator* (i.e., arts, jewelry, and textiles dominate female making) (Intel, 2014). The results help to support the Su et al. (2009) study's findings, which showed women were more interested in artistic pursuits than men. Interestingly, there was a marginal difference in how Chinese male and female makers identified themselves in the Intel/Harris study (Intel, 2014).

Motivation. First and foremost, makers are intrinsically highly motivated to live actively (Davies, 2017). Secondly, to be a maker, one must crave making, as makers are not content to live lives of passive consumption (Davies, 2017). Davies (2017) also suggested that the resurgence of DIY and making can be understood as individuals trying to regain control of their lives in a world in which elites make decisions about what is stylish and important. Because of this desire for control, most makers would be profoundly unhappy coming home after a mundane job and lying on the couch watching mindless television shows every night after work (Davies, 2017). Simply put, although many in the Maker Movement suggest making is for everyone, a prerequisite to participation is the choice to live an active, doer lifestyle, and this is choice not everyone will select if given the opportunity because many people prefer living a passive

consumerist lifestyle (Davies, 2017). Makers also derive much pleasure from working with their hands and problem-solving (Davies, 2017).

The Intel (2014) study collected information on the motivation of 963 adult makers from the United States, China, and Mexico. Most makers were inclined toward entrepreneurship, but they found female makers in the U.S. to be 31% more likely than males to make in order to give to others or to help others (Intel, 2014). In fact, helping or giving is the number one reason women in the survey gave for making (Intel, 2014). For example, female makers enjoy making gifts for family and friends and enjoy teaching others to make (Intel, 2014). In their study of computer science majors, Fisher and Margolis (2003) also found that 44% of women wanted to use computer science to help others (e.g., to solve medical problems), whereas nine percent of male students felt the need for “computing with a purpose” (p. 53), i.e., men were more inclined to feel that coding itself was rewarding enough. Additionally, males found intrinsic reward in simply playing around with computers (Fisher & Margolis, 2003).

Women across all countries also enjoy the collaborative aspect of making more than males and are more likely to take part and connect with others in maker events and clubs (Intel, 2014). The majority of female makers make with others, and females were eight percent less likely than males to make by themselves, which was considered a significant difference (Intel, 2014). This corroborates the results of the 2009, Su et al. (2009) meta-analysis that showed large sex differences in interest areas, with women preferring to work with people.

In 2015, Bean et al. conducted focus groups with eight women who participated in a Midwestern co-ed community makerspace to investigate attraction and barriers to making. Although the study was not conducted on women techmakers specifically, all members had been attending weekly meetings at the makerspace, six were dues-paying members, and two were

thinking of becoming members. The women identified their main attraction points as networking, showcasing products, tools and workspaces, encouragement and motivation to finish projects, and mentoring (Bean et al., 2015). The majority also noted that they valued the makerspace as a place to get away from personal responsibilities and focus on creativity. Contrary to women who fled co-ed makerspaces for feminist makerspaces, the women in the Bean et al. (2015) study were satisfied with their experiences at the makerspace, viewing it as a positive resource. They were hopeful that the organization would grow in participation and provide more opportunities for members to sell their products and services to the community (Bean et al., 2015).

Young people and making. The Intel (2014) youth study revealed that seven out of 10 young people would like to learn to techmake, and that techmaking is as popular among girls as it is among boys. Girls primarily used techmaking to add movement and sound to objects and to make jewelry or clothing that light up (Intel, 2014). Girls and boys participate in making in the same places (e.g., at home, in clubs, and at school), and they have the same motivations for making, but girls were more likely to consider themselves artistic, caring, and creative, and significantly more likely to enjoy making art projects to show to friends and family (Intel, 2014). Although girls and boys are equally likely to make in clubs outside of school, 20% of girls compared to 12% of boys participated in making in groups and clubs at school, which is a significant difference according to the study (Intel, 2014). The top reasons girls and boys gave for making were for the inherent joy of learning and for the pleasure they found in making (Intel, 2014). Both male and female youth were more likely than peers who did not make to describe themselves as hardworking, sociable, and problem-solvers (Intel, 2014). However, girls were more likely to describe themselves as persistent (Intel, 2014).

From 1995-1999, Fisher and Margolis (2003) conducted more than 200 interviews with 100 computer science students at Carnegie Mellon School of Computer Science, a school that is consistently ranked as one of the top in the world. They found about 75% of their male students felt an instant passion for computers, a “magnetic attraction” (Fisher & Margolis, 2003, p. 16), the moment they were introduced, and became consumed with them throughout childhood. “It is as if they fell in love at first sight, and from then on they knew that this would be something they would spend the rest of their lives doing” (p. 16). Only 25% of their female students felt that level of attraction to computers at a very young age, and many of the female students in the study did not become deeply involved in computers until high school. Additionally, it was male students who gravitated toward taking the computers apart and tinkering with them to learn the inside as well as the outside, whereas the female students were content to work mainly from the outside (Fisher & Margolis, 2003).

Barriers and Challenges

According to the literature, a common barrier to female entry into computer science related fields is the socialization process that occurs during childhood (Fisher & Margolis, 2003; Su et al., 2009). In the Fisher and Margolis (2003) study, computer science students often spoke of having mothers who were computer-challenged. Fisher and Margolis (2003) asserted that daughters may not be exploring or tinkering with computers because they identify with their mothers and believe that they too must be somehow deficient when it comes to the ability to learn to compute. Children often identify the computer itself as a male object because of their observations that the father is typically in control of buying the hardware and software, and he is in charge of who uses the computer at home (Fisher & Margolis, 2003). Parents also tended to engage their sons more than daughters with hands-on explorations of computers at home (Fisher

& Margolis, 2003). The belief that the computer is gendered as male is further reinforced by parents who assert that their sons, as opposed to their daughters, are the ones inclined for computer careers, and who often brag about what they perceive as their sons' superiority with computing (Fisher & Margolis, 2003). Parents often fail to recognize their daughters' interest in computers because girls often have many other interests outside of computing (Fisher & Margolis, 2003). Parents also commonly put the family computer in their sons' rooms even when their daughters also express a strong interest in computing (Fisher & Margolis, 2003). These phenomena and practices can lead to girls becoming less and less interested in computers (Fisher & Margolis, 2003). Interests stabilize very early in life, so removing these types of parental barriers during formative years may be essential, if not the only way, to increasing girls' interest in STEM-related fields (Su et al., 2009).

According to Fisher and Margolis (2003), another barrier many females must overcome in computer science-related fields is the feeling that they are alone in a daunting struggle to catch up to males who have superior knowledge and networks. Many more boys than girls enter secondary classrooms with extensive formal and informal education about computer science (Fisher & Margolis, 2003). "At the heart of this phenomenon is the 'magnetic attraction' that motivates many boys to engage in intense self-guided exploration" (Fisher & Margolis, 2003, p. 40). The boys also typically have networks of male friends to whom they can turn in order to gain even more knowledge. This "experience gap" (p. 69) can be especially intimidating to females, ultimately causing many to believe they may lack ability in the field of computer science. Exacerbating this problem is the fact that the story of the computer science genius who forgoes college as waste of time and goes on to become a mogul in the tech industry is an almost exclusively male narrative (Fisher & Margolis, 2003).

The female college students in the Fisher and Margolis (2003) study also admitted that they were worried about entering the computer sciences as a profession because they did not want to sacrifice their other interests in order to compete with men in the field. They believed the men in their program did not fear sacrifice because many were so into computing that they were completely willing to devote every moment to computer science pursuits. As one female student stated, “I’m just not like that at all; I don’t dream in code like they do” (p. 69). “Scary” (Fisher & Margolis, p. 71) and “afraid” (p. 71) were terms the female students used again and again when talking about majoring in computer science because of the sacrifices they deemed essential to be successful in the field. Louise, a second-year computer science student, stated,

I’m not going to sacrifice my life for it. But I think that there are quite a few guys that do. Their whole life is pretty much centered around their classes and programming and programming outside of class, and I just don’t think women do that for anything, at least not that I’ve seen. That’s very rare... You see all the guys who are like, “Wow, this is my life.” You see their drive. You think you can’t compete with this. You can, it’s just that some people aren’t willing to and become uncomfortable with all that. (p. 70)

It is not only females who experience feelings of insecurity when they find they are in the company of highly driven experts in these spaces (Davies, 2017). As cited in Davies (2017), a former president of a student-run hackerspace, articulated the feeling,

Sometimes people just come in and see people-they’re new; they don’t know anyone. They’ve come to this space that they’ve been told is awesome and see all these kind of like older people working on projects they couldn’t dream up. Like, hmm. And they just stand there and don’t talk to anyone and everyone is working on projects and doesn’t notice they’re there. And they’re like, oh, god, I should leave and they leave. (p. 97)

Feelings of not being good enough or of not belonging can also be felt by all genders while working in group projects alongside experts in makerspaces because the less experienced sometimes find they must step back and let those with more knowledge take over (Davies, 2017).

The Intel (2014) results problematized gender in making and used analogies from the field of computer science. Although the study reported that men and women primarily faced similar challenges to making—such as lack of money for tools, lack of mentorship, and lack of information—women were more likely to identify lack of mentorship as a barrier. The Intel (2014) study did not report whether the women makers actually pursued and were rejected by mentors, but it did imply that lack of mentorship for females in computer science, coupled with the perception that it is a field for men, may have crossover implications as to why there is a gender gap in making. Women also identified cultural biases and safety as additional barriers to making (Intel, 2014). More specifically, there were 106 female techmakers surveyed, and one in six women reported being excluded due to being a woman, with the exact same fraction reporting living in a culture that views making as inappropriate for females. Additionally, one in 14 women reported that they did not “feel safe going to maker activities” (p. 42). For example, a coordinator for after-school youth programs explained that Latino parents are a challenge because they expect their female children who are under 15 to come home after school because of safety concerns and to help take care of the house.

It was unclear which variables contributed to females not feeling safe in the Intel (2014) study because the statistic was not broken down based on concerns. For example, it is unclear to the researcher whether the participants were concerned about safety with machines in the makerspaces, safety traveling to or from maker events, or safety with male members. Regardless, the study implied that male behavior was a primary safety concern. It reported that unfriendly

atmospheres and harassment from male members may discourage women from participating in co-ed makerspaces. The study claims that gender stereotyping is not conducive to promoting female participation in STEM-related fields and that there is a lack of mentoring, but the study also included Henry explaining what a female should expect from a male at a co-ed makerspace:

You might be there coding, and you want to stop for a while and draw in your notebook and think, but if you're not staring at black and green screen or, like, melding your brain with an Arduino every second, some dude is going to come up to you and act like you need his expert lessons in how to hack. (Intel, 2014, p. 44).

Bean et al. (2015) asked the eight active female makers in their study of a co-ed Midwestern makerspace to identify barriers women face to engagement and participation in makerspaces. The women did not blame oppression for the barriers they identified. In fact, the highest endorsed theme was that there were no gender differences in the barriers. Personal shortcomings were the main themes that emerged: the women expressed personal fears such as fear of the unknown, fear about putting themselves first, fear of critique or failure, and fear of gender imbalance (Bean et al., 2015). They also expressed concerns about lack of time due to family obligations and the makerspace environment being disorganized, noisy, and dusty (Bean et al., 2015). The conservative feminist may argue that the women in this study were successful because they applied conservative feminist values, such as resisting the temptation to place blame for consequences of personally inhibiting choices or feelings on oppression (Kersten, 1991).

Strategies and Supports

In 2009, Powell, Bagilhole, and Dainty used apparently random theoretical arguments to investigate how gender “gets done and undone” (p. 411) in engineering organizations. Somehow,

they concluded that their study of women engineering students' first experiences in male-dominated engineering workplaces confirmed that women's behavior "in many ways contributes to maintaining an environment that is hostile to women" (Powell et al, 2009, p. 411). However, the headings used in the article appeared to contradict the content; the results under the heading, "Acting like one of the boys" (Powell et al., 2009, p. 418), were interpreted that the women rejected their femininity as a result of attempting to fit in by socializing and bantering with the men and demonstrating they did not need any special treatment. One engineering environmental technology student proclaimed, "I give as good as I get. So it's equal. And you have a laugh. If you give them respect, they'll give you respect back" (Powell et al., p. 418). Under the heading, "Accepting gender discrimination" (Powell et al., 2009, p. 418). the women were accused of accepting discrimination, but the women did not identify any discrimination worthy of personal outrage in the environment. In fact, one student admitted that she did not deserve a bonus compared to a male student because he was exceptional at his job. Under the heading, "Achieving a reputation" (Powell et al., 2009, p. 419), the research showed that women thought it was important to demonstrate they were capable engineers in order to overcome potential discriminatory barriers. A mechanical engineering student stated, "Once I'd proved that I was there to just get on with it, I think that kind of barrier just went" (Powell et al., 2009, p. 419). Under the heading, "Gender conflict" (Powell et al., 2009, p. 421), the researchers implied there was conflict when the results indicated female students thought only positively of their experiences with male superiors in the classroom and workplace. They believed women were more likely than men to ask for help, and they more likely to receive help and cooperation from male engineers in the engineering classroom and places of work. Under the heading, "Adopting an 'anti-woman' approach (Powell et al., 2009, p. 420), the researchers concluded that the

women were turning on their own sex by stating that they enjoyed their status as an unusual presence in the engineering field and because some stated that they did not appreciate women who used crying to gain advantages. Under “Advantages over disadvantages” (Powell et al., 2009, p. 420), the results showed that the women believed themselves to be more employable than men as a result of their sex.

Powell et al. (2009) implied that the women in the study were not strong, independent, critical thinkers using powerful strategies for success in engineering, but rather weak victims demonstrating coping strategies in dealing with their oppressive environments. The coping strategies, they argued, ranged from denial and delusion to “Queen Bee Syndrome” (p. 420), a phenomenon in which females who have succeeded refuse to help other females in their pursuits of success. Powell et al. (2009) also accused the participants of undoing their gender by failing to challenge the male-dominated culture and structures which may have provided solutions to solve the anti-woman problem in engineering. After a researcher reporting on the gender-based digital divide in France was told by a female participant that she thought women were not at all excluded from techmaking and that the lack of female techmakers was due to relative lack of interest of females in STEM, the researcher also implied that the participant may be suffering from Queen Bee Syndrome (Maric, 2018).

Female college students should be focused on learning to achieve in a world that demands talents and abilities (Sommers, 1995). In the opinion of the researcher, had the Powell et al. (2009) study been filtered through a conservative feminist lens, the strategies and supports used by the women may have been championed because of their ability to mitigate potential tensions in the workplace. Harm can be done to female students when they are made to believe

the environments they enjoy and succeed in are actually institutions and cultures of oppression (Sommers, 1995).

The Fisher and Margolis (2003) study found that female computer science majors who surrounded themselves with positive people were more likely to succeed. They also found that a key moment of success, such as passing a difficult course, was often a key to persistence in the field. Both the Fisher and Margolis (2003) and the Intel (2014) studies call for more affirmative action initiatives to increase female representation in making. Abir-Am (2010) claimed that affirmative action programs and interventions have not been effective in increasing women's representation in STEM because they removed overt barriers to entry into STEM fields but not covert barriers, such as female tokenism in academia, which are more difficult to identify. In contrast to claims made by Abir-Am (2010) and Intel (2014), Kugler, Tinsley, and Ukhaneva (2017) found little evidence that female university faculty members in STEM are important to female students. Lack of previous preparation in male-dominated STEM fields was also not a factor in women's decisions switch out of these majors (Kugler, Tinsley, & Ukhaneva, 2017). They found that women were more likely than men to switch out of male-dominated STEM majors only when they were achieving low grades, when there was a majority of males in their classes, and because the STEM field itself was associated with masculinity (Kugler, Tinsley, & Ukhaneva, 2017). Men, in contrast, felt they had more ability to succeed in these fields than women, even when their grades were low (Kugler, Tinsley, & Ukhaneva, 2017). This suggests current efforts and policies that aim to increase women in male-dominated STEM fields may actually be backfiring by strengthening the association of male-dominated STEM majors with masculinity (Kugler, Tinsley, & Ukhaneva, 2017).

Stoet and Geary (2018) called for a new perspective on ideas for increasing STEM participation among women based upon what they identified as the “educational-gender-equality paradox” (p. 581); countries that give girls more opportunity and empowerment and promote women’s engagement in STEM have relatively fewer women among STEM graduates than countries with less gender equality. In fact, countries that were the least gender-equal had the most women graduates in these fields (Stoet & Geary, 2018). Also supporting their call for new thought regarding women and STEM, Stoet and Geary (2018) found that science literacy gaps become larger between the sexes in more gender-equal countries, as well as boys expressing higher self-efficacy and more enjoyment in science in those countries than girls.

Chapter 3: Methodology

This chapter commences by reviewing the purpose of this phenomenological study and the research questions it sought to answer. Following the purpose and questions are descriptions of the methodology and rationale; setting; and population, sample, and sampling procedures. The chapter also includes human subject protections, validation strategies and interview instrumentation, and data collection and data analysis procedures.

Study Purpose

The purpose of this qualitative, phenomenological study was to investigate the experiences and perspectives of female members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. The researcher selected six U.S. women techmakers to interview and explore their lived experiences of how they thrive in a predominantly male subculture within the makerspace community.

Research Questions

Through this study of female techmakers who have persisted in co-ed community makerspaces for over 1 year, the researcher sought to understand:

1. What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces?
2. What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them?

3. What supports, if any, have long term active female techmakers accessed/received to persist in co-ed community makerspaces?

Research Methodology and Rationale

The study used a qualitative existential phenomenological research design. The researcher used a semi-structured interview process to interview six U.S. women techmakers who are active, long-term members of co-ed community makerspaces. The questions were designed to explore the perceptions and lived experiences of these women techmakers. The researcher asked three primary questions to explore experiences related to the independent variables in this study: attraction to techmaking in co-ed makerspace, barriers to techmaking in co-ed makerspaces, and strategies and supports utilized to persist in techmaking in co-ed makerspaces. Interviews were conducted one-on-one in an in person or virtual format using the Zoom platform.

This study fit Creswell and Poth's (2018) definition of a phenomenological study; it "describe[d] the common meaning of experiences of a phenomenon (or topic or concept) for several individuals. In this type of qualitative study, the researcher reduces the experiences to a central meaning or the 'essence' of the experience" (p. 314). Phenomenology is important in feminist research because feminist scholars believe women's lived experiences are core to addressing perceived social injustices, as well as to understanding feminism itself (Garko, 1999).

Existential phenomenology is especially well-suited to feminist research for a number of reasons (Garko, 1999). First, it aligns with values and principles espoused by feminist researchers: descriptiveness, openness, and understanding of lived experiences. According to Garko (1999), feminist scholars believe women's voices and experiences tend to be hidden by scientific reductionist methods that attempt to operationally define human experiences. Human

experiences should be relayed in the descriptive, open language of those who have had the experiences (Garko, 1999). Secondly, existential phenomenology complements the feminist value of consciousness-raising because the existential-phenomenological perspective is that humans are connected to existence through consciousness, and consciousness is how “humans relate to and intentionally give meaning to phenomena” (Garko, 1999, p. 170). Thirdly, existential phenomenology is compatible with the notion that the participants in a research study and the researcher cannot and should not be separated (Garko, 1999). In existential phenomenological studies, participants are considered *co-researchers* because they are the true experts on their own experiences, and nothing can be considered objective reality. “Existential truth and meaning are gained through the intersubjectivity of the subject and object and the relationship between the subject and object is a dialectical and dialogical relationship” (Garko, 1999, p. 171). However, the researcher must still bracket his/her own assumptions because “failing to suspend one’s taken-for-granted presuppositions represents the existential kiss of death in researching lived experiences” (Garko, 1999, p. 171).

Setting

This study focused on female U.S. techmakers who have been active techmakers in co-ed community makerspaces for over 1 year. The study locations were determined at the participants’ convenience. Face-to-face interviews were conducted in the participants’ makerspaces or through the virtual platform, Zoom. No recordings were made on the Zoom platform.

Population, Sample, and Sampling Procedures

The target population for this study was U.S. women techmakers who met the criterion of long-term active participation in techmaking in co-ed community makerspaces. The criteria for

inclusion in the study were: (a) participants must be adult female U.S techmakers and long-term members of co-ed community makerspace; (b) partially modeled after the Intel (2014) study, the female techmakers needed to have been a member of a co-ed community makerspace for more than 1 year, and they must have used one of these tools within a co-ed community makerspace within the past 6 months: microcontroller, laser cutter, computer numerical control (CNC) machine, computer development board, open source robotics, 3D manufacturing tools, or a 3D printer; and (c) participants must also be actively pursuing tech making projects. The exclusion criterion included females who do not possess any one or more of the inclusion criteria. The researcher used online discussion boards and social media platforms to recruit subjects, as well as snowball sampling.

Participant numbers have varied tremendously in phenomenological studies, ranging from three to 325 participants (Polkinghorne, 1989). The aim is to interview enough individuals who have experienced the phenomenon to give a “full range of variation in the set of descriptions” (Polkinghorne, 1989, p. 48). Current literature on female makers in co-ed spaces has been used as a guideline in the selection of six or more participants, which is the amount directly in between the number of participants in the Bean et al. (2015) and Maric (2018) studies. In their study of women makers in co-ed spaces, Bean et al. (2015) were able to recruit eight female makers; however, it was unclear how many were techmakers. Maric (2018) attempted to recruit many diverse perspectives in the study of the gender-based digital divide in co-ed spaces in France; however, Maric was only able to recruit four female techmakers. The researcher aimed to recruit six or more participants in order to obtain the “richly varied descriptions” (Polkinghorne, 1989, p. 48) required for a successful phenomenological study. Additionally, the researcher selected the first six qualified applicants for the study because existential

phenomenology does not use the positivistic criterion of selecting an appropriate number of randomly selected subjects in order to generalize findings (Garko, 1999). “The only generalization allowed by phenomenology is this: ‘Never generalize!’” (Van Manen, as cited in Garko, 1999, p. 172). In the event that more than six participants were recruited through snowball sampling, the additional participants would have been respectfully thanked for their interest and told they may be contacted in the event that one or more of the study participants withdraws or interviews do not produce enough description.

Human Subject Protections

There was minimal risk to the human subjects involved because the intent of the study was to examine successful practice and because informed consent procedures were followed. Approval was sought through the Pepperdine’s Institutional Review Board (IRB). This approval better ensured human subject protection. In addition, ethical criteria were met; risks were reduced and fair procedures were followed. Participation was confidential and voluntary. Participants were informed of their roles and were emailed consent to participate forms (see Appendix A). The forms explained the participants’ roles, the potential importance of the study, and the participants’ rights (e.g., the right to ask to see the results of the study and to refuse participation). The researcher took great care to minimize interruptions at the site and to report findings honestly and accurately.

The risks for participants included distress about barriers and challenges in techmaking and in the makerspace, and possible discomfort engaging in an approximately 60-minute interview. The researcher took precautions to minimize potential risks to participants by ensuring confidentiality, asking permission to record the interview, conducting the interview in a professional manner, observing the approximately 60-minute interview time frame,

communicating that the participant could opt out of the interview at any time and/or not answer all questions, and pausing the interview and then resuming should the participant become tired or uncomfortable. The researcher used pseudonyms to protect the participants' identity. A master list of participants' names with corresponding pseudonyms will be kept separate from data in a locked file cabinet for 3 years to further protect participants. The researcher assured participants that the decision to participate would not affect their membership in their makerspace. Potential benefits to current and future female techmakers were explained (i.e., the potential for removal of barriers to female participation in co-ed community makerspaces).

Design Validity

Creswell and Poth (2018) recommended that qualitative researchers use at least two accepted validation strategies, but they also believe there is no one validation strategy aligned specifically for phenomenological studies. Additionally, researchers need to feel comfortable with their chosen avenues for validation. To increase credibility and confirmability, the researcher provided copies of interview transcripts to the participants in case they wished to read them. The researcher used participant feedback to verify that participants' accounts were reflected accurately. After discussing transcripts, the researcher updated the data analysis to include important and/or missing information provided by the participants. The researcher used an external consultant not related to the study to confirm that findings and conclusions were supported by the data.

Instrumentation

The interview instrument for this study consisted of six demographic questions, three primary questions that were asked to all participants, and 10 follow-up questions asked as-needed to explore the women techmakers' experiences, insights, strategies, and

recommendations (see Appendix B). The interview began with a scripted overview of the study. Then, participants were asked a series of six questions for the purpose of obtaining information relating to the variables in the study. The questions were also related to the corresponding literature. By asking these questions, information was secured regarding the participants' age, educational background, professional background, years in techmaking, years in co-ed makerspaces, and nature of techmaking. Following the demographic questions, there were three sections of interview questions related to the independent variables in the study: attraction to techmaking in the co-ed makerspace; challenges and barriers in techmaking in the co-ed makerspace; and strategies, supports, and recommendations for persistence in techmaking in co-ed makerspaces. See Appendix B for the interview protocol and questions. The questions were broken down as follows:

- Demographic Questions for Participants
 1. Are you between the ages of 18-28, 28-40, or over 40?
 2. What college degrees or credentials do you hold?
 3. What is your profession?
 4. How many years have you been techmaking?
 5. How many years have you been a member of a co-ed makerspace?
 6. What is the nature of your techmaking?
- Section 1: Attraction to techmaking and co-ed community makerspaces.
 - Primary 1. What were the circumstances that led you to join the makerspace?
 - Follow-up:
 - 1a. What were the circumstances that led you to begin techmaking?

- 1b. What experiences, if any, have you have had with respect to sustaining your motivation to continue your participation in techmaking?
 - 1c. What were your desired outcomes in joining the makerspace?
 - 1d. What are the key factors, if any, that motivate you to continue your membership?
- Section 2: Challenges and barriers in techmaking in co-ed community makerspaces.
 - Primary 2. What significant challenges, if any, have you faced in a co-ed makerspace?
 - Follow-up:
 - 2a. Were there unique factors you experienced as a woman?
 - 2b. What issues or challenges, if any, have you faced in techmaking?
 - 2c. Were there unique factors you experienced as a woman?
- Section 3: Strategies, supports and recommendations.
 - Primary 3. What strategies, if any, do you use to continue techmaking in the co-ed makerspace, and how might your strategies help future female techmakers be successful in co-ed makerspaces?
 - Follow-up:
 - 3a. What supports, if any, do you use to continue to techmake in the co-ed makerspace?
 - 3b. Can you tell me about any mentors who assisted you?
 - 3c. What recommendations do you have for other female techmakers to assist them in persisting in their pursuits in co-ed community makerspaces?

Content validity. Content validity for the interview instrument was supported by the literature and expert review. Table 1 demonstrates the alignment between overarching research questions and interview questions, as well as the relevant literature support.

Table 1

Relationship among Research Question, Interview Questions, and Literature

Research Questions	Interview Questions	Literature Source
RQ1 What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces?	1. What were the circumstances that led you to join the makerspace?	Bean et al. (2015) Davies (2017) Dougherty (2016a) Intel (2014) Maric (2018) Su et al. (2009) Toupin (n.d.)
	1a. What were the circumstances that led you to begin techmaking?	Faulkner & McClard (2014) Fisher & Margolis (2001) Haraway (2009) Intel (2014) Kugler et al. (2017) Maric (2018) Su et. al. (2009)
	1b. What experiences, if any, have you have had with respect to sustaining your motivation to continue your participation in techmaking?	Faulkner & McClard (2014) Fisher & Margolis (2001) Haraway (2009) Intel (2014) Kugler et al. (2017) Maric (2018) Stoet & Geary (2018) Su et al. (2009)
	1c. What were your desired outcomes in joining the makerspace?	Bean et al. (2015) Davies (2017) Dougherty (2016a) Henry (2014) Intel (2014) Maric (2018) Su et al. (2009) Toupin (n.d.)

(continued)

Research Questions	Interview Questions	Literature Source
	1d. What are the key factors, if any, that motivate you to continue your membership?	Bean et al. (2015) Davies (2017) Dougherty (2016a) Henry (2014) Intel (2014) Maric (2018) Reed (2018) Stoet & Geary (2018) Su et al. (2009) Toupin (n.d.)
RQ3. What supports, if any, have long term active female techmakers accessed/received to persist in co-ed community makerspaces?	3. What strategies, if any, do you use to continue techmaking in the co-ed makerspace, and how might your strategies help future female techmakers be successful in co-ed makerspaces?	Bean et al. (2015) Davies (2017) Dougherty (2016a) Faulkner & McClard (2014) Henry (2014) Intel (2014) Maric (2018) A. Powell et al. (2009) Reed (2018)
	3a. What supports, if any, do you use to continue to techmake in the co-ed makerspace?	Su et al. (2009) Toupin (n.d.) Bean et al. (2015) Faulkner & McClard (2014) Henry (2014)
	3b. Can you tell me about any mentors who assisted you?	Intel (2014) A. Powell et al. (2009) Reed (2018). Su et al. (2009) Toupin (n.d.)
	3b. What recommendations do you have for other female techmakers to assist them in persisting in their pursuits in co-ed community makerspaces?	Davies (2017) Dougherty (2016a) Faulkner & McClard (2014) Henry (2014) Intel (2014) Maric (2018) A. Powell et al. (2009) Reed (2018) Su et al. (2009) Toupin (n.d.)

To ensure the validity of the questions, the researcher submitted them via email to two experts for review (see Appendix C). The first expert was Dr. Sarah Davies, who earned a PhD in Social Studies of Science and is an Associate Professor in a Department of Media, Cognition,

and Communication. She has written or co-written over 40 research articles, and she recently published the book, *Hackerspaces: Making the Maker Movement* (Davies, 2017), which is cited multiple times throughout this study's literature review. The second expert was Katherine Kersten, an attorney who is also a respected and renowned conservative feminist thought leader. Her work, "A Conservative Feminist Manifesto," (Kersten, 1991), is the primary source the researcher cited during the literature review related to the conservative feminist framework. She has written articles over a span of decades on cultural issues for publications such as the *Wall Street Journal*, and she has appeared as a commentator on numerous conservative talk shows. Her current area of research is focused on increasing female awareness of high-paying careers that do not require college degrees.

The experts were asked if the questions supported the guiding questions and purpose of exploring attraction to techmaking and co-ed community makerspaces, barriers to techmaking in co-ed spaces, and supports and recommendations. They were also asked if the questions were clear and made sense given the purpose of the study, and they were asked for their opinion about the feasibility of asking these particular questions to obtain meaningful responses within approximately 60 minutes via personal interviews. The critical feedback from both sources was taken into consideration and incorporated into the interview instrument in order to improve effectiveness of the interviews and to increase the richness and clarity of responses. Questions 2, 5, 6a, and 7a were also modified to be more open-ended (see Appendix C).

Pilot interviews. Upon completion of the expert reviews and revisions to the interview instrument, the interview questions were piloted with two female professionals who have strong backgrounds in technology. The first pilot interviewee holds a Master of Arts degree in Computer Education and serves as an Assistant Principal at a large, comprehensive high school

in Los Angeles, California. The second pilot interviewee holds undergraduate degrees in History and Physics, and is employed as a Science and Technology Program Integration Specialist in Washington, DC. The piloted interviews were conducted to test the effectiveness and clarity of the questions. The recommendations from both of these sources were used to further improve the readiness and strength of the instrument (see Appendix C).

Data Collection Procedures and Data Management

The researcher selected six active female techmakers who are long-term members of co-ed community makerspaces and who could articulate their experiences in an interview. Interviews lasted approximately 60 minutes. Field notes were taken if the interviews were conducted within the participants' makerspace.

During virtual or face-to-face interviews, the participants were asked a set of questions related to the overarching research questions and the theoretical framework of the study. These questions were developed to bring forth rich responses about attraction, barriers, and strategies participants have experienced in relation to techmaking in co-ed community makerspaces. Follow-up questions were asked depending on participant responses. Views from a number of participants provided specific statements that helped to generate a composite description of their common experiences (Creswell, Hanson, Plano Clark, & Morales, 2007). According to Garko (1999), existential-phenomenological studies may involve unstructured interviews; however, Creswell et al. (2007) asserted that the researcher's experience and comfort level with structure should be taken into consideration. Due to a lack of comfort with the unstructured interview process, the researcher opted for semi-structured, recorded, interviews with open-ended questions that were focused on the shared phenomenon. Semi-structured interviews offer more

focus than the unstructured interview while still revealing rich descriptive data on personal experiences.

Interviews were conducted verbally and recorded digitally using a password-protected cellular phone and a password-protected iPad. Two devices were used to increase fidelity and to ensure against technical difficulties or malfunctions. Once the interviews were completed, the researcher uploaded the recordings to transcribe the interviews using NVivo, a secure service for transcribing recorded dialogue; these data were inputted into a password secured, cloud-based database. Transcripts were offered to participants to review for accuracy. All participants asked to review the transcripts and were given digital copies. Hard copies will be kept in a locked file cabinet for 3 years, after which the digital recordings will be destroyed and hard copies will be shredded. The research in this study is non-commercial; therefore, copyright clearance is unnecessary. Results will be archived indefinitely and will be available for future studies, which will be indicated in the consent information. Copies of the results will be provided to the participants should they wish to have them.

The following procedures were followed while conducting this study:

- Compile a list of co-ed makerspaces using hackerspaces.org.
- Identify and establish rapport with gatekeepers in the co-ed makerspaces via email and ask for recommendations for potential participants.
- Obtain potential participant email contact information from gatekeepers and discussion forums.
- Obtain Pepperdine IRB approval (see Appendix H).

- Recruit potential participants through an email invitation and offer of a complimentary \$50 Amazon gift card using a template provided by the university (see Appendix D).
- Recruit potential participants through an advertisement posted at the makerspace, if necessary, after receiving permission from co-ed community makerspaces (see Appendix E).
- Send a reminder email 1 week after the invitation as needed (see Appendix F).
- Schedule in-person or virtual interviews with participants.
- Email consent form (see Appendix A).
- Confirm the date, time, and interview protocol via email with participants 2 days prior to conducting interviews, if appropriate.
- Use a predetermined script for semi-structured interview (see Appendix B).
- Record the interviews using password-protected iPad and cellular phone.
- Write field notes and analytic memos.
- Transcribe interviews using NVivo transcription service and store in Google Drive.
- Send transcripts to willing participants to check for accuracy and inform them they have a deadline of 1 week to make revisions.
- Upload transcriptions to NVivo qualitative coding analysis software.
- Use NVivo qualitative data analysis software to help code the data and identify themes.
- Use critical colleague to review themes and codes to support data analysis.
- Review field notes and analytic memos.
- Write a summary narrative of the experiences of the female techmakers in Chapter 4.

Data Analysis

After the interviews are conducted and recorded, the researcher transcribed them into written hard copies using NVivo's transcription service. Once interview transcripts were received, the researcher read them thoroughly while listening to audio playback to correct errors and uploaded them to NVivo qualitative analysis software to help code and organize content into themes. A trusted and experienced colleague was used to examine the codes and themes, as this increased the reliability of the coding and data analysis. Saldaña (2016) suggested that in vivo coding is appropriate in studies that "prioritize and honor the participant's voice" (p. 106). Because the researcher's intention was to explicitly ground analysis in the experiences and opinions of the female techmakers, in vivo coding was used. Additionally, analytic memos were generated to help capture emerging themes and to demonstrate what was learned and how, if at all, the data support or refute the conservative feminist theoretical framework.

Chapter 4: Results

This chapter presents the findings of this study. The chapter commences by restating the purpose, research questions, and the design of the study. The chapter also includes the reflections of six U.S. women techmakers who are long-term members of co-ed community makerspaces.

Restatement of the Purpose

The purpose of this qualitative, phenomenological study was to investigate the experiences and perspectives of female members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. The researcher conducted individual semi-structured interviews with six long-term women techmakers who are members of co-ed community makerspaces.

Research Questions

1. What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces?
2. What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them?
3. What supports, if any, have long-term active female techmakers accessed/received to persist in co-ed community makerspaces?

Research Design

This study was conducted using a qualitative phenomenological research design. Criterion and snowball sampling were used. The researcher compiled a list of U.S. hackerspaces through hackerspaces.org and wrote emails to the spaces explaining the purpose of the study and

asking for recommendations for potential participants. Gatekeepers of the makerspaces referred potential participants to the researcher. The researcher interviewed six long-term women techmakers who were members of these co-ed hackerspaces. The semi-structured interviews were conducted virtually on the Zoom platform and face-to-face using an expert approved interview instrument consisting of three primary questions and 10 as-needed follow up questions related to the independent variables in this study: attraction to techmaking in co-ed makerspaces, barriers to techmaking in co-ed makerspaces, and strategies and supports utilized to persist in techmaking in co-ed makerspaces. Two experts were used to validate the interview instrument. The approximately 60-minute interviews were audio-recorded and transcribed by an external transcriber, NVivo. For further analysis and theme identification, the researcher used NVivo qualitative data analysis software and an experienced and trusted colleague.

Participants' Demographic Information

Each of the six participants was asked six demographic questions relating to information about their backgrounds, i.e., age, educational and professional experience, years in techmaking, and years in makerspaces. These questions ensured participants qualified for the study. Table 2 depicts demographic information collected in the study. It should be noted that this study did not include participants from the Eastern United States, and four unique makerspaces were represented.

Participant Profiles

The following profiles represent the discourse between the researcher and female techmakers. The participants were asked the same open-ended primary questions with follow-up questions included as needed. Quotes are used from participants to richly represent their individual stories.

Table 2

Demographic Information

Participant	Age	Degree	Profession	Years tech-making	Years of membership
P1: Jolie	28-40	A.A. General Arts/Science + University coursework	Software architect	20+	10+
P2: Tamra	28-40	MBA Marketing/Management	Freelance web design/events	5	2-3
P3: Rickie	28-40	B.A. Spanish	Tech YouTuber	20+	10
P4: Wendy	28-40	B.M. Music + Masters coursework in electronic music and sound design	Maker educator	20+	4
P5: Deb	28-40	Bachelor's in a somewhat technical field	Freelance, non-tech	20+	8-10
P6: Katrina	28-40	M.A Vehicle Design	Automobile designer	20+	2-3

Participant 1 (pseudonym: Jolie). Jolie's interview was performed on the Zoom platform. She began the interview by explaining that she has completed a great deal of university coursework; however, her highest degree was an associate's because she is "one of those people that doesn't really fit into institutional parameters very well." In fact, she wished she had dropped out of high school and ventured out on her own much earlier than she did. "I spent a lot of time spinning wheels like trying to fit into other people's notions of how I should learn from them." She was relatively unsuccessful learning in school after 10th grade because she began getting upset when she felt someone was telling her the wrong answer or a convenient answer. She recalled, "At some point, I started asking more questions than people wanted to answer. Yeah, well, I just kind of went to the library instead."

Jolie considers herself a strong communicator and capitalizes on her ability to bring people together in her profession. She believes she has a strong ability to help others see things

with more clarity, and this ability helps her in her career as a software architect, but she also thinks there is something about her personality that distances her from others. She says she has to work consciously to bridge that gap. “You know, like study, ‘What is vulnerability?’ And things like that.”

Attraction to co-ed community makerspace. Jolie has been techmaking since she was a young child. When she was around 8 years old someone put a computer in her room and she perceived it as a toy. She recounted being fascinated by a floppy disc with a game on it and the excitement she felt learning commands to get it to work. She wrote her own word games as a child, which also taught her programming basics. She never exerted a conscious effort to learn to code because Jolie thought it was inherently satisfying just to make the computer do things. Jolie has been a member of a co-ed community makerspace for over 10 years. At this point, she is not always just trying to do things she does well at the hackerspace. Instead, she enjoys learning a variety of skills there.

She decided to join the makerspace after spending 3 very lonely months walking around monasteries in Japan by herself. She said, “I had gotten all the introspective work that I possibly could. And I came back and I was like okay what can I enjoy? What can I get involved with?” Then, a friend took her to a party at the hackerspace. Once there, she saw that it was crammed with salvaged computers and parts and old console games, and it also had a technical library and an electronics lab.

... and I’m in there going like, Whoa! There’s a place where like people just hang out for free and just talk tech and stuff. This is amazing! And there’s people talking about Sci-Fi at the party and like all these sorts of things that I had been absorbing as my own personal

culture for a while, and I just didn't know that there was a place for people to gather for that sort of thing.

She went on to describe the clientele at the hackerspace that evening. "It was heavily dude, like the dude energy was very thick." However, the male-dominated presence did not deter her because she had come to expect to be the only girl in the room because of growing up in tech culture in the 1990s. The friend who took her to the party left town, but Jolie kept coming back to the space on her own. Although she has persisted in the space, she has had times in her life where she felt she had to get away and come back with a fresh perspective. For example, she had a child 8 years ago. "I had a kid and like you know it's not really that fun to bring a wailing 1 year old child that you have to breastfeed to the hackerspace." Now, she finds motivation through bringing him to the space to teach him things and have him help out there.

She says the structure of the space itself helps people feel entitled to participate, and she enjoys going there to feel free to "make lots of dumb mistakes." When she visits the space, it's not necessarily to learn about one thing. She explained, "It's the craft of craft itself. And like art and making and the willingness to make mistakes and learning how to forgive yourself for like you know it taking a long time for you to pick something up." She used to think she excelled at everything. "That's how I was raised which is like really bad priming for adulthood. And so it took me many years to get over myself and be like, 'No. I'm a beginner at most things and it's fine.'" Hanging out at a makerspace encourages her to try new things, but she also enjoys working on projects at which she is skilled. For example, she says she gets a thrill from wiring up old payphones to create old-style telephone networks using open source software.

Jolie also enjoys and is motivated by helping others in the hackerspace. In fact, Jolie says one of the main things that keeps bringing her back to the space is the feeling that she can bring

social perspective that new members are not able to bring. She says there is usually a core group of people who are running a space, even if it is an anarchist space, and there are others whose voices tend not to be heard at all. Those people may not know it is even possible for them to have a voice. As a veteran member, Jolie can have say in helping people who are not in the dominant group feel that they have agency in the space.

It's usually just a matter of kind of being willing to go up to these groups like 'Hey we're having a meeting about blah and this may affect you in this way and that other way, and we're wondering if you would be willing to come in and talk about what your group is doing.'

Helping people is also one of the biggest motivators for Jolie to continue her professional techmaking. In particular, her favorite projects involve making tools to help scientists do their jobs better. She says tech is the default she has to return to because it is her profession, but she admits sometimes she does not enjoy it. She is at an age now where she feels she is repeating herself, and she is looking for something new to come along.

If I don't feel like the work matters in some way I like completely turn off. I don't want to help more front-end developers do their work faster. It's too meta. I don't care. I don't feel like that pushes the needle on good in the world.... I have no interest in making shovels for the gold rush, and that's what most of Silicon Valley is doing.

Barriers and challenges. Jolie explained that the culture of her hackerspace has changed over the past 5 years to become more welcoming to women; however, she readily acknowledges that women may still have a hard time there, as they may with any predominantly male environment. She says that in a male-dominated work space, there “tends to be an assumption

that if you're not elbowing your way in then you know what are you here for?" She believes some women may have a difficult time with that.

Although she believes her hackerspace is mostly supportive and welcoming, Jolie has had to contend with some challenging male behaviors.

Sometimes men will have this thing where like if you ask them a question they insist that you're trying to get them to solve your whole problem or do the thing for you. That is so counterproductive. Basically, it's very infantilizing.

An example of this occurred when she asked how to get on the Wi-Fi network. As she started typing the command, one of the men took her laptop out of her hands, made fun of her for using an old command, completed the task for her, and shoved the computer back at her.

A few years ago, Jolie's hackerspace implemented an anti-harassment policy that has shifted the space from one with more masculine energy to one with more feminine energy. Jolie says this is due in part to a group of women who participated at the hackerspace at the time who were complaining about the behavior of a male member and did not feel anyone was listening or taking action to help them. She believes there was a need for a policy, but she has mixed feelings about some of the outcomes. On the one hand, she says it seems to work to quell some questionable behaviors. "It says stuff like, people come here to hack. They're not here for you to bother them about how lonely you are." On the other hand, she does not like an excess of any particular energy. Jolie lamented, "Dare I say I actually find it stifling. I find it very exhausting to constantly check in with people's feelings." She is currently fighting for members' freedom of expression and does not think it is right that members now have to fear reprisal because something they said may have hurt someone else's feelings. She claims she is not alone in this struggle. There are other members there who think of it as a safe space policy and are not sure if

they want to be known as a safe space since they believe that ideology runs counter to the original anarchist ideology upon which the hackerspace was founded.

One issue that Jolie thinks is worthy of concern in her space is the issue of racial tension. She feels her space operates within a predominantly White culture with which members of other races may not feel comfortable. She worries people who have not been socialized in a White culture may be subjected to racial profiling due to their natural resistance to what she calls White rituals of decorum expected of all members. Jolie thinks it is important to keep the space free from these “dangerous distractions,” and she would like to see her hackerspace do a better job of addressing this concern.

Strategies, supports and recommendations. Jolie counts her natural instinct to set up boundaries as one of the reasons she has been able to persist in a co-ed makerspace. She makes sure there is always comfortable physical space between herself and others there. She is also content to hold conversations from a distance and that revolve solely around objects, programs, and programming language; in contrast, she believes many other women would feel uncomfortable if other members did not engage them with people-oriented conversation and a “warm presence.”

Although Jolie is comfortable frequenting the hackerspace on her own, she suggests that women who do not have the same ability to feel secure walking into a space that is heavily male-dominated may want to bring a friend or two. She recommended, “Start having a meet-up with a couple of people you feel safe with and just have that little bubble because that little bubble will have an impact on the rest of the space.” She worries that women tend to be socialized that being feminine means giving things over and accepting being told,

That's not your thing or that because there's a bunch of people who are like better than you that you shouldn't try. Or you have to be twice as good to be seen...like if you're not working on an epic, you know, electronics or whatever or like some kind of epic project, that you don't have a place there.

Jolie says her hackerspace helps to counter this feminine defeatist mentality by holding events that are designed to bring in people who would normally be intimidated by the expertise in the space. One of the events encourages people to come in to work on silly projects that may never work or be of use to anyone. She says it brings in people who would not necessarily come in and many tend to be women. In fact, the last one was 60-70% women and transwomen who were encouraged by the event because it gave them permission to enjoy making things that were never going to work.

Jolie points to mentors outside of the hackerspace who helped her persist in her techmaking pursuits. She looks to her grandmother, a world-renowned mathematician during World War II, as her earliest mentor. She says she lived with her grandmother in her early teens and they had similar, no-nonsense personality types. Jolie says hearing her grandmother describe stories about how the women would get together and solve problems during the war was inspirational. Jolie's other biggest mentors have been from martial arts. There were a couple of martial arts teachers that "just so embodied what they taught and the concept of why discipline matters and why being true to your word matters and things like that. I thought it was almost like the finishing school that I needed."

Participant 2 (pseudonym: Tamra). Tamra began the interview by showing the researcher around her makerspace. There were two other members working in the space at the time of the interview, both of whom were male. They appeared to be woodworking and using the

3D printer. Tamra explained that although she is a board member, she is a relatively new techmaker and does not consider herself highly skilled on any of the equipment. She mostly makes jewelry, dabbles in 3D printing, and has member of the makerspace for a little over 2 years.

Tamra's educational background is in business and the social sciences. She holds an MBA in marketing and management. A few years ago, Tamra was in her eighth year working for a giant biotech corporation when she found out she had cancer. Not long after, she was laid off from her job. She explained that some of the skills she learned at the hackerspace helped her to pursue freelance career opportunities such as web design and event planning the past few years, but she may return to biotech in the future.

Attraction to co-ed community makerspace. Tamra first became interested in techmaking when she was promoted into an emerging electromechanical device group while working at the biotech company. At the time, she had no education in electrical engineering, but she fell in love with electronics while working on a diabetes device that was being repurposed to deliver other medicines. Ironically, the device was later used to treat the cancer with which Tamra had been diagnosed. Tamra said working on that device also sparked a new curiosity about how everything worked. She was more interested in the human aspect of how electronics could benefit people in medicine, whereas to her it seemed male engineers were more interested in the electronics themselves.

After Tamra learned she had cancer and found herself unemployed, she began evaluating her purpose and values. "I took my severance and was just trying to figure out a meaningful path." She was taking art classes when she came across the hackerspace by accident. She found a very vague description of it as a "collaborative space for people to come together to learn and do

weird things” on the Internet, and that was the key that drew her in. She did not join to actually make things but to get together in a decentralized space where people learned from failure and helped and shared with each other. She said, “I was kind of like so disillusioned with humanity at that point and just really didn’t think a place like that would exist.”

After finding out about the hackerspace on the Internet, Tamra drove by one night and peeked in the window. “I just saw all these gadgets and I just thought it was so interesting, unique, and weird. I just love weird stuff like that!” She went home that night without entering the space, but she decided to join by using the website PayPal system and attend a weekly meeting to find out more about it. Upon arriving at the meeting, she just sat there as if she had no idea what was going, as if she just came in to sit down. The other members were welcoming but did not single her out, which she appreciated because she was going through a lot personally with her cancer treatments and did not want to be the focus of attention. “So, they kind just like let me be a fly on the wall.”

Tamra said there was something about the space that was not intimidating, and anyone could just drop in on classes and have their questions answered. She found herself inspired by two women at the space and says they were hugely instrumental in making her feel comfortable. One of the women, who was one of the founders of the space, led coding classes Tamra enjoyed tremendously. Tamra started showing up more often and attending more events. Then, some of the board members encouraged her to be more involved and consider a position on the board. Initially, Tamra was surprised by this suggestion because she was not as experienced using the hackerspace equipment as the other board members, and her only real contribution to the space before that was donating a 3D printer. She truly did want to contribute more of herself, however. Now, she feels that being part of the hackerspace community keeps her relevant. She enjoys

being around creative people, and promoting the space and the education happening there gives her a higher purpose in life.

For me personally, gosh it has to give back to be able to give back to community and the world. It's not necessarily to take from the space, but it was one of the only avenues at that time that I felt like I could actually have a more meaningful impact back out to the world because being employed and being like you know, after coming through medical treatment where I wasn't even able to get a good job...all like sick and stuff. So it was one of the most kind of like fruitful avenues that I could find that was an avenue to be part of a bigger community...like potentially higher principals and values.... No one really has to be here. They don't want from me. No one's ever going to get money out of you try to sell you anything.... Really, identity being so closely tied to your work and everything, and it was nice that it wasn't that.

Barriers and challenges. Tamra believes that since her purpose for joining the hackerspace was mostly to be part of the community, her motivation to use a lot of the equipment there may not be as strong as other members who may have joined for the tools. She shared that technology can intimidate her, and she is sometimes insecure about letting others watch her learn. One of her biggest barriers experimenting with the equipment is fear of breaking it. She would like to overcome this fear because she actually learns best by breaking things, but she says she simply cannot afford to replace the equipment at the space. For example, she once took a class on the CNC machine at the space and immediately after the instructor announced that it was possible to ruin it, Tamra froze up. She attributes this paralyzing fear to working in the disciplined biotech industry where, unlike the hackerspace, there are many processes and

procedures to alleviate risk. “I was like, Holy shit! Like nothing else absorbed because I was like if I can’t figure out how to mitigate that then I don’t even want to learn the rest.”

Tamra does not think gender is an issue at her hackerspace and often stated she felt uncomfortable putting a gender on people or their behavior. She asserts that there is a lot of expertise at her space, and most of the experts in the space just happen to be men, but there are experts who are women there and that adds an important balance. She states that a possible barrier may have been that new members need to be accompanied by keyed members (i.e., those who are trusted enough in the space to have a key), but she was fortunate because there was a keyed member who was female with whom she felt comfortable during her initiation phase. She credits all of the board members there for being very supportive people and believes they are a collective reason she does not feel unwelcome as a woman who lacks strong techmaking skills. “They’re always accessible, always so kind, and trying to willingly answer any question you have.”

Strategies, supports, and recommendations. Although not a specific strategy or recommendation, Tamra believes natural curiosity is key for persistence in a hackerspace. “If you like to poke at things, that’s something you should continue to pursue.” She suggests that new members understand that learning to be less self-conscious is one of the skill sets that will come out of the membership, and she believes women will be more successful in pursuing techmaking in the long run if they see failure as an essential ingredient for learning. “Ask stupid questions And I think women have to embrace that. You know, think of it as practice.” Tamra also recommends seeking out experts who can help with tech in hackerspaces. She is inspired by other women, but she does not see gender as a stand-alone quality when seeking mentorship.

“It’s always fundamentally for that expertise, but if the person is not kind enough to answer your dumb questions and genuine in a helpful way then it doesn’t matter.”

She believes her hackerspace has been successful in attracting and retaining female members because it offers many mechanisms for engagement. For example, it has a lot of drop-in events and educational opportunities, but she wishes there was a way to make women feel more liberated to try techmaking in hackerspaces. She thinks one idea may be to offer women something to break without them having to worry about being held accountable or liable.

To have something to learn to use and it’s okay to break like maybe it’s even cool to just break it....take it apart and figure out how it works. Break it! Break it! Hopefully, get it back together if you can figure it out, or make it into something even better, cooler, or put two different things together. Yeah! Yeah! So maybe like that. A project of taking something down and figure out what to do with it.

Participant 3 (pseudonym: Rickie). Rickie’s interview was conducted virtually using the Zoom platform. She has been dabbling with electronics since she was a child, but she has been techmaking professionally for about 10 years and has been a member of a co-ed hackerspace for also about 10 years. She spent her college years studying languages such as Spanish, Russian, Chinese, and Tolkienian Elvish, but decided to pursue a career in technology because it was lucrative. When asked why she did not major in something tech-related in college, Rickie stated, “Because there’s lots of things to be excited about.” Currently, she works for a website where people can share their open source projects. She considers herself a media professional and marketer, “kind of a YouTuber.” In her job, she teaches people about new technologies and how to build electronics over the Internet. She also shows off projects she is working on and interviews other techmakers. At the hackerspace, she says, “I build projects that

are at the intersection of robotics, music, wearable tech, especially brainwave technology, jewelry, and bike lights.”

Attraction to co-ed community makerspace. Rickie has been interested in electronics since a very young age, and her fascination would often drive her to take things apart. Her biological father, who was not in her life very often, taught her how to solder when she was around 5 years old, and she found herself highly intrigued by it. Her interest in techmaking was sparked even more in high school when she was a member of an all-girls’ FIRST Robotics program.

Rickie first learned about hackerspaces when a friend who was starting one described it to her as a community resource for creative people from all walks of life who are interested in technology to work together and share their experience.

So I got really excited about that. I like the idea of learning stuff and the idea of having access to machines that I couldn’t afford. And the idea of hanging out with other nerds who were into making stuff and especially technology.

These days, the hackerspace is a place where she has found a “a solid crew” of friends.

The hackerspace community is about repurposing and investigating and tearing things apart, and this sort of ability to learn about things and also things that you didn’t directly seek out. It’s also good to work on something electronic at like 3 a.m.,. It’s a place that feels cozy, feels like you know the people or they’re kind of like your people, and you can kind of be alone together working on similar sort of things. That sort of element is really nice.

Although it is sometimes difficult for her to focus on one interest for a substantial amount of time, Rickie says there is so much possibility with technology and the fact that it overlaps with

all of her other interests keeps her motivated to continue techmaking. Currently, “magical technology” and “mind altering gadgets” have captured her attention. For example, she is passionate about sleep technology, especially that which helps elicit dreams. Her motivation to continue her membership includes the tools and friends she has made, but she is also strongly interested in how technology can help others. “There’s cool events I’m really interested in. The intersection of technology and like building a better world a better future which can be very absent when you’re around all these kind of corporate technology entities.”

Barriers and challenges. Rickie feels fortunate that she came from an all girls’ high school when she was competing on the school’s FIRST Robotics team. She says the female members on her team were “super solid and really cool,” but the females on other teams were on the periphery of the competitions, and many could not even hold a conversation about their robots. Their jobs appeared to be handing out stickers, and they seemed more like the spirit team within their robotics teams. Rickie was glad that was not the case for her team. “We felt really confident because we came from a place where we didn’t have to feel like we had to impress the boys around us.” However, she would feel frustrated when people would come up to their booth and look for the male mentors in order to avoid talking to the women. Teachers told her that this may have happened, in part, because people did not want to appear “creepy” talking to the female robotics team. Rickie felt this was an unfortunate stifling of communication. She also experienced frustration when people would assume the all-girl team did not know what they were doing.

We would get questions like the classic, “You’re an all girl team, how did you build your robot?” Uh, unless your dick is prehensile, that was our general response, like you don’t really have an advantage. And so yeah that was pretty frustrating.

She recounted another experience when her team won a competition and was running through a tunnel people made to congratulate them, and some of the team was groped by people who were making the tunnel. She said it did not happen to her directly, but it became a “huge controversy” had a “chilling effect.”

These days, Rickie says the negative experiences that she has with men are mostly what she considers “annoyances” in the workplace and in the hackerspace. In her previous tech job she encountered the occasional man who feels a need to explain why they believe there are so few women in tech and so few women world leaders. Although some may consider that a form of harassment, Rickie tended to not pay too much attention, and she has not experienced it much in the hackerspace. Her biggest pet peeve in tech and the hackerspace is mansplaining.

If I give a talk and some dude comes up right after the talk and basically tries to explain my talk to me. Yeah. That makes me so mad! Or, I’m doing something online and somebody who’s never done what I’m doing, some dude who’s never 3D printed, would try and tell me what I’m doing wrong. Actually, I’ve done this a bunch of times and explained why I made the decisions that I did.

She thinks some men would say there are just people who do that to everyone, but Rickie believes the ratio of occurrences is definitely higher for men doing that to women in techmaking.

Although Rickie is highly skilled in techmaking and would like to be a mentor on a FIRST Robotics team, she says she still sometimes struggles with imposter syndrome in robotics because she does not have an engineering education background. “You know, I probably couldn’t explain really easily what a PID loop is.” She feels extra pressure to represent her gender and thinks this may be one of the most challenging aspects for a female in a makerspace. “You feel like if you’re a beginner then you’re reinforcing stereotypes.”

Strategies, supports, and recommendations. Rickie suggests that having dedicated women's nights may help to increase women's interest in co-ed makerspaces. She was briefly a member of a feminist hackerspace and said it helped increase her ability to relax and try new things. "Take away that feeling of needing to be everything you know to even show up." She also participates in a WTF (women, trans, femme) night at another makerspace because she can feel free to be a beginner and learn new skills without feeling as if she is letting down her gender.

Rickie's hackerspace has instituted an anti-harassment policy, and she believes this has been beneficial and will make things better for women in the future.

It's like a super positive thing. Like having an anti-harassment policy makes it way friendlier for people who are unsure about the makerspace because you know that there's consequences and that there's probably some form of a, a chain of accountability. And you know what those would be. And so it really I think helps people with feeling comfortable to stand up for themselves and things.

Rickie has friends with whom she trades skills, but she cannot point to any specific in-person mentor who has helped her in her techmaking endeavors. "Honestly, I don't feel like I've missed anything with that." She believes that, because of the Internet, one does not need people in-person much anymore. Social media is very important because she can follow women who are doing interesting things and demonstrating expertise. Rickie encourages other women techmakers to interact and learn online, but she is concerned that some women are afraid of being targeted online, such as in the Gamergate Scandal. She thinks makerspaces should have some focus on helping women learn to protect themselves. "If you feel like you want to show your stuff online but you're afraid that you might get attacked or doxed something it's very important to have a sense that you could sort of hold your own security-wise."

Participant 4 (pseudonym: Wendy). Wendy's interview was conducted at her hackerspace. When the researcher arrived, she was greeted in a warm, friendly manner by an attractive, middle-aged gentleman who unlocked the door and invited her to have a seat on the couch in the front room. There was loud drilling sound coming from one of the back rooms. It turned out to be Wendy, who was using the CNC machine to make jigs to clamp up musical instruments she was also creating. There were three other members in the space at the time. They were all males, and one was significantly older than the other two. It was obvious to the researcher that everyone there got along and felt comfortable with each other.

Wendy has a B.M. in music performance and Master's coursework in an electronic music and sound design. She worked in the entertainment industry for a while in post-production sound, but did not find it fulfilling. "I wanted to do more with my hands and more with building physical things." Now, Wendy is a Maker Educator by profession. She proudly stated, "I teach kids to use power tools." Wendy does a lot of woodworking at her hackerspace, but she also enjoys making electronic wearables and uses all of the techmaking equipment regularly.

Attraction to co-ed makerspace. Wendy said, "I have been making things always. My mom's an artist and my dad's a computer guy." There were always computers in her house that she enjoyed experimenting with. For example, she coded her own webpage on GeoCities as a child, and she learned to program computers to play music such as compositions from Bach.

While Wendy was in the entertainment industry, she started looking online and to MAKE Magazine for inspiration for hands-on explorations and projects. It was through a tweet from MAKE that she found out about the Maker Education Initiatives and she jumped right in to be part of it. She says they sent her a Makey Makey, Squishy Circuits, and a plethora of other things to use to help educate elementary and middle school children. "And so I dove into that, and I got

sent to a space, and so my hobbies of making things tied really tightly in and my full-time job now is teaching kids to make stuff.”

Wendy was a member of a pop-up maker group about 5 years ago when one of the women in the group invited her to a party at her current hackerspace. She said, “That’s like two blocks from my house! How have I never seen this before?” She went to the party at the hackerspace and she became a member immediately. “I realized that these were my people. We all speak the same here.” When asked if she had any desired outcomes in joining the space, she stated,

Honestly, meet people where I didn’t have to have any conversations about Kim Kardashian. I want to meet people who are smart and will challenge me intellectually and are interested in projects and making things and seeing what other people are doing and brainstorming and just making our heads better.

One of her biggest motivators to continue to use the hackerspace is her self-imposed personal goal of posting one educational video per week on her YouTube channel. Most weeks, she posts videos herself physically making something, and she said she was making one of those videos when the researcher arrived. Some weeks, if she is tired, she may just post a video talking about making or about education. She is also motivated by working on group projects. “It’s that commitment together to keep going.” She says the emotional support embedded in group projects can also help her to persevere. “When you have the frustrations with something or you’re not understanding something you can bounce ideas off each other or vent your irritations and have somebody say ‘Yes, I 100% understand that frustration you’re going through.’”

Barriers and challenges. When asked if there were any significant challenges or barriers she faced in the co-ed community makerspace, Wendy replied,

In society in general, obviously we get plenty of mansplaining. You get that here as well. I visited a lot of different hackerspaces, and there are ones that have more of a tendency to guys treating you like you don't actually know what you're talking about and people not respecting you as much. Here is better.

Wendy admitted a male member once said something so offensive to her she felt she needed to leave the makerspace and go to the corner 7-11 to decide what to say or do in response, but when she came back another member had already intervened and explained to the male member that what he said was "not cool," and he apologized. Although she has experienced it, Wendy believes other women struggle more with gender-based frustrations than she does. "It depends on how much you see it, how much you are aware of it, and how much you want to let roll off your back." She also believes women who experience it outside of the hackerspace, for example, women who work in tech companies, may see it as more of a barrier within the space.

So, leaving work and then coming over here and experiencing the same kind of little pinpricks. Yeah. Too much. Too much.... I work with elementary school kids all day... I don't have to deal with tech guys during my day job.

When asked if there were any specific barriers or challenges that she has experienced as a female that get in the way of techmaking, Wendy joked, "I mean, my boobs don't get in the way. There shouldn't be. We have no tools that are operated by genitals. We should have no reason for gender to make a difference. Okay. No." However, she went on to state she feels that most of the time women's barriers are socially and mentally constructed. Wendy believes women tend to feel as if they need to know everything in order to become heavily involved in a hackerspace. Wendy was not surprised when another "awesome" woman techmaker was reluctant to become a board member due to insecurities about her expertise with techmaking. Wendy thought her

colleague was being too hard on herself but understood that she may have felt insecure. “Well, don’t women have to be twice as good as something to be seen as half as competent?”

Strategies, supports, and recommendations. Wendy’s hackerspace has recently updated its code of conduct to make it more specific and actionable, and she believes this is helpful as a guide for members to navigate and manage their issues in the space. She stated that it basically says, “These are microaggressions. Don’t do that! And if somebody does something and it bothers you, here are ways of managing it.” Although she believes the code of conduct is important for making everyone feel supported, she also believes experienced members in hackerspaces should be mindful of the insecurities that may be holding women back and make concerted efforts to help them overcome those barriers. She believes a little extra encouragement can go a long way.

Guys are always going to feel like they belong anywhere they want to be. Yeah, women sometimes need because they’ve been trained that they don’t belong any old where, that they only have a certain stature, I mean like they need an invitation. Well, not that they need it, but it helps.

She pointed to a popular coding event the hackerspace hosted that was targeted toward women. She said a lot of women attended, but unfortunately it “kind of fell off.”

Wendy says setting goals, having group projects, and celebrating project milestones are also valuable to sustaining motivation to be an active techmaker in the hackerspace. “Having a project inspires people to want to keep coming back and keep working on it.” She believes many women also crave connection with other people, especially other women. “In tech fields, it’s just so valuable to have another woman in tech friend you can talk to because guys don’t get it. They

really don't." She also believes getting women in the door may simply involve encouraging them to come in to work on stereotypically feminine projects, such as making jewelry and clothing.

When asked if she had any mentors in her techmaking, Wendy exclaimed, "Oh yeah, definitely. My mom's a badass! My mom doesn't apologize for wanting to do what she wants to do." She also pointed to another woman techmaker who was also one of the founders of her hackerspace. "She's smart as fuck. She's so intelligent. She knows a lot of things and she is super happy to share her flaws with you, too." Wendy said she values any time she can spend with her because she learns so much and feels at the same time she can be herself around her. Wendy attended the 2019 Sparklecon conference recently and said the best talk was given by Helen Lee who works with children and makes wearable tech. "She was talking about all this electronic music stuff and I'm like, 'You are my people!'" Wendy also looks to women social media for inspiration. She finds Simone Giertz, self-described Queen of Shitty Robots, "hilarious." She thinks Felicia Day, famous gamer and author of best-selling memoir *You're Never Weird on the Internet*, is "fabulous." She follows woodworkers Linn, from the YouTube channel Darbin Ovar, and Becky Stern. She also admires Naomi Wu.

Naomi Wu goes, goes through so much shit. She's in China and there are all kinds of like complexities of her life and like what kind of publicity she can and can't do safely.

People push and push at it and, and make things difficult for her, and because she's in China like any kind of like funding things for her especially without having her personal information out there available for everybody to find her and make all of that public. So, people can dox her and stuff. It's really difficult for her. So she doesn't want to be quiet and subtle about it. She's like, "You fucked me! What the fuck, you know?" So, she's, she's pretty impressive.

In the future, Wendy would like to be involved with facilitating the opening of more avenues to highlight women and people of color in her hackerspace. She believes having some form of representation by people who look like you is important to anyone seeking to belong in a space. She thinks there are simple things that can help to increase representation and consciousness. For example, simply playing a movie about Ada Lovelace on the screen while people are working at the hackerspace could help. Wendy is especially conscious about doing projects with her students that are based on lesser-known makers, and she sometimes goes out of her way to praise and highlight the abilities of her female students.

There was this little girl who was using a drill, she was using an impact driver, and she did it really, really well. She was just learning how to do it, and I stopped everybody else who was learning and I'm like, "Did you see that? That was perfect. That was exactly right!" And later on she came up to me and she said, "Thanks for saying that. I felt so good."

Wendy believes although there may need to be this more intentional drawing in of females to techmaking and hackerspaces, she also feels it is important that women understand going in that it will be difficult at times. "Sometimes things are tough. I mean if it's worth doing, it's gonna be a challenge, you know."

Participant 5 (pseudonym: Deb). Deb's interview was conducted over the Zoom platform. She says her education is in an overly specific technical field, and because of that she felt uncomfortable sharing it with the researcher. She also found it difficult to describe the nature of her work, stating, "I have a few different things going on, so I'm not really sure how to characterize that at the moment." When the researcher asked if she was freelance, she stated,

“Yeah, freelance sounds good for that.” Although she is “not exactly working in tech at the moment,” she may seek additional certification in the future to work more heavily in technology.

Deb has been making since she was a little girl. Her mother and father always had DIY projects they were working on, and she really had no choice but to help them.

Even if I didn’t necessarily feel like making something, it was, “Well tough, kid, we’re working on this today.” And I’ll say at the time I didn’t always appreciate that. I’m learning interesting things, but you hear about your friends in school are going and doing you know some amusement park or something on the weekend maybe and you think well why couldn’t I have gone there? But I realized later on that it’s really given me a good basis in a lot of different skills.

Deb’s techmaking still usually comes out of necessity due to the specifics of a project she is working on, and her projects are not based in one discipline. For example, she knows how to solder and has taught others the skill, but she does not look for projects that specifically involve soldering.

She thinks her DIY background also resulted in her approaching techmaking in a broader fashion than most contemporary techmakers. She grew up studying electronics and coding, but she feels equally comfortable with hands-on making, as opposed to others who have never made anything away from the computer keyboard. She says watching people step into hands-on making later in their lives opened her eyes. “I realized that other people didn’t necessarily grow up with the idea that you can do this.”

Attraction to co-ed makerspace. Deb joined her makerspace because she was interested in the Maker Movement. She had been an organizer of a local discussion group around making when she came across MAKE Magazine on a magazine rack one day and thought “it was really

neat and exciting.” She became a subscriber, which piqued her interest in the Maker Movement. Soon, she found herself attending the Maker Faire in San Mateo County, where she was excited by the huge variety of things people were making, and she wanted to support it.

To me, it seems sort of like a exciting thing happening in our time. It’s like times I’ve read about the past, like in the ‘60s. You know there’s this zeitgeist maybe. So it sort of seems like it’s there’s some interesting things going on in makerspaces at this point in the world. And I think that’s pretty neat.

She thinks her natural inclination toward making is one of the main reasons she has persisted in techmaking, but she finds her makerspace community the strongest reason for her continued membership and participation at the space. “I find the interplay of different ideas in seeing other people working on things inspiring.” She uses the tools, but other than the 3D printer, she has many of the same tools found in the makerspace at her home. Part of her motive to join the space was simply an understanding of the space’s financial need for memberships. “I want to continue to support this because I’d like this place to continue to be around.”

Barriers and challenges. Deb has a long history of working in predominantly male businesses and taking classes that are heavily male dominated, and she is comfortable in those arenas. Her first impulse was to say that she had not experienced any obstacles or challenges in the makerspace due to male dominance in the space; however, there were sometimes “awkward situations” in which male members would expect her to stand in for all women when giving her opinion on procedures or operations at the space. “I mean, I’m aware that those types of things I’m comfortable with are going to be different than what somebody else is comfortable with because everybody has their own life experiences.” Essentially, she would have to explain to the male members that she may not speak for all women. For example, she would explain that there

are many women as well as men who may not go out after dark unless they have a friend with them, but she would find that personally very constraining. In other words, Deb tries to model speaking in a more general way about the types of concerns people would have. “I just try and talk about it in a way that’ll help get them more tools to think about that themselves.”

Deb also shared that trying to navigate through gender bias at supplies stores can be a barrier to techmaking.

So maybe I go to the place to buy the supplies and maybe feeling like the people there are treating me a particular way because I’m a woman and mostly it’s men who come to this store to buy these supplies, and you know that’s not something I like dealing with certainly.

She shared a story of a hardware store clerk who would only address Deb’s male friend who had nothing to do with the supplies she was purchasing and was literally just along for the ride. She has actually discontinued projects upon realizing that some of the supplies may have to be purchased at one of these types of stores. “You have to decide, Do I want to deal with these jerks at this store? Yeah, just maybe pick a different project.”

Deb suggested that even with all of her expertise, she thinks “stereotype threat” may pose a mental barrier for her once in a while. She says knowing that women are typically stereotyped as not doing well in techmaking can possibly lead to a mental block during problem-solving. Even with all of her expertise, she can still question her own ability as a female because of stereotyping, and this barrier can lead to a lack of perseverance in completing a project.

Strategies, supports, and recommendations. Deb sometimes thinks about the importance of representation in supporting women to think about participating in a makerspace. If people are looking at photos of a space and there are only men in those photos, a women may not be

inclined to check it out. She thinks if there were more women around, that would help bring in more women because they would feel more supported. She told a story of visiting an open house at another makerspace and the only other female there was 4 years old. No one even spoke to Deb at first and she thought a lot of other women would feel very intimidated by that. Because of this, she said, "I put more effort to represent." For example, she says she tries to nurture connections with other females that visit the space. "I try to make sure I talk to them more so than I otherwise might... I try to make other people feel comfortable because then you end up making your friends of the future."

Deb tries to be an ambassador for the makerspace, but she finds that it can be difficult to recruit females into it. She described trying to encourage a female who was volunteering for a local science organization to visit, someone Deb thought would be naturally curious about the space. Instead of making plans to see the space, the woman suggested it was something only her husband may want to join. However, Deb admits this phenomenon may not necessarily have anything to do with gender.

You know there's a variety of reasons someone could say that. You could be intimidated or you could just be thinking. "My husband, he's retired and oh my gosh he's around the house all the time. Give me some alone time!" So, you know you might specifically want him to go do something that you're not doing. Yeah. Something like that.... Some people have people have different reasons for doing what they do, and you know it's not always necessarily something to do with gender. I mean you don't really know what's in somebody else's head.

Deb is very independent, so it does not occur to her to go to the makerspace in a group or rely on a specific group there for support.

Just for reference, I've done a fair bit of travelling by myself. At some point in the past I just kind of decided there were things that I was interested in doing. This was way before makerspace... like if I'm really curious about say a new restaurant, I'll just go ahead and go.

She also does not have any what she calls "mentor-mentee two way street" relationships in her makerspace, but she is not afraid to ask for advice from others who are more knowledgeable. Her projects are eclectic, so she finds herself learning different skills from different people. She follows some people on social media but could not name anyone in particular. She also finds inspiration in other fields, such as women who work in automotive repair. She feels these women are more peers than role models, but she says they are strong examples of women who do not give up because things feel too complicated.

If you are a woman who grew up to being told, "No, that thing is right for boys, you do this thing that's for girls." Having role models of women doing those things can be really important. Just being able to realize, "Oh, not everyone thinks this way," and kind of internalized is helpful for allowing people to get away from that sort of thing about their role that they were told that they had to follow, or that wasn't necessarily their personal preference.

Participant 6 (pseudonym: Katrina). Katrina's interview was held over the Zoom platform. She holds a Master's Degree in Automobile Design and is currently designing cars as a profession. She grew up and studied abroad. She studied car design in England and Hong Kong, and she has lived and worked in the United States for a little over 2 years. She has been techmaking ever since she can remember, with the support of her grandfather, an electrical engineer, and her father, who owned an auto body shop. She has always had a love for

innovating and inventing. These days, Katrina is working on environmental projects such as sustainable packaging products that will have RFID chips integrated into them. She said, “I use the laser cutter because it’s so great at templating, I use a 3D printer quite a lot for prototyping parts, and I use CAD quite heavily as well with the animation.

Attraction to co-ed makerspace. When Katrina first moved to the United States a couple of years ago, she was looking for a “workshop” that had a laser cutter to help her develop her inventions. She did not know anything about “the makerspace thing,” so when she came across her current space, she thought, “It’s a godsend! It’s wonderful!” She said, “It was a match made in heaven because it had so many tools, so much equipment...everything you could possibly want.”

Katrina experiences no difficulty staying motivated to techmake, and she has always been curious about how things worked.

I was really annoying as a child I was constantly asking you know asking my mom or dad How does that work? How does this work? And I’d take things apart. I took apart like big old 80s movie camera and got in trouble for that.

She considers herself an “idea a minute person,” and during the interview, Katrina had four notebooks open, each for a different project. “Once I get bored of one project, I go to another rather than losing interest in the whole making thing.” She is also driven to have something manufactured that she made by herself.

I wanted something that was my own. When you build and design a car, there are hundreds of people involved. Whereas, I wanted something with my name on it. I’ve got a patent on it. Awesome! I see it on the shelf, and I would say, “I designed that!” So, that’s what I’m trying to do at the moment.”

She says the tools are the biggest motivator for her to visit the makerspace, but she also thinks, “The people are fantastic!” She points out that at her makerspace everyone has a different specialty.

Just chatting with them, and if you have a problem they’re usually someone who knows the answer to it there. It’s kind of like a real-life Internet. Really cool people in the makerspace. Yeah, and if they don’t know they might put you in contact with someone who does or can help you out in a field you don’t know anything about, and that’s gold.

Challenges and barriers. Katrina claims she has not suffered any barriers in the makerspace based on gender.

There’s certainly no sexism, I think there, and no one assumes because you’re a girl you can’t do it, which is wonderful. Which is weird because even at my university, I mean I was in the minority there: There was 150 people in my degree program, and I was one of two girls there. Even amongst some of my best friends there, there is an inadvertent sexism. They don’t really realize they are talking down to you, and even when I know I could do it just as well as if not better than men sometimes. I haven’t experienced that in the makerspace which is great.

Although Katrina does not experience challenges at the makerspace due to her gender, she has experienced them in her profession. “I mean in my industry, car design, for sure, but it’s not usually the creative people, it’s more engineering.” She has worked in Germany, Sweden, the United States, and England. She says the men in Germany and Sweden “were cool with it, they’re fine,” but she had the most challenges in England.

I think the region of England though is quite insular and a lot of the engineers I was working with were quite inadvertently sexist. I was a big designer on the projects. I was running projects and I would get emails that started with “Morning, Chaps.”

She also found herself having to raise her voice in all-male meetings in order to make herself heard.

Physiologically, I’ve got a weaker, higher-pitched voice, so when they’re talking and I’m trying to make myself heard I have to shout. And therefore they think I’m kind of getting all wound up and heightened emotions and that’s not necessarily the case I’m trying to make myself heard because their voice carries a lot more and they don’t hear me. So that can be very frustrating.

Katrina’s main barrier to techmaking at the makerspace right now is lack of time. The makerspace is located some distance from her home, and the traffic makes it doubly difficult for her to visit the space often as she would like. She visits about once a week and tries to cram in as much as possible. She has no real complaints, but she would love a larger, faster laser cutter and says it would be great if someone were there to teach people how to use tools more often than there is now.

Some of the more dangerous equipment like saws and stuff there’s not normally anyone.

Last year, I kind of broke my hand on a table saw. It wasn’t the actual saw, a piece of wood came back and hit me, and it was just if someone had maintained it, it wouldn’t have happened. But, it’s no big problem. I mean accidents happen so it’s fine.

Strategies, supports, and recommendations. Katrina does not use any specific strategy to persist in her techmaking pursuits. At her makerspace there are few females around with whom to mingle, but she says there is a female new volunteer there who seems nice. This lack of female

representation does not appear to be a concern for her at all. She is comfortable visiting the makerspace on her own.

I think I'm a curious person and really stubborn. If I want to do something, I do it. I'm always curious. I want to know how things work and that lends itself to making stuff in makerspaces.... I think it's just such an innate part of me that I just have to carry on with it because I know it's part of me. And so in my mind I can't understand people that would want to quit.

Katrina does not have any specific techmaking mentor in her makerspace, and she could not point to any female mentors in her life. She said it was easy to identify her grandfather as her biggest inspiration.

He was just the best man in the world for that sort of thing. Every time I was over at the house, I'd spend all if it in the garage with granddad inventing stuff. It was some of the best moments of my life. I remember banging rusty nails into blocks of wood out there...and he was a draftsman and he taught me how to draw which is obviously very important in my line of work.

Her father was also a great support to her in her childhood. She did not have any brothers and her father's partner had a son, but Katrina was the one who was always down at their auto body shop helping out.

Dad never showed any sexism because I was a woman. He made me do stuff that he'd had like a man apprentice do at the workshop. So that was really great. Again and again he taught me to be self-reliant and just crack on the things.

She also had some inspirational design tutors in Hong Kong.

Katrina suggested women may become more persistent if they have a project at the makerspace that goes beyond what they know. For example, when learning a new CAD program, she will have a goal in mind as to what she wants to achieve.

It will be incredibly excruciatingly painful to start off learning it but once you have the hang of it, it gets exponentially quicker and then you have that skill set in your pocket and then you go into the next thing.

Learning to make things by hand first is another recommendation. Katrina explained that in car design, designers make full scale cars out of clay, but a lot of people jump into using laser cutters and 3D printers.

When you learn to build something by hand there is more the relationship there between you and the product you're making and this is really rewarding, rather than just hitting print to print or cut something. Yeah, but tech is equally fantastic because you get to iterate stuff much more quickly.

She recommends that parents and teachers not fuel bias from a young age and strive to nurture curiosity. If an adult is tired of a curious child's incessant questions or does not have the answers, Katrina suggests pointing them in the direction of how to figure it out, as opposed to telling them to be quiet. Katrina struggled in school because she was severely dyslexic. "I hate math, just terrible at it" but she excelled at science and art, and she wishes she could have had more time for things she was passionate about instead of being forced to work on her weaknesses constantly. Recently, she bought her newborn niece pajamas that said "Future Rocket Scientist." "I wanted to get it for her because I want her to know it doesn't matter what gender you are, you can do everything you want and be happy with it."

Research Question 1 Findings

Research question 1 asked, What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces? The interview questions that were used to probe question 1 include:

Primary 1. What were the circumstances that led you to join the makerspace?

Follow-up 1a. What were the circumstances that led you to begin techmaking?

1b. What experiences, if any, have you have had with respect to
sustaining your motivation to continue your participation in techmaking?

1c. What were your desired outcomes in joining the makerspace?

1d. What are the key factors, if any, that motivate you to continue
your membership?

Based up participant responses, the three most identified themes are listed in Table 3.

Table 3

Research Question 1 Key Themes

Key Themes (Number of times identified)	Key Theme Definition
Natural Curiosity (25)	A natural inclination to want to learn how things work
Helping Others (25)	The desire to give back or to help others
The People (24)	The desire to connect with the people at the makerspace

First, all six of the participants felt they possessed a natural curiosity and inclination for techmaking and all but Tamra had been tinkering and techmaking since childhood. All six of the participants expressed inherent joy when learning new things, and all six of the participants said

the makerspace environment encourages them to learn and try new things. All participants were intrinsically motivated to continue their membership.

Second, all participants were motivated to help others with their techmaking pursuits in and outside of the makerspace. Jolie enjoys solving problems and making software tools that help people (especially scientists) perform their jobs better or more easily in some way. She also finds fulfillment in helping others in her makerspace learn to develop agency in the space and express themselves without fear. Tamara is passionate about giving back and having a positive impact on her community and world, and she volunteers in the educational outreach and community-based efforts of her makerspace. Rickie enjoys projects that are tied to building a better future for the world, and she teaches others how to techmake on her website. Wendy is immersed in maker education. Deb enjoys supporting her makerspace financially, and she serves as a female ambassador in her space by making extra effort to recruit, welcome, teach, and help new and potential members feel comfortable. Katrina is passionate about the environment and is currently working on sustainable packaging projects.

Third, all participants expressed strong favorable attitudes towards the members of their makerspace. They all enjoyed the feeling of being part of the community, and they all used the expertise of other members as a resource when learning new skills. Jolie said her makerspace is very welcoming to those who want to come in and learn new things, and the members are generally helpful. Tamra said she believes the members at her space are connected through a sense of higher principles and purpose. Moreover, many of the members at Tamra's space are accessible and donate their time to help others. Ricky enjoys hanging out with creative people in her space who are into technology, and she instantly felt as if she had found kindred spirits when she first visited her makerspace. Like Ricky, Wendy and Jolie also recalled feeling as if they had

found “their people” when introduced to their respective makerspaces. Wendy craves intelligent conversations, and she enjoys the fact that members in her makerspace challenge her intellect. Deb says she appreciates that there is very little stereotyping in the activities men and women in her space participate in. She also considers new members her “friends of the future.” Katrina says the members of her makerspace are wonderful, knowledgeable and helpful.

Research Question 2 Findings

Research question 2 asked, What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them? The interview questions that were used to probe question 2 include:

- Primary 2. What significant challenges, if any, have you faced in a co-ed makerspace?
- Follow-up:
 - 2a. Were there unique factors you experienced as a woman?
 - 2b. What issues or challenges, if any, have you faced in techmaking?
 - 2c. Were there unique factors you experienced as a woman?

Based up participant responses, the three most identified themes are listed in Table 4.

Table 4

Research Question 2 Key Themes

Key Themes (Number of times identified)	Key Theme Definition
Psychological (35)	Feelings and beliefs that get in the way
Male-female relations (21)	Navigating social relations in male-dominated spaces
Tools (2)	Risks involved with using tools in the makerspace

First, all participants shared personal feelings they have had to overcome or are still struggling with in techmaking and/or in their makerspaces. Jolie, Rickie, and Wendy feel extra pressure to excel at things in order to represent their gender in a positive light, and they have all had to learn to lighten up and feel free to make mistakes. Jolie has also had to work on getting over the idea that she is naturally good at everything. Tamra confided that she feels uncomfortable at times when other people are watching her learn. She shared that she has difficulty with auditory processing and struggles to learn from others at the makerspace who do not use hands-on or visual mapping in their instruction. She also feels intimidated by technology and worries she may be too old to learn to code. Deb said she sometimes struggles to overcome stereotype threat when working through a difficult project, and Katrina shared that she is naturally introverted and shy, so it takes a lot for her to ask questions.

Second, five participants shared stories of what may be considered challenges with inadvertent sexism in their techmaking pursuits, but only three participants shared stories specific to their own experiences within their makerspaces. Jolie shared a story of a male member at her makerspace who many years ago treated her as if she was a child wanting him to solve her problems after she asked him a question. She also spoke of male members who talk about women and shout to each other about trivial matters across the room. Jolie worries that these behaviors can cause the women in the space to feel intimidated. Rickie shared a story of a male member at her space who came up to her after her lecture on holograms to explain her own talk back to her, and Wendy also spoke of feeling frustrated by men in her makerspace who mansplain and treat her like she does not know what she is talking about. Jolie was the only participant who alluded to any form of sexual harassment in her makerspace. She shared about a male member who posed a threat to some of the women before her makerspace adopted an anti-

harassment policy in 2013. She did not offer details other than to suggest the policy stopped men from expecting women at the space to listen to “how lonely they are.”

Third, only two women suggested barriers to techmaking at their makerspaces were related to the tools. Tamra has a fear of breaking the tools at the makerspace. She said that because she cannot afford to replace them, she has developed a mental block on even learning about some of them since she is so worried about liability. Katrina actually broke her hand because someone did not maintain the CNC machine, and she wishes there was someone on-site around the clock to show members how to use all of the tools in the space properly. Deb did not find the tools inside her makerspace to be a barrier, but she found the thought of having to deal with inadvertent sexism in a certain local, male-dominated hardware store hindered her desire to pursue certain techmaking projects that required materials to be purchased from that particular store.

Research Question 3 Findings

Research question 3 asked, What supports, if any, have long-term active female techmakers accessed/received to persist in co-ed community makerspaces? The interview questions that were used to probe question 3 include:

- Primary 3. What strategies, if any, do you use to continue techmaking in the co-ed makerspace, and how might your strategies help future female techmakers be successful in co-ed makerspaces?
- Follow-up
 - 3a. What supports, if any, do you use to continue to techmake in the co-ed makerspace?
 - 3b. Can you tell me about any mentors who assisted you?

- 3b. What recommendations do you have for other female techmakers to assist them in persisting in their pursuits in co-ed community makerspaces?

Based upon participant responses, the three most identified themes are listed in Table 5.

Table 5

Research Question 3 Key Themes

Key Themes (Number of times identified)	Key Theme Definition
Role Models, Experts (25)	Key people who support or inspire
Self-determination (23)	Ability to think and pursue interests independently
Projects (10)	Having a project to work on

First, all participants looked to role models and experts for support and inspiration in techmaking. Five of the six participants pointed to family members who were instrumental in sparking and supporting their natural curiosity and inclination for techmaking in childhood; one grandmother, one grandfather, three fathers, and two mothers were mentioned. None of the participants pointed to a relationship with siblings in their techmaking pursuits. Also, none of the participants defined their relationship with any of the other members at their makerspace as an official mentor/mentee relationship; however, they all spoke of being inspired by others at the makerspace. Jolie, Tamra, Deb, and Wendy find it very exciting and intriguing to see what others are working on in their makerspaces. All participants spoke of receiving help from other members who had more expertise in specific areas of techmaking. Three of the participants also looked online for inspiration and instruction in making, with Wendy appearing to be the most active with regard to following other female techmakers social media.

Second, self-determination was identified by the researcher as a common theme in the interviews that contributed to persistence in the makerspace. There was a sense that the

participants generally understood themselves to be the type of people who do not let obstacles get in the way of their goals and dreams, and this self-awareness appears to be a key ingredient in helping them persist in techmaking past the point where others may lose interest. All participants frequented their spaces alone, and they all demonstrated willingness to explore and learn independently inside and outside of their makerspaces. Jolie and Deb travel alone (e.g., Jolie shared that she walked around Japan by herself for 3 months), and Deb enjoys going to restaurants by herself. Rickie learns most of her techmaking alone online. After a bout with cancer, Tamra became determined to lead a more meaningful life and sought out the makerspace on her own to facilitate that pursuit. Wendy and Katrina both described themselves as “stubborn” and believe this quality helps them stay disciplined and determined to reach their goals. To summarize, Katrina appeared to speak for all when she proclaimed, “If I want to do something, I do it.”

Third, four of the six women said they felt having a project to work on was an essential component of persistence in techmaking in co-ed community makerspaces. Deb has always been a DIY person, so her techmaking is naturally DIY project-driven. Tamra suggests having a project of taking something apart and putting it back together may be helpful. Wendy says group projects are important to her persistence because of the shared experience, support, and commitment inherent in them. Katrina uses the makerspace to work on projects that require skills beyond what she already knows, and she says that forces her to persevere to acquire the new skills needed to complete the projects.

Finally, all of the participants offered suggestions for strategies and supports to help attract and make other women feel more comfortable in co-ed makerspaces. Jolie, Rickie, and Wendy suggested that there should be more female-oriented events within their makerspaces.

However, they also acknowledge that makerspaces need to focus on sustainability because when they hosted women-friendly events in the past, they did bring women in, but those women did not become persistent, long-term techmakers in the space.

Summary

This phenomenological study explored the lived experiences and perceptions of six members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. Five of the six women are currently employed in technology-related fields in some capacity, with the other having a goal of pursuing additional certifications to work in an area of technology. The participants were all Caucasian women between the ages of 28-40. All six participants live and participate in makerspaces in the Western half of the United States. Participants were asked three primary and 10 as-needed follow-up questions relating to their attraction to co-ed makerspaces, the barriers and challenges in co-ed makerspaces, and the strategies and supports they have used to persist in co-ed makerspaces.

In response to questions regarding attraction to co-makerspaces, all six participants described themselves as naturally curious and thought curiosity was a key ingredient for persistence in techmaking. All six described a strong attraction to the people at the makerspace. Without exception, the participants said they enjoy helping people and found the makerspace to be a conduit that helped them fulfill that desire.

In response to questions regarding challenges and barriers, all six women gave examples of feelings and beliefs that pose barriers to participation in techmaking in general. Five out of six shared negative experiences with men in their techmaking pursuits, with three of the participants

sharing stories about particular men in their respective makerspaces. Only two of the women pointed to negative experiences using the tools at the space.

In response to questions regarding supports and strategies, all women pointed to family members or role models who either supported them or inspired them in techmaking in some way. All participants shared recommendations for supports and strategies to help other women, but the participants themselves did not appear to personally need many of the supports or strategies they recommended (e.g., some recommended women attend the makerspaces in groups, but they visited their makerspaces alone). Four of the participants suggested that having projects is a big motivator to staying persistent in techmaking at the co-ed makerspace.

Chapter 5 will discuss how these findings relate to the literature review and how they tie into the conservative feminist framework. Conclusions and recommendations to increase women's persistence in co-ed makerspaces will be discussed. Additionally, recommendations for policy/practice and future research will also be offered.

Chapter 5: Discussion, Recommendations, and Conclusion

Today's world is designed by technology, and there is tremendous opportunity for the individual techmaker (Anderson, 2012; Hatch, 2014); however, if women are not techmaking, their voices will not be heard in the shaping of our environment and culture. In other words, the world will be designed by men for men (Fisher & Margolis, 2003). Therefore, it is important to hear from female techmakers (Faulkner & McClard, 2014). In the Maker Movement, anyone can claim the identity of maker, and the culture is intended to value inclusivity (Dougherty, 2016a); however, it has been estimated that 80% of all makers are male, which is similar to representation in major tech companies (Karlin Associates, 2012). Therefore, there should be more exploration on ways to close the gender gap in the Maker Movement and to ensure supportive environments in which for female makers to work (Bean et al., 2015). Diversity in the Maker Movement will promote economic progress and competition (Intel, 2014), and feminist makers believe diversity is important in technology-related arenas (Reed, 2018); however, some female techmakers have abandoned co-ed community makerspaces for feminist makerspaces that primarily exclude White, heterosexual males. It is well-known that co-ed community makerspaces lack female membership and participation (Davies, 2017; Faulkner & McClard, 2014); however, little is known about how female techmakers persist in co-ed community makerspaces. If inclusivity and diversity are the ideal in techmaking, it is important to hear from these persistent women.

This study strove to encourage more women to pursue techmaking by sharing the practices, strategies, and recommendations of women who persist in co-ed community makerspaces. This study could help community makerspaces increase membership and participation, help to provide insights to close the gender gap in technology-related fields, and

provide information as to why girls and women lose interest in STEM. It also sought to add to feminist theory regarding women and their relationships with men, technology, and innovation.

This final chapter discusses the key findings that were developed from interviewing the six women techmakers who are long-term, active techmakers in co-ed community makerspaces. The findings were compared with the literature review in Chapter 2. The researcher drew conclusions and implications from the results, and recommendations for further study are made.

Purpose

The purpose of this qualitative, phenomenological study was to investigate the experiences and perspectives of female members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. The researcher selected six women techmakers to interview and explored their lived experiences of how they thrive in a predominantly male culture within the makerspace community.

Research Questions

The research in this study focused on the following three questions:

1. What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces?
2. What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them?
3. What supports, if any, have long-term active female techmakers accessed/received to persist in co-ed community makerspaces?

Research Design Overview

This study utilized a phenomenological approach to research design. Data were collected from six female techmakers who are long-term active members in co-ed community makerspaces. The interviews were conducted virtually on the Zoom platform and face-to-face. Interviews were conducted using a semi-structured protocol, consisting of three primary questions and 10 as-needed follow-up questions (see Appendix B) related to the literature review conducted in Chapter 2. The questions were designed to explore the lived experiences of attraction to co-ed makerspaces, barriers and challenges to persistence in co-ed community makerspaces, and supports accessed to persist in co-ed community makerspaces. The data were coded and analyzed using the NVivo coding platform, and an experienced colleague reviewed the codes and themes to ensure data were analyzed accurately and thoroughly.

Discussion of Key Findings

Nine important themes emerged from the analysis of the participants' collective interview responses; this section discusses the findings as related to other studies and claims specific to women techmakers in co-ed community makerspaces. The three primary themes in response to questions related to attraction to co-ed makerspaces were natural curiosity, helping others, and attraction to the people at the makerspace. The three primary themes that emerged in response to questions related to barriers and challenges at the co-ed makerspace were psychological barriers, social relations with male members, and tools. The three primary themes in response to questions regarding supports and strategies used to persist in techmaking at the co-ed makerspace were the lasting effects of early role models and supportive people, strong sense of self-determination, and ongoing techmaking projects.

Research question 1. Research question 1 asked, What are the reasons long-term active female techmakers are attracted to co-ed community makerspaces? Subsequently, the common themes that emerged in relation to this research question are discussed, as well as their relation to the literature review.

Natural curiosity. All six participants described themselves as naturally curious or having a natural inclination for techmaking, and they also all believed curiosity was a key ingredient for persistence in techmaking in a co-ed community makerspace. The participants have always possessed an inherent love of learning and compulsion to understand how things work. In fact, 50% of the women in this study spoke of a strong desire to take electronics apart to learn more about them. Rickie said, “Even when I was a little kid, I would take apart electronics because I was fascinated by them.” Katrina was even willing to risk destroying her parents’ video camera and getting in trouble to satisfy her need to break it open to see how it worked. This finding stands in contrast to the experiences of most of the female computer science students in Fisher and Margolis’s (2003) study who did not care about taking apart their computers to learn about their inner workings. Additionally, the participants in this study find intense pleasure in problem-solving and hands-on techmaking, which supports Davies (2017) and Dougherty’s (2016a) assertions that makers desire hands-on exploration and want to live active, doer lifestyles.

The results of Su et al.’s (2009) study indicated that women tend to prefer conventional, artistic, and social pursuits whereas men show a stronger interest in STEM. The Su et al. study also showed men show a much stronger interest in working with things and women with people. The participants in this study by definition had demonstrated some interest in STEM, as well as an unconventional pursuit (i.e., techmaking at the co-ed makerspace), but this study’s

participants were also different from most women in the Su et al. study in that they demonstrated a strong attraction to working with both people and things (i.e., not just people).

Helping others. The number one reason women in the Intel (2014) and Fisher and Margolis (2003) studies gave for techmaking was helping or giving to others, and helping others was also the number one way in which the women in this study were using in their techmaking. Rickie, Deb, and Wendy were involved with teaching others how to techmake and Jolie, Tamra, and Katrina were techmaking to solve problems people were having and trying to make the world a better place. In contrast to many women in the Intel/Harris study, the women in this study were not using their techmaking skills simply to make gifts for others. Also in contrast to the Intel/Harris study, the majority of women in this study were not primarily interested in techmaking to pursue artistic endeavors, nor did they come to techmaking through the arts. Women in the Bean et al. (2015) and Faulkner and McClard (2014) studies used their making to get away from personal responsibilities such as those that come from raising a family. The women in this study did not mention getting away from personal responsibilities as an attraction, and Jolie actually brought her child with her to her hackerspace.

Jolie, Tamra, Wendy, and Deb were not only using their techmaking to help people, they were also all voluntarily using their status within the makerspace to help others feel welcome and comfortable. In addition, this group was involved with setting policy and helping with events. In stark contrast to Henry's (2014) claims that men exploit women's labor in these spaces, there was no evidence of exploitation. In fact, quite the contrary; these women found it inherently satisfying to help in these capacities.

The people. All six participants spoke of a strong attraction to the people at the makerspace. Katrina thought the people were "fantastic," and Jolie, Rickie, Wendy, Deb, and

Tamra spoke about their respective spaces filling a deep need for community and meaningful personal connections, which supports the Intel (2014) and Bean et al. (2015) findings that women want to connect with others in their techmaking environments. Overwhelmingly, the participants described the other members at the respective makerspaces as accessible, helpful, and competent. This finding stands in stark contrast to claims made by Henry (2014) that men act as if they own the spaces and women face constant harassment. Jolie, Rickie, Wendy, and Tamra acknowledged that their spaces were heavily male-dominated, yet they instantly felt as if they had found “their people” on their first visit. Rickie described her people as a “nerd community” and Wendy a “geek community.” Jolie felt immediately at home talking about science fiction with the members in her makerspace, and Tamra felt an instant attraction because the people were doing “weird things,” which she likes.

Like the women in the Bean et al. (2015) study, all of the women enjoyed the freedom they felt inside the makerspace to explore creative interests. Jolie, Tamra, and Rickie felt the decentralized structure of their spaces offered a welcome relief from corporate confines and coldness they had endured in their careers. Tamra appeared to sum up this group’s feelings when she said “It’s been the opposite of corporate...so the opposite of what I had seen...corporate just for profit turning people over.” It should be noted that the researcher did not find anything in the literature pointing to escape from corporate structures as an attraction point for women in hackerspaces, so the results of this study may have added this additional piece to the literature.

The researcher also did not find literature pointing to people watching as an attraction point for hackerspaces, but the women in this study appeared to find much enjoyment and inspiration in observing as others worked on projects in their spaces. They also felt a sense of relevance and belonging by keeping up with what was happening in their spaces. Deb felt the

Maker Movement was like a “zeitgeist” and loved that people in her makerspace were a part of it. Tamra felt her makerspace was keeping her “relevant and seen.” All of the women spoke of wanting to learn from others in the spaces, whether through events that were being hosted at the spaces or through personal connections. This supports the Intel (2014) finding that women do want to connect with others, but it adds an additional piece that women can fulfill a need for community or meaningful personal connections through peripheral participation at their spaces. In support of this argument, although the tools at the space were an important attraction for four of the participants, Deb and Tamra did not appear to have any pressing need for the tools (i.e., both had the equipment they needed for their primary techmaking at home).

Research question 2. Research question 2 asked, What challenges or barriers, if any, have long-term active female techmakers experienced as they persisted in the co-ed community makerspace, and how did they overcome them? Subsequently, the common themes that emerged in relation to this research question are discussed, as well as their relation to the literature review.

Psychological barriers. In response to questions regarding challenges and barriers, all women gave examples of feelings and beliefs that pose barriers to participation in techmaking. In contrast to the women in the Bean et al. study (2015) but in alignment with Faulkner and McClard (2014), Henry (2014), and Intel’s (2014) claims, four of the six participants did describe gender-specific psychological barriers; 50% felt there was added internal pressure to represent their gender in a male-dominated space and one felt stereotype threat was a barrier to her persistence with difficult projects in the makerspace. The results may not have been in alignment with the Bean et al. study’s findings because it was open to any woman who made any type of artifact in the space (i.e., it was not limited to techmakers).

None of the women in this study mentioned any feelings that the techmaking tools themselves were biased toward male sensibilities. This runs counter to arguments from Faulkner and McClard (2014), Fisher and Margolis (2003), Reed (2018), and Wajcman (2009) that technology itself is intimidating women because it is gendered as male. In fact, the women in this study were adamant that gender had nothing to do with the design and use of technology or the ability to techmake, and four of the women actually found the question laughable.

Although psychological barriers were referenced in this study, they were primarily limited to feeling extra pressure to excel, and many of the other gender-specific barriers mentioned in other studies were not represented in this study. In alignment with Bean et. al (2015), Davies (2017), Hollingsworth (2017), and Maric (2018), but in contrast to Faulkner and McClard (2014) and Henry's (2014) claims, none of the women in this study identified oppression as a personal barrier to persistence in techmaking in co-ed community makerspaces. In contrast to the 17% of the 106 U.S. female makers surveyed in the Intel/Harris (Intel, 2014) study, none of the women felt excluded for being a woman. Also in contrast to 11% of the women in the Intel(2014) study, cultural views of the inappropriateness of women in tech making were not a barrier; however, it should be noted that all women in this study were Caucasian. In contrast to the women in the Bean et al. (2015) study who pointed to fear of the unknown, fear about putting themselves first, and fear of gender imbalance as possible barriers for women's participation in co-ed community makerspaces, none of the women in this study mentioned experiencing any of those fears. Additionally, none of the women in this study felt unsafe going to their makerspaces. This contrasts with the feelings of 12% of the women participants in the Intel (2014) study who said they did not feel safe going to maker activities.

Relations with men. In contrast to claims from many women in the Faulkner and McClard (2014) report and claims from Henry (2014), none of the women in this study pointed to negative social relations with men as a primary obstacle to techmaking at their makerspaces, and many of the references coded by the researcher involved anecdotal stories of isolated incidents experienced by four women. In alignment with Henry (2014) and Faulkner and McClard's (2014) claims, one of the primary social challenges three of the women in this study had to overcome was the discomfort they felt when male members singled them out to offer unsolicited advice and/or to mansplain. However, it should be noted that all three had over 20 years of techmaking experience. Moreover, one was a world-renowned techmaker and another hosted a YouTube channel with close to 3,000 subscribers. In addition, two of these women were also members of feminist hackerspaces, so the intensity of their sensitivity may have been more severe, especially since one of the reasons for the creation of feminist spaces was to provide a place where women techmakers could be taken seriously (Henry, 2014; Toupin, n.d.). It should also be noted that the majority of women in this study did express empathy for other women who may feel too intimidated, unsupported, or annoyed to persist in a co-ed makerspace.

Tools. Only two of the women pointed to negative experiences and perceptions about using the tools at the space, but their concerns were noteworthy, and the particular barriers were not found in the literature review. Tamra was concerned about the idea of having to assume personal liability for breaking the tools in the space, and Katrina was concerned with a potentially dangerous lack of maintenance. Katrina was especially concerned because there was usually no one around to teach or enforce responsible use and maintenance of dangerous tools, and she believed she suffered a broken hand in part due to another member's neglect and/or ignorance about how to leave the CNC machine properly for others after use.

Research question 3. Research question 3 asked, What supports, if any, have long-term active female techmakers accessed/received to persist in co-ed community makerspaces? Subsequently, the common themes that emerged in relation to this research question are discussed, as well as their relation to the literature review.

Role models and supportive others. In response to questions regarding supports and strategies, all women pointed to family members or role models who either supported them or inspired them in some way in techmaking. This finding supports the Intel/Harris (Intel, 2014) claim that family is a significant source of inspiration for female makers. Counter to some of parental stereotypes found in the Fisher and Margolis (2003) study, none of the women felt their parents failed them in any way as a result of gender stereotyping. None of the participants mentioned anything about having to compete for resources with male siblings; however, the researcher did not ask whether or not the participants were only children. Jolie, Deb, Wendy, and Katrina expressed gratitude that family members introduced them to techmaking resources when they were children. Tamra was by far the newbie of the group; however, she blamed herself for her late start in techmaking, citing other artistic interests in childhood.

Self-determination. In contrast to the women in Bean et al. (2015) study and many of the women in the Faulkner and McClard (2014) and Intel/Harris (Intel, 2014) studies, the women in this study did not feel a need to rely on others for support in their techmaking pursuits. They were all strong women who were comfortable visiting their makerspaces alone and working on projects alone, and they were also not afraid to ask questions in order to accomplish their goals. The demographic data collected regarding the participants' backgrounds also confirmed that these women were fiercely self-determined; Jolie was a freelance software architect; Rickie was a tech educator, speaker, and host of a popular techmaking website; Tamra became an

independent web developer and event planner after leaving the corporate world; Wendy left a career in music production to pursue her dream of becoming a maker educator, and she was also the star of her own popular weekly YouTube series on making; Deb was a freelancer and life-long DIYer; and Katrina was a well-respected automobile designer who was patenting her own inventions on the side. It should also be noted that five of the participants were also highly involved board members at their respective makerspaces.

Projects. Four of the participants suggested that projects are a big motivator to staying persistent in techmaking at the co-ed makerspace, and most of the projects the women in this study were currently working on had some benefit to others. Deb suggested group projects were a great motivator because of the shared commitment and inherent support involved. This finding supports Faulkner and McClard (2014) and Intel's (2014) findings that women techmakers are interested in working on projects that are meaningful and connect them to others.

Discussion of Key Findings as Related to Theoretical Framework

In this section, key findings regarding challenges and barriers will be discussed using the conservative feminist framework. As noted in the literature review, conservative feminism is based upon three assertions: unvarying standards of justice and equality must apply to both sexes, women have suffered and still do suffer from injustice, and the problems women face can best be addressed by improving upon, rather than discarding, the institutions and principles of Western culture. Conservative feminists believe that men and women are different, but gender equality exists as long as women and men are judged by the same standards (Kersten, 1991). Conservative feminists are concerned with equal opportunity but not equal outcomes (Fox-Genovese, 2004; Kersten, 1991). They are not concerned with group rights, entitlements, or the destruction of power hierarchies (Kersten, 1991), and they accept as a fact of life that there will

be ongoing negotiations between men and women about sexual and social relations (Sommers, 2013). The framework seeks to differentiate between needs and wants as well as to distinguish between real injustices and irritations (Kersten, 1991; Paglia, 2017). Conservative feminists resist the temptation to plead victimhood when personal shortcomings lead to failure, and they face difficult challenges with grace, fearlessness, and humor (Kersten, 1991).

All the women in this study were strong, articulate, educated, and socially conscious, so their views about the equality of opportunity afforded to women techmakers in their co-ed makerspaces should be held in high regard. It was a fact that the membership at all spaces was male-dominated, yet women in this study spoke of their memberships' commitment to outreach efforts, campaigns, and events that were aiming to attract more women to the spaces. Jolie believes all individuals and groups in her hackerspace have social agency, whether or not they know it and use it. In fact, Jolie shared that it was even possible to turn a "rough environment for female-oriented people" into one that was more feminine than masculine. Before 2013-2014, Jolie said her space was "mostly White dudes getting together and wanting their own clubhouse," but now it is one that has "more feminine energy than masculine at this point due to a concerted effort of many people."

Although the participants are experiencing equal opportunity to techmake at their respective spaces, some of the women spoke of struggles their members have faced in trying to formulate and regulate standards of behavior inside of their spaces. Jolie, Rickie, and Wendy spoke of the need for implementation of anti-harassment policies and codes of conduct at their spaces. Jolie and Rickie shared that it took groups of women to band together to make the policy that speech or behavior deemed inappropriate by these particular groups of female members will not be tolerated inside their spaces. Jolie felt that the policy did help to stop some inappropriate

behavior, but it also had the negative consequence of stifling communication, and she now finds it “exhausting to constantly check in with people’s feelings.” She even commented that some of the members were upset because they felt it was turning her hackerspace into a safe space. In contrast, Rickie thought her space’s anti-harassment policy helped her space become “way friendlier” and people are now freer to stand up for what they believe in. Wendy helped develop a code of conduct that lists microaggressions as actionable offenses, and she believes it is important and useful. It should be noted that the actual policies and codes of conduct were not shared with the researcher.

Conservative feminists would argue that there should be policies in these spaces to prevent harassment of any individuals, but they would also argue that the ends in these cases do not justify the particular means used to achieve them. Where crimes against women have occurred, all feminists should castigate them (Paglia, 2016); however, the Constitution of the United States (U.S. Const. art. I) guarantees individuals the right to freedom of speech, so any policy in conflict with the First Amendment would not fit with the conservative feminist framework, especially if it was based upon the sensitivities of self-appointed group of spokespeople claiming their group is being victimized by the microaggressions of another. Conservative feminists reserve the right to decide as individuals whether or not harassment or inappropriate behavior has occurred (Schreiber, 2012).

With regard to these women’s success in overcoming personal psychological barriers to persist in techmaking in their co-ed community makerspaces, the conservative feminist framework fits perfectly. None of these women blamed the men in their spaces for lack of female membership or their own personal shortcomings. In fact, they recognized the men as partners in the quest for more females at the space, and they readily acknowledge that the men were

generally helpful, knowledgeable, and nice. These women did not cry victim and run to safe spaces when they felt outnumbered or irritated by the behavior of male members. Rather, they used simple strategies. For example, Wendy went outside to get some fresh air once and came back in to an apology from a male member who had time to realize what he was saying was offensive to her. Jolie said that over the years she has learned to be comfortable in male-dominated settings, but offered, “I can’t necessarily put my finger on what’s stopping somebody else from being able to just take some deep breaths, just sit with it for a while and it will be okay. You’ll adjust.” Some of these women also used humor to help them through their negotiations with men in their spaces.

One of the recurring themes regarding barriers and challenges found in the literature referenced by Jolie, Rickie, and Wendy is the feeling women experience that they must excel in order to represent their gender in male-dominated arenas. In the conservative feminist framework, this internal pressure would actually be viewed as a motivator. Jolie, Rickie, and Wendy actually do excel in techmaking, and they are perfect examples that competition, a key tenet in the Western ideal, is good for women and makes them stronger—that is, should they choose to participate.

One of the most prevalent and apparently upsetting behaviors needed to be negotiated by women in the study and in the literature is inadvertent form of sexism known as “mansplaining” (Faulkner & McClard, 2014; Henry, 2014; Intel, 2014; Reed; 2018). It is the opinion of the researcher, this is a challenge worth examining within the conservative feminist framework because although the women in this study were able to persist in their environments in spite of this irritation, it is apparent that other women in the literature were not (Henry, 2014; Toupin, n.d.). First, conservative feminists look to men as partners, not adversaries (Bruce, 2014;

Kersten, 1991; Paglia, 2016), so the challenge is not how to get rid of men but how to get rid of the behavior that is undermining the partnership. Second, it is fair to assume many men who exhibit this behavior inside makerspaces are unaware of the tension it is causing in the partnership, as there is much evidence in the literature and in this study that the overwhelming majority of men inside these spaces are good, competent people who enjoy helping others (Anderson, 2012; Davies, 2017; Dougherty, 2016a; Hatch, 2018), and there is evidence in this study that men desire to have more female members in their hackerspaces, as they participate in outreach efforts and event planning targeted toward women. Third, to be fair, there are statistics that strongly support men in the U.S. in their assumption that the women in hackerspaces are significantly less experienced (Intel, 2014).

That being said, it is the opinion of the researcher that women should not have to tolerate recurrences of this behavior if it is detrimental to their mental well-being. There are solutions to help to eradicate this behavior that fit with the framework. First, women must provide a graceful, working definition of mansplaining to men in order to have a productive conversation about it. For the women in this study, it meant a man (but it should be noted mansplaining most certainly can be performed by a woman) either explaining something in a condescending manner and/or assuming a woman does not understand something because she is a woman. Women must be fearless and firm in their mission for understanding and change, especially if this behavior has become more than a minor irritation. Finally, women should remain good-humored in their approach in order to stay within the framework.

One support to help eradicate mansplaining in co-ed community makerspaces that fits within the conservative feminist framework is a behavior chart created by a female digital designer in response to sincere requests from male colleagues who were unsure whether or not

certain behaviors were considered mansplaining (Goodwin, 2018). Goodwin (2018) tweeted the chart and it resonated so well with others it had over 53,578 retweets and was liked 126,956 times at the time of this research (see Figure 1). By gracefully prefacing that this chart was actually created to fulfill a need expressed by men, it should help to guide the behavior of empathetic, yet misguided mansplainers who do want to strengthen relationships with women in their spaces. It could also serve as a filter to discern which men are actually using this behavior to harass women in these spaces, as they will most likely either refuse the chart, insult the chart, or continue to produce the behavior after reading it. The behavior chart is helpful for visual learners, is good-humored, and serves as a viable alternative to verbal interaction that may become too emotional and/or misinterpreted.

Am I mansplaining?

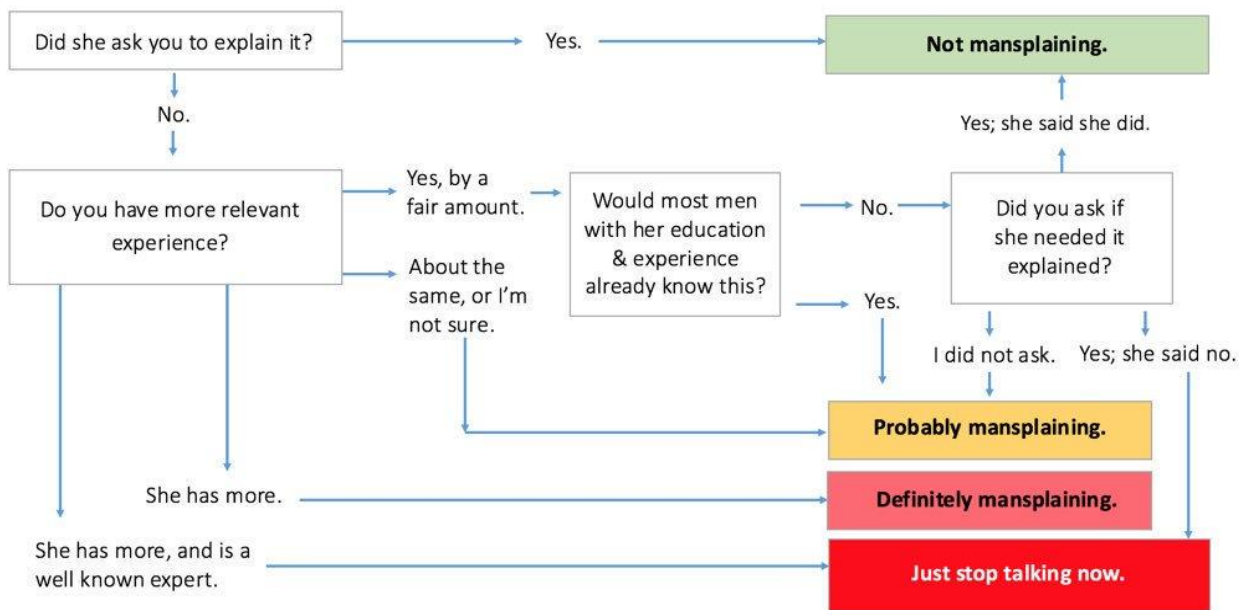


Figure 1. Mansplaining flow chart. Reprinted from “I Have Had More than One Male Colleague Sincerely Ask whether a Certain Behavior is Mansplaining. Since Apparently this Is Hard to Figure Out, I Made One of them a Chart [Tweet],” (Goodwin, 2018). Copyright 2019 by the author. Reprinted with permission.

The conservative feminist believes and celebrates that there are differences between men and women, but is aware there will be ongoing social negotiations (Kersten, 1991). However, the conservative feminist will always approach those negotiations with the assumption of innocence and fairness, and she will refrain from demonizing or running away from men when unconscious biases are unveiled (Kersten, 1991). Women and men getting along is an age-old struggle, but most certainly a universal human interest (Kersten, 1991). It is the conservative feminist belief that there is still important work to be done, but solutions must be offered that respect the dignity of both partners in this struggle (Kersten, 1991).

Conclusions

This study has resulted in five conclusions based upon the analysis and interpretation of the findings: natural tendencies played an important role in the participants' attraction to techmaking and makerspaces, participants were attracted to makerspaces because they offered meaningful personal connections, an ongoing challenge for these women in their techmaking pursuits and in co-ed community makerspaces is inadvertent sexism, the participants were self-determined and did not rely on a lot of supports or strategies to persist in techmaking in co-ed community makerspaces, and early supports and role models helped the participants in their techmaking pursuits.

Attraction: Natural tendencies. The first conclusion reached in this study was that the participants' innate interests played an important role in the participants' attraction to techmaking. This sample of women techmakers is similar to other populations with respect to the importance of nature in techmaking. The Intel (2014) youth study results showed that the top reason girls gave for making were the inherent joy of learning and pleasure of making things, and all of the women in this study gave similar reasons for their techmaking. They also all felt

they were naturally gifted with boundless curiosity: Jolie commented that as a youth she asked “more questions than people wanted to answer;” Tamra said she has “always been naturally curious;” Rickie has always had many interests and said it is still often difficult to focus on one thing because there are “lots of shiny things in the world;” Wendy said she has “been making things always;” Deb realized she enjoyed “learning interesting things” as a child; and Katrina said she was an extraordinarily curious child who would not stop asking her parents, “How does that work? How does this work?”

A natural attraction to technology also emerged as a common trait shared among the participants. Like the boys in the Fisher and Margolis study (2003) who appeared to have a “magnetic attraction” (p.16) to computers, most of the women in this study appeared to have a magnetic attraction to electronics: Jolie expressed nostalgic feelings as she shared the instant attraction she felt to her hackerspace due to it being “jam-packed at every level with salvaged computers and old console games that people were taking apart to turn into clusters and stuff...and I’m in their going like, Whoa!” Tamra expressed a similar sentiment as she reminisced about her first time seeing her makerspace, “I saw all these gadgets and I just thought it was so interesting.” She also expressed overwhelming joy at her first peek inside a medical device—“Yeah. Oh my God, I loved it!”—and said hackerspaces appealed to her because she liked to break things apart to figure out how they worked, as well as making things into “something even better or cooler” or merging things together. Rickie said, “Even when I was a little kid, I would take apart electronics because I was fascinated by them.” Katrina also took apart electronics as a child and cannot imagine life without techmaking. She stated,

I think it's just such an innate part of me that I just have to carry on with it because I know it's part of me, and so in my mind I can't understand people that would want to quit.

Deb asserted that she simply has “a natural inclination towards” techmaking and “never really thought about, about a particular motivation for it.”

Attraction: Meaningful connections. The second conclusion in this study was that the participants were not just attracted to their makerspaces for access to technology, they also wanted to help others and form personally meaningful connections. These desires were strongly aligned with the literature regarding the motivations of female makers (Bean et al., 2015; Davies, 2017; Faulkner & McClard, 2014; Intel, 2014). Jolie was elated to find people who expressed interest in the same things she enjoyed, and she used techmaking to help people. “I really like helping people. I like making tools that help people in some way.” Rickie liked the idea of “hanging out with other nerds who were interested in making stuff and especially technology,” and she is also “interested in the intersection of technology and building a better world, a better future.” Tamra enjoys the fact that she shares common interests with the people at her makerspace, and she believes her participation in the space is serving her new commitment to living her life on a “meaningful path.” Wendy calls the people in her space “my people,” and she enjoys making videos at the space to inspire other techmakers. Deb said she “found it pretty neat that people were doing this in my geographic area” and she goes out of her way to help other women feel welcome in her space. Katrina says “the personality around me makes me want to carry on coming, I guess because everyone is really nice and friendly and helpful;” she uses her time in the makerspace to invent products that can help the environment.

Barriers and challenges: Inadvertent sexism. The third conclusion of this study is that unconscious biases existed in the participants' backgrounds in techmaking and in co-ed community makerspaces, but it was not at the level of harassment suggested by Henry (2017), Fox (2015), and Reed (2018), nor did it pose any significant barrier to the participants' success in techmaking. Moreover, there was no evidence of oppression in these women's environments. This contrasted starkly to stories from other women in the literature (Cho, 2017; Faulkner & McClard, 2014; Fox, 2015; Gaudette, 2017; Hollingsworth, 2017; Intel, 2014; Wu, 2016, 2017; Toupin, n.d.).

Five of the participants did experience inadvertent sexism in their personal histories in various forms in and around techmaking. The newbie of the group, Tamra, did not share stories of inadvertent sexism in and around her techmaking, which may mean the more experienced participants were more sensitive to inadvertent sexism, especially behaviors they perceived as condescending. Jolie gets frustrated when she asks men questions in her hackerspace and they believe she is really just trying to get them to take over her project. She called it "infantilizing." Rickie finds it very offensive when she is sharing her techmaking skills online and men who have inferior skills tell her what she is doing wrong. She is also outraged when male members in the audience come up after her talks and try to explain her talks back to her. For example, she shared once gave a talk on how to make holograms and a man came up afterward and started "telling me how to build holograms. I'm like, I just told you this and you're even using the same Star Wars metaphor. I'm like, ugh!" Wendy says women get "plenty of mansplaining" at her hackerspace. Deb finds it tokenizing when male members ask her to speak for all women in her makerspaces instead of asking for her opinion on universal needs within the space. Katrina says

she experienced inadvertent sexism during college as one of two women in a 150 person degree program, but not at her hackerspace. She said,

Even amongst some of my best friends. They just assume there is a kind of inadvertent sexism they don't really realize that they're kind of talking down to you when I know I could do it just as well if not better than them sometimes. But I haven't really experienced that in makerspace which is great.

Supports and strategies: Self-determination. The fourth conclusion was that a strong sense of self-determination was an essential ingredient in the participants' persistence in techmaking and techmaking in co-ed community makerspaces. It was clear to the researcher the women in this study mirrored the descriptions of the youth in the Intel/Harris (Intel, 2014) study: hardworking, sociable, problem-solvers, and persistent. However, participants demonstrated that self-determination helped them grow into persistent adult female techmakers: Jolie began writing her own computer games at around the age of 8 and started going to the library for answers her teachers were not providing; Rickie does not feel she missed anything by not having mentors as an adult and said when she wants to learn something she visits online tutorials; Tamra was a career changer who was taking more control of her life and was determined to live a more meaningful life; Wendy described herself as "stubborn," and she sets personal goals such as making one YouTube video per week; and Katrina also called herself "stubborn" and said that nothing gets in the way of her achieving her goals. Deb is also self-reliant and does not let others drive her decisions about what she is going to do. She said it is just easier and more productive to get out of the habit of relying on others. She demonstrated what it might be like for her to try to get a group of women together to go to the makerspace,

Oh, do you want to go to this thing with me? Oh, no you don't. You think that's not interesting. You don't. You know, maybe ask a few people and then go why bother with this? It's too much scheduling. It's too hard. I'm just going to go. Yeah!

Supports and strategies: Early supports and role models. The fifth conclusion was that early supports were important in the participants' development as female techmakers. In support of Fisher and Margolis's (2003) claims that early support and role models are important to persistence in computer science-related fields, all participants spoke of having family members or others who were either inspirational or supportive of their creativity and inclination toward techmaking early in their lives. Jolie found inspiration from her world-renowned mathematician grandmother, and "someone" put a computer in her room as a child; Rickie's father taught her how to solder at the age of 5, and she was encouraged by mentors on her all-girls robotic team; Tamra's father was supportive of her artistic pursuits (although reasonably worried about her ability to make a living in the arts); Wendy's mother was an artist and father a computer programmer; Deb's parents were DIYers; and Katrina's grandfather, an electrical engineer/inventor, and father, an owner of auto-body shop, were both hugely instrumental in her persistence in tech because they taught her to be self-reliant and did not put limits on her via gender stereotyping. She said, "Luckily the people around me were able to show a passion and show interest in what I wanted to know, and that was wonderful."

Implications for Practice

Three practical recommendations to increase the persistence of female techmakers resulted from the analysis of this study's findings and conclusions. First, it is recommended that those who parent or work with extraordinarily curious children help foster that curiosity by providing or seeking accurate answers to the questions they ask. Parents and others should also

do what they can to provide resources and support to aspiring female techmakers while at the same time teaching them self-determination and giving them effective strategies to contend with self-defeating thoughts and harmful gender bias.

Second, it is recommended that educational policy in and around techmaking and makerspaces ensure that curriculum or talking points address the potential for meaningful social connections and community-serving benefits. The women in this study found the social and serving aspects of techmaking in their spaces as much as or more of an attraction than the tools. In other words, women want more than just the tools inside their makerspaces. Their projects and interactions must be meaningful, and hackerspaces wishing to increase female membership and retention need to make a concerted effort to help women identify ways in which they can become part of projects or activities that can meet their demand for deeper meaning.

Third, the conservative feminist framework can help women navigate male-dominated spaces and should taught be more widely. It should be noted that the framework and socio-political views of the participants were not discussed in the interviews; however, after analysis it was clear these successful and persistent women mostly worked within the framework. The strongest conservative feminist ideal demonstrated by the participants pertaining to this study was the ability to differentiate between irritations and injustices.

Recommendations for Further Research

Study women of color. This study was limited in its depth and complexity as it only examined the stories of Caucasian women. More research should be done to explore the stories of persistent women techmakers of color. In order to increase diversity in techmaking, is important to hear from people from all walks of life.

Study newbies. A longitudinal study of women who are new to techmaking in co-ed community makerspaces would have value because most of the women in this study have extensive techmaking backgrounds as well as extensive experience working in male-dominated arenas, so they felt a high degree of comfort with the tools and the men in these niche spaces. Additionally, they have already demonstrated strong persistence and will most likely continue to do so. It would add to the literature to follow women new to techmaking to see how, if at all, they are able to persist in these spaces. For example, Tamra, the relative newbie in this study, shared that new members have to be accompanied by keyed members for 3 months before they are awarded a key to the makerspace. She said she was happy there was usually a female board member there with her early on because it would have been more difficult to feel comfortable in the space if the keyed members were exclusively male in the beginning of her membership.

Study the perceptions of male techmakers. To further understand the dynamics between men and women in techmaking in co-ed community makerspaces, a study of the perceptions of men would be illuminating. What do men think about women techmakers in their spaces? What behaviors are women exhibiting that may be undermining relationships within these spaces? What barriers and challenges did they face and how did they overcome them? What recommendations do they have to increase women's participation in STEM and techmaking in co-ed community makerspaces?

Study social media. This study could have been improved upon if the researcher had probed into the participants' use of social media. The researcher wrote about women techmakers in social media in the literature review; however, the impact of their stories was relatively unexplored. During an interview with one of the participants after she was asked about mentors, she indicated that she was a heavy follower of women makers online. It was also only discovered

after the interviews that three of the women in the study had their own impressive online presences. The power of social media is undeniable, and this arena should be explored further to demonstrate how, if at all, it is motivating persistent women techmakers. It should also be examined to see how, if at all, it is impacting young female techmakers.

Summary

The researcher noted that the participants were enthusiastic about sharing their stories, and they were generally very happy with their makerspaces. There was no question in the researcher's mind that the women found tremendous personal satisfaction in techmaking and in the friendships they had made in their makerspaces. Although most of the participants had experienced inadvertent sexism, they were able to use humor when sharing those vignettes. They were also able to persist in spite of the annoyances they sometimes felt with men in techmaking and male members in their spaces. It is inconclusive whether these women are naturally more comfortable with men than women who have not spent as much time in male-dominated spaces might be, but it was obvious that they understood the value the men in these spaces bring to the table. All of the women appreciated the opportunities they had been afforded through their spaces, and those opportunities would not exist without male members because the spaces themselves primarily rely on male members to support them.

This study's findings support the notion that it is time to change the lens from one that focuses on oppression in techmaking to one that focuses on solutions to help strengthen the partnerships between women and men who choose to work in these spaces. It is also time to start giving men in tech the credit they truly deserve and stop blaming them as a main reason for women's lack of interest in tech or hackerspaces. Overwhelmingly, the participants spoke of the male members in this study as genuinely helpful, good people. In the press, Naomi Wu

demonized Dale Dougherty as an oppressor of women, and he will be forever shamed by liberal feminists for his unconscious bias toward Wu, but his contributions and his message should not be lost on all women because of it. It should be obvious to anyone who knows anything about the Maker Movement that Dougherty is anything but the sexist “bozo” (Gaudette, 2017, p.6) accused him of being. In fact, Dougherty is a visionary who is committed to inclusivity in the Maker Movement, and without him there would be no Make Magazine and most likely no Maker Movement for Wu to take advantage of. It should also be obvious that Wu is anything but a helpless victim.

In closing, this study was not able to answer the question of whether nature or nurture was more important in techmaking. There was no “aha” moment regarding that question; however, the women in this study were clearly not average people. They were extraordinarily articulate, intelligent, and insightful. It was also unquestionable they were all highly educated (although some more formally than others). They also all demonstrated unusual attraction to electronics and most self-identified as nerds or geeks. Only time will tell if research, initiatives, and programs will result in additional persistent female techmakers’ stories in the making.

REFERENCES

- Abir-Am, P. (2010). Gender and technoscience: A historical perspective. *Journal of Technology Management & Innovation*, 5(1). <https://doi.org/10.4067/s0718-27242010000100012>
- Allen, K., Barnett, A., Brodsky, B., Davidson, T., Evans, S. Fletcher, S., Gum, C., ... Hamilton, J. (2016). What is making? Retrieved from <https://maker.utexas.edu/making>
- Anderson, C. (2012). *Makers: The new industrial revolution*. New York, NY: Crown Business.
- Arduino. (n.d.). What is Arduino? Retrieved from <https://www.arduino.cc/en/Guide/Introduction>
- Bajarin, T. (2014, May 19). Why the maker movement is important to America's future. *Time*. Retrieved from <http://time.com/104210/maker-faire-maker-movement/>
- Bean, V., Farmer, N., & Kerr, B. (2015). An exploration of women's engagement in makerspaces. *Gifted and Talented International*, 30(1-2), 61-67. <https://doi.org/10.1080/15332276.2015.1137>
- Bilimoria, D., & Liang, X. (2015). *Gender equity in science and engineering: Advancing change in higher education*. New York, NY: Routledge.
- Bruce, T. (2014). *Feminism 2.0* [Video File]. Retrieved from <https://www.prageru.com/videos/feminism-20>
- Chafetz, J. S. (1992). *Gender equity: An integrated theory of stability and change*. Thousand Oaks, CA: Sage.
- Cho, K. (2017, November 20). A male CEO has apologized after saying that this female tech designer wasn't real. Retrieved from <https://www.buzzfeednews.com/article/kassycho/a-male-ceo-has-apologized-after-saying-that-this-female#.kbvYvz5gW>
- Corcoran, B. (2015, May 27). Dale Dougherty, father of the maker movement talks about breaking rules, erasers, & building a learning culture. *EdSurge News*. Retrieved from

<https://www.edsurge.com/news/2015-05-27-dale-dougherty-father-of-the-maker-movement-talks-about-breaking-rules-erasers-building-a-learning-culture>

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W., Hanson, W. E., Plano Clark, V. L., & Morales, A. (2007). Qualitative research designs. *The Counseling Psychologist*, 35(2), 236-264.

<https://doi.org/10.1177/0011000006287390>

Dalepd. (2017, May 26). Untitled [Online forum comment]. Retrieved from

<https://pastebin.com/PcJFQ00k>

Davies, S. R. (2017). *Hackerspaces: Making the maker movement*. New York, NY: Wiley.

Devlin, H., & Hearn, A. (2017, August 8). Why are there so few women in tech? The truth

behind the Google memo. *The Guardian*. Retrieved from

<https://www.theguardian.com/lifeandstyle/2017/aug/08/why-are-there-so-few-women-in-tech-the-truth-behind-the-google-memo>

Dougherty, D. (2012). The maker movement. *Innovations: Technology, Governance, Globalization*, 7(3), 11-14.

Dougherty, D. (2016a). *Free to make: How the maker movement is changing our schools, our jobs, and our minds*. Berkeley, CA: North Atlantic Books.

Dougherty, D. [Dalepd]. (2016b, September 16). @RealSexyCyborg hi, I'd like to understand the problems you have had with @make. We should be helpful and supportive of you and your work [Tweet]. Retrieved from

<https://twitter.com/dalepd/status/773568142089949184>

- Dougherty, D. [Dalepd]. (2017a, May 24). Not true. How to refute your many falsehoods that build on your previous lies [Tweet]? Retrieved from <https://twitter.com/dalepd/status/867505753380184064>
- Dougherty, D. [Dalepd]. (2017b, May 26). Yes, I did continue the dialog and you know it. Here is the email I wrote to you in April [Tweet]. Retrieved from <https://twitter.com/dalepd/status/868235083890671616>
- Dougherty, D. [Dalepd]. (2017c, November 4). Here is the full story: [Tweet]. Retrieved from <https://twitter.com/dalepd/status/926813927769440256>
- Dougherty, D. [Dalepd]. (2017d, November 17). My apology to Naomi Wu and the Make community. Retrieved from <https://makezine.com/2017/11/19/apology-to-naomi-wu/>
- Faulkner, S., & McClard, A. (2014). Making change: Can ethnographic research about women makers change the future of computing? *Ethnographic Praxis in Industry Conference Proceedings, 2014*(1), 187-198. <https://doi.org/10.1111/1559-8918.01026>
- Fisher, A., & Margolis, J. (2003). *Unlocking the clubhouse: Women in computing*. Boston, MA: MIT Press.
- Fox-Genovese, E. (2004). Feminism and the unraveling of the social bond. *Voices, 19*(3), 1-10. Retrieved from <https://www.catholiceducation.org/en/controversy/feminism/feminism-and-the-unraveling-of-the-social-bond.html>
- Fox, S. (2015, June). *Feminist hackerspaces as sites for feminist design*. Paper presented at the 2015 ACM SIGCHI Conference on Creativity and Cognition, Glasgow, UK. <https://doi.org/10.1145/2757226.2764771>
- Garko, M. G. (1999). Existential phenomenology and feminist research. *Psychology of Women Quarterly, 23*(1), 167-175. <https://doi.org/10.1111/j.1471-6402.1999.tb00349.x>

- Gaudette, E. (2017, November 17). Meet Naomi Wu, target of an American tech bro witchhunt. *Newsweek*. Retrieved from <https://www.newsweek.com/naomi-wu-sexy-cyborg-misogyny-silicon-valley-704372>
- Goodwin, K. [kingoodwin]. (2018, July 19). I have had more than one male colleague sincerely ask whether a certain behavior is mansplaining. Since apparently this is hard to figure out, I made one of them a chart [Tweet]. Retrieved from <https://twitter.com/i/web/status/1020029572266438657>
- Haraway, D. J. (2009). *Manifestly Haraway*. Minneapolis, MN: University of Minnesota Press.
- Hatch, M. (2014). *The maker movement manifesto: Rules for innovation in the new world of crafters, hackers, and tinkerers*. New York, NY: McGraw-Hill Education.
- Hatch, M. (2018). *The maker revolution: Building a future on creativity and innovation in an exponential world*. New York, NY: Wiley.
- Henry, L. (2014). The rise of the feminist hackerspaces and how to make your own. Retrieved from <https://modelviewculture.com/pieces/the-rise-of-feminist-hackerspaces-and-how-to-make-your-own>
- Hollingsworth, J. (2017, December). How Naomi Wu wants to change the tech scene's sexist wiring. Retrieved from <http://www.sixthtone.com/news/1001396/how-naomi-wu-wants-to-change-the-tech-scenes-sexist-wiring>
- Intel. (2014). *MakeHers: Engaging girls and women in technology through making, creating, and inventing*. Retrieved from <https://www.intel.com/content/dam/www/public/us/en/documents/reports/makers-report-girls-women.pdf>

- Kalil, T., & Santoso, S. (2015). Announcing June 17-23 as a week of making [Web log post]. Retrieved from <https://obamawhitehouse.archives.gov/blog/2016/03/09/announcing-june-17-23-week-making>
- Karlin Associates. (2012). Maker market study. *Makezine.com*. Retrieved from http://www.nyu.edu/social-entrepreneurship/speaker_series/pdf/Maker%20Market%20Study%20FINAL.pdf
- Kersten, K. (1991). What do women want? A conservative feminist manifesto. *Policy Review*, 56, 4-15.
- Koslow, T. (2017). Making amends: Make magazine & sexy cyborg resolve feud for the good of makerkind. Retrieved from <https://all3dp.com/make-magazine-sexycyborg-resolve-feud-for-the-good-of-makerkind/>
- Kugler, A., Tinsley, C., & Ukhaneva, O. (2017). Choice of majors: Are women really different from men? [NBER Working Paper] <https://doi.org/10.3386/w23735>
- Lisa Q. (2011, August 3). Noisebridge [Online forum comment]. Retrieved November 18, 2018 from <https://www.yelp.com/biz/noisebridge-san-francisco>
- Lou, N., & Peek, K. (2016). By the numbers: The rise of the makerspace. *Popular Science*. Retrieved from <https://www.popsci.com/rise-makerspace-by-numbers>
- Make. (2017). Make: Innovation +culture= education media kit. Retrieved from http://makermedia.com/wp-content/uploads/2017/02/Make_Media-Kit_2017.pdf
- Makerspace. (n.d.). In *Oxford online dictionary*. Retrieved December 1, 2018 from <https://en.oxforddictionaries.com/definition/makerspace>

- Maric, J. (2018). The gender-based digital divide in maker culture: Features, challenges and possible solutions. *Journal of Innovation Economics*, 27(3), 147-168.
<https://doi.org/10.3917/jie.027.0147>
- Noisebridge. (2018). Yelp review. Retrieved from <https://www.yelp.com/biz/noisebridge-san-francisco>
- Paglia, C. (2016). Camille Paglia explains why feminism is the collapse of western civilization [Video File]. Retrieved from https://www.youtube.com/watch?v=_AmrtzMF8bQ&t=3s
- Paglia, C. (2017). *Free women, free men: Sex, gender, and feminism*. New York, NY: Vintage Books.
- Pavlich, K. (2015). *Assault and flattery: The truth about the left and their war on women*. New York, NY: Simon & Schuster.
- Peppler, K., & Bender, S. (2013). Maker movement spreads innovation one project at a time. *Phi Delta Kappan*, 95(3), 22-27. <https://doi.org/10.1177/003172171309500306>
- Polkinghorne, D. E. (1989). Phenomenological research methods. In R. S. Valle & S. Halling (Eds.), *Existential-phenomenological perspectives in psychology* (pp. 41-60). Boston, MA: Springer. https://doi.org/10.1007/978-1-4615-6989-3_3
- Powell, A., Bagilhole, B., & Dainty, A. (2009). How women engineers do and undo gender: Consequences for gender equality. *Gender, Work & Organization*, 16(4), 411-428.
<https://doi.org/10.1111/j.1468-0432.2008.00406.x>
- Powell, D. (2013, January 17). Women in makerspaces [Online forum comment]. Retrieved from <http://lists.hackerspaces.org/pipermail/discuss/2013-January/007285.html>

- Reed, A. (2018, February 14). Feminist makerspaces: Making room for women to create. *The Riveter*. Retrieved from <https://www.therivetermagazine.com/feminist-makerspaces-making-room-for-women-to-create/>
- R/Skeptic. (2018, February 24). Naomi “Sexy Cyborg” Wu is a fake [Online forum comment] https://www.reddit.com/r/skeptic/comments/800r2m/naomi_sexycyborg_wu_is_a_fake/
- Saldaña, J. (2016). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.
- Schreiber, R. (2012). *Righting feminism: Conservative women and American politics*. Oxford, UK: Oxford University Press.
- SexyCyborg. (2016, October 26). Make magazine exclusion [Online forum comment]. Retrieved from <https://pastebin.com/Z9eP9ShE>
- Shawn L’s expulsion from hackerspaces. (2013, January). Retrieved from http://geekfeminism.wikia.com/wiki/Shawn_L%27s_expulsion_from_hackerspaces
- Sommers, C. (1995). *Who stole feminism? How women have betrayed women*. New York, NY: Simon & Schuster.
- Sommers, C. (2013). *Freedom feminism: Its surprising history and why it matters today*. Washington, DC: AEI Press.
- Sowell, T. (2015a). *Basic economics: A common sense guide to the economy*. New York, NY: BASIC Book
- Sowell, T (2015b, March 3). The honesty gap. *Townhall*. Retrieved from <https://townhall.com/columnists/thomassowell/2015/03/03/the-honesty-gap-n1964678>

- Stoet, G., & Geary, D. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science*, 29(4), 581-593.
<https://doi.org/10.1177/0956797617741719>
- Su, R., Rounds, J., & Armstrong, P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin*, 135(6), 859-884.
<https://doi.org/10.1037/a0017364>
- Terry, L. (2013, September 30). North Portland man, 43, pleads guilty in drugging, abusing women. *The Oregonian*. Retrieved from
https://www.oregonlive.com/portland/index.ssf/2013/09/north_portland_man_43_pleads_g.html
- Timeline of Incidents. (n.d.). Retrieved from
http://geekfeminism.wikia.com/wiki/Timeline_of_incidents
- Toupin, S. (2013). Feminist hackerspaces as safer spaces? *Feminist Journal of Art and Digital Culture*, (27). Retrieved from <http://dpi.studioxx.org/en/feminist-hackerspaces-safer-spaces/>
- Unterfrauner, E., Voigt, C., Schrammel, M., & Menichinelli, M. (2018). The maker movement and the disruption of the producer-consumer relation. In S. Diplaris, A. Satsiou, A. Følstad, M. Vafopoulos, & T. Vilarinho (Eds.), *Internet science: Lecture notes in computer science* (pp. 113-125). New York, NY: Springer. https://doi.org/10.1007/978-3-319-77547-0_9
- U.S. Const. art. I.

U.S. Department of Labor. (2017). Economic news release: Table 1. Fatal occupational injuries counts and rates by selected demographic characteristics, 2016-17. Retrieved from <https://www.bls.gov/news.release/cfoi.t01.htm>

Wajcman, J. (2009). Feminist theories of technology. In S. Jasanoff (Ed.), *Handbook of science and technology studies* (pp. 189-204). Thousand Oaks, CA: Sage.
<https://doi.org/10.4135/9781412990127.n9>

Wu, N. [RealSexyCyborg]. (2016, October 3). Since @make is suddenly feeling chatty. Coincidence there has not been a female midriff in the magazine in eight years? Lets talk policy [Tweet]. <https://twitter.com/RealSexyCyborg/status/783112323061784576>

Wu, N. [RealSexyCyborg]. (2017a, April 5). No no. I should be so lucky @make actually publicly admits what their problem is I wrote this: <https://pastebin.com/Z9eP9ShE> Now blacklisted [Tweet]. Retrieved from <https://twitter.com/RealSexyCyborg/status/849862333396594688>

Wu, N. [RealSexyCyborg]. (2017b, May 5). Seriously, @dalepd specifically reaches out to @realDonaldTrump. Makers need to take a hard look at what their communities are really about [Tweet]. Retrieved from <https://twitter.com/RealSexyCyborg/status/860648315091697664>

Wu, N. [RealSexyCyborg]. (2017c, May 24). Nah, @dalepd threw a tantrum because I posted this: <https://pastebin.com/Z9eP9ShE> and had me blacklisted [Tweet]. Retrieved from <https://twitter.com/RealSexyCyborg/status/867356205295038469>

Wu, N. [RealSexyCyborg]. (2017d, May 24). I want my kids to grow up in this magical White lady fantasy land where they can delude themselves that everyone has the same

opportunities [Tweet]. Retrieved from

<https://twitter.com/RealSexyCyborg/status/867360916693803008>

Wu, N. [RealSexyCyborg]. (2017e, May 26). Yup- your response to the above very reasonable

email "Thanks for writing me" with no further response or discussion [Tweet]. Retrieved from

<https://twitter.com/RealSexyCyborg/status/868235628789374976>

Wu, N. [RealSexyCyborg]. (2017f, November 3). @dalepd = MAGA (but most of you already know that and are onboard) [Tweet]. Retrieved from

<https://twitter.com/RealSexyCyborg/status/926664346465267712>

Wu, N. [RealSexyCyborg]. (2017g, November 6). Nothing will happen. Old white men like

@timoreilly don't hold men like Dale accountable for what they do to yellow women in the 2nd world [Tweet]. Retrieved from

<https://twitter.com/RealSexyCyborg/Status/927524720886497281>

APPENDIX A

Informed Consent for Participation

PEPPERDINE UNIVERSITY

Graduate School of Education and Psychology

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES

“STORIES IN THE MAKING: A PHENOMENOLOGICAL STUDY OF PERSISTENT WOMEN TECHMAKERS IN CO-ED COMMUNITY MAKERSPACES”

You are invited to participate in a research study conducted by Stacey Shinnick, Doctoral Student of Education in Educational Leadership, Administration, and Policy with Dr. Linda Purrington, Committee Chair, at Pepperdine University, because you are an adult female techmaker who has been an a long-term, active member of a co-ed community makerspace for one year, and you have used a microcontroller, laser cutter, computer numerical control machine, computer development board, open source robotics, 3D manufacturing tools or 3D printer in the past six months. Your participation is voluntary. You should read the information below and ask questions about things you do not understand before deciding to participate. Please take as much time as you need to read this form. You may also discuss participation with family and friends. You will be given a copy of this form for your records.

PURPOSE OF THE STUDY

The purpose of this qualitative, phenomenological study is to investigate the experiences and perspectives of female members of co-ed community makerspaces who are long-term, active techmakers to learn about what attracted them, any barriers/challenges they may have experienced and how they overcame them, and support they have received that has helped them persist. This study proposes to conduct individual semi-structured interviews of 6 women techmakers.

STUDY PROCEDURES

If you volunteer to participate in this study, you will be asked to participate in an approximately 60-minute, face-to-face or virtual interview with Stacey Shinnick. During your participation in the study you may be asked six demographic questions, three primary interview questions, and 10 as-needed follow-up questions that relate to your experience in techmaking in co-ed community makerspaces. The interview will be audio-recorded and later transcribed by an external transcriber. The transcriber will be asked to maintain confidentiality and the audio recording will be de-identified before being provided to the transcriber. If you choose not to be recorded, the researcher will ask to take written notes. You will be given a \$50 Amazon gift card at the end of the interview as an incentive for your participation.

POTENTIAL RISKS AND DISCOMFORTS

The potential and foreseeable risks associated with participation in the study include mental fatigue or loss of personal time for the length of the interview session.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

While there are no direct benefits to the study participants, there are several anticipated benefits to society which include: This study could encourage more women to explore techmaking through an understanding of the practices and strategies used by those who overcame obstacles to persist in co-ed community makerspaces. Current and future techmakers may be able to benefit by implementing the practices of persistent women techmakers. This study may provide women techmakers strategies to use when dealing with adverse conditions in co-ed community makerspaces. This study may provide information to help community makerspaces increase female membership and participation. It may provide insights that help to close the gender gap in computer-science related fields, and it may provide insights to why many girls lose interest in STEM during adolescence.

CONFIDENTIALITY

The records collected for this study will be confidential as far as permitted by law. However, if required to do so by law, it may be necessary to disclose information collected about you. Examples of the types of issues that would require me to break confidentiality are if disclosed any instances of child abuse and elder abuse. Pepperdine University's Human subjects Protection Program (HSPP) may also access the data collected. He HSPP occasionally reviews and monitors research studies to protect the rights and welfare of research subjects.

The data will be stored for a minimum of three years on a password protected computer in the researcher's place of residence. The data collected will be de-identified, transcribed by an external transcriber, and coded. Any identifiable information obtained in connection with this study will remain confidential. Your responses will be coded with a pseudonym and transcript data will be maintained separately. The audio-recordings will be destroyed once they have been transcribed.

SUSPECTED NEGLECT OR ABUSE OF CHILDREN

Under California law, the researcher, who may be a mandated reporter, will not maintain as confidential, information about known or reasonably suspected incidents of abuse or neglect of a child, dependent adult or elder, including, but not limited to, physical, sexual, emotional, and financial abuse or neglect. If any researcher has or is given such information, he or she is required to report this abuse to the proper authorities.

PARTICIPATION AND WITHDRAWAL

Your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study.

ALTERNATIVES TO FULL PARTICIPATION

The alternative to full participation in the study is not participating or only completing the items for which you feel comfortable. Participation in this study will not in any way, shape or form infringe upon the relationship between you and your employer.

EMERGENCY CARE AND COMPENSATION FOR INJURY

If you are injured as a direct result of research procedures you will receive medical treatment; however, you or your insurance will be responsible for the cost. Pepperdine University does not provide any monetary compensation for injury.

INVESTIGATOR'S CONTACT INFORMATION

You understand that the investigator is willing to answer any inquiries you may have concerning the research herein described. You understand you may contact Stacey Shinnick (Researcher) at [REDACTED] or email [REDACTED]; or Dr. Linda Purrington (Committee Chair) at [REDACTED] or email [REDACTED]; if you have any other concerns or questions about this research.

RIGHTS OF RESEARCH PARTICIPANT- IRB CONTACT INFORMATION

If you have questions, concerns, or complaints about your rights as a research participant or research please contact: Dr. Judy Ho (GPS IRB Chairperson) at [REDACTED] or email at [REDACTED]

APPENDIX B

Interview Instrument

Active women Techmakers who are Long-term Members of Co-ed Community Makerspaces

Pseudonym of interviewee: _____

Location of Interview: _____

Date of interview: _____ Time of interview: _____

- Thank the participants for their time.
- Review the purpose of the study.
- Remind participant that the interview will be recorded and the researcher may also take notes.
- Remind the participant she can stop at any time.

Demographic Questions for Participants

1. Are you between the ages of 18-28, 28-40, or over 40?
2. What college degrees or credentials do you hold?
3. What is your profession?
4. How many years have you been techmaking?
5. How many years have you been a member of a co-ed makerspace?
6. What is the nature of your techmaking?

Section 1: Attraction to techmaking and co-ed community makerspaces.

Primary 1. What were the circumstances that led you to join the makerspace?

Follow-up 1a. What were the circumstances that led you to begin techmaking?

1b. What experiences, if any, have you have had with respect to

sustaining your motivation to continue your participation in techmaking?

1c. What were your desired outcomes in joining the makerspace?

1d. What are the key factors, if any, that motivate you to continue your membership?

Section 2: Challenges and barriers in techmaking in co-ed community makerspaces.

Primary 2. What significant challenges, if any, have you faced in a co-ed makerspace?

Follow-up 2a. Were there unique factors you experienced as a woman?

2b. What issues or challenges, if any, have you faced in techmaking?

2c. Were there unique factors you experienced as a woman?

Section 3: Strategies, supports and recommendations.

Primary 3. What strategies, if any, do you use to continue techmaking in the co-ed makerspace, and how might your strategies help future female techmakers be successful in co-ed makerspaces?

Follow-up 3a. What supports, if any, do you use to continue to techmake in the co-ed makerspace?

3b. Can you tell me about any mentors who assisted you?

3b. What recommendations do you have for other female techmakers to assist them in persisting in their pursuits in co-ed community makerspaces?

- Ask if there is anything else the participant would like to share.
- Thank them again for their time and participation.

APPENDIX C

Expert Review and Pilot Interviews

Original Questions Sent to Experts for Review

Section 1: Attraction to techmaking and co-ed community makerspaces.

1. What were the circumstances that led you to begin techmaking?
2. Can you detail some experiences that you have had with respect to sustaining your motivation to continue your participation in techmaking?
3. What were the circumstances that led you to join the makerspace?
4. What were your desired outcomes in joining the makerspace?
5. Can you tell me about the key factors that motivate you to continue your membership?

Section 2: Challenges and barriers in techmaking in co-ed community makerspaces.

- 6a. Can you tell me about issues or challenges have you faced in techmaking?
- 6b. Were there unique factors you experienced as a woman?
- 7a. Can you tell me about significant challenges that you faced in a co-ed makerspace?
- 7b. Were there unique factors you experienced as a woman?

Section 3: Strategies, supports and recommendations.

8. What strategies did you employ to start and continue techmaking in the makerspace, and how might your strategies help future women techmakers navigate these spaces successfully?
 9. Can you tell me about any mentors who assisted you?
 10. What recommendations do you have for other female techmakers to assist them in persisting in their pursuits in co-ed community makerspaces?
- Ask if there is anything else the participant would like to share.

- Thank them again for their time and participation.

Expert Review of Instrumentation

The first expert, Dr. Davies, thought the study was interesting, and she commented the questions were good and would get the researcher the type of responses the researcher is seeking. The main concern this expert expressed was the amount of questions. She suggested since researcher was thinking of relatively short, one-time interviews, the researcher may want to consider having just one primary question in each section, with others as potential further prompts or follow-up questions if the primary question does not illicit rich enough response. She was concerned that if all questions were asked there is a danger that participants will get fatigued, bored, or they may end up having to repeat themselves. She also strongly recommended piloting my questions with a woman maker who will not be participating in the study or with a friend or colleague because even if they do have experience with the topic, the researcher will be able to assess the extent that the questions make sense to them.

The second expert, Katherine Kersten, thought the topic was excellent. She thought the questions were the right questions to ask, were phrased clearly, were organized logically. She also thought the study presented an effective methodology for approaching the subject.

Alterations to Original Instrument Based Upon Expert Review

Based upon these recommendations, the researcher kept the questions intact but redesigned the interview instrument to include primary and follow-up questions in each section. In section one, question three became the primary question and the other questions became the follow-up questions that will be asked as needed. In section two, question 7a became the primary question and others as follow-up as needed. In section three, question eight became the primary

questions and others will be used as follow up questions as needed. Additionally, questions 2, 5, 6a, and 7a were altered to be more open-ended.

Pilot Interviews

After the original interview instrument was reviewed by experts, two pilot interviews were conducted to test the effectiveness and clarity of the questions. The first pilot interviewee thought the questions were clear and she was able to answer them with relatively strong understanding of the questions, with the exception of primary question number three. She recommended modifying the question by using language that could be more easily understood. The second expert suggested that section three should be more specific to elicit richer responses.

Alterations to Revised Instrument Based Upon Pilot Interviews

Based upon the first interviewee suggestions, the researcher changed the language in primary question three from “did you employ” to “did you use.” Based upon discussion with the second expert, it was decided that strategies should be the focus in the primary question in section 3, with the focus on supports in a follow-up question because participants may only answer to one or the other if grouped together. This may prevent the depth the researcher seeks. For example, the interviewee may simply answer that they have a babysitter as a support but fail to mention deep mental coping mechanisms or strategies that help her deal with adverse conditions in a co-ed makerspace. The primary question was also modified to include clearer language, which could potentially help the participant feel more comfortable with the researcher (i.e., that the researcher is more personable and relatable).

APPENDIX D

Participant Recruitment Email

Dear (Name),

My name is Stacey Shinnick, and I am a doctoral student in the Graduate School of Education and Psychology at Pepperdine University. I am conducting a research study examining females' persistence in techmaking in co-ed community makerspaces. If you agree to participate in this study, you are invited to participate in a one-on-one semi-structured interview. I plan to recruit six to ten participants.

The interview is expected to take approximately 60-minutes and it will be audio-recorded. Participation in this study is voluntary; however, a complimentary \$50 Amazon gift card will be given at the end of the interview to thank you for your time. Your identity as a participant will remain confidential during and after the study. Your identity will be protected by assignment of an alias. The audio-recording and any written notes from the interview will be destroyed after the dissertation is completed.

If you have any questions or would like to participate, please contact me at:

[REDACTED]

Thank you for your consideration,

Stacey Shinnick
Pepperdine University
Graduate School of Education and Psychology
Doctoral Student

APPENDIX E

Recruitment Advertisement

Seeking long-term (1 year +), active, female techmakers to participate in an interview for a study conducted by Stacey Shinnick, Educational Leadership, Administration, and Policy Doctoral Program at Pepperdine University, doctoral student.

Approximately 60 Minutes
\$50 Amazon Gift Card

For more information please contact:
Stacey Shinnick



APPENDIX F

Follow-Up Email

Dear _____,

This is a follow-up email to see if you are interested in participating in my study examining persistence of female long-term techmakers in co-ed community makerspaces. You are one of six or more women who are active members of co-ed community makerspaces who were asked to participate in an approximately 60-minute semi-structured interview. If you are available for this study, please contact me as soon as it is convenient so we can schedule the interview.

Sincerely,

Stacey Shinnick

Pepperdine University

APPENDIX G

Email Declining Potential Participant

Dear (Name),

Thank you for your response and willingness to participate in my study. At this time, I have already recruited the maximum number of subjects. I appreciate your interest in my research and wish you the best in your techmaking.

Sincerely,

Stacey Shinnick

APPENDIX H

Pepperdine IRB Approval



Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263
TEL: 310-506-4000

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: January 22, 2019

Protocol Investigator Name: Stacey Shinnick

Protocol #: 18-12-927

Project Title: STORIES IN THE MAKING: A PHENOMENOLOGICAL STUDY OF PERSISTENT WOMEN TECHMAKERS IN CO-ED COMMUNITY MAKERSPACES

School: Graduate School of Education and Psychology

Dear Stacey Shinnick:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

