Exploring the Relationship of E-textiles and STEM in Middle School Girls and Underrepresented Youth: A Mixed Methods Approach

Project #3 Dr. Carnahan

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Chapter I: Introduction

Introduction

Lego's, 3D printers, building book based video games with Raspberry Pi, Scratch programming, Drones, and Ozobots are just a few of the tools and technology that one might find in a middle school makerspace. The maker movement, a broad term to describe inventors, designers and tinkerers, will, according to according to the NHC/CoSN Horizon Report: 2017 be expected to be adopted in some manner schools, in one year or less. Making, or the process of hands-on creating that may include using technologies, is not a new concept. Since humans have roamed the earth, they have invented, tinkered, created art, tools, and other useful items to improve their existence. Makerspaces most recently have come to the forefront, as a "new" phenomenon, since the three locations in Germany in 2005. (Davis, 2017) Makers are traditionally older, white, males and activities reflected "typical" male projects or interests. (Barton, Tan, & Greenberg, 2017)) School libraries, communities, and recently, classrooms (Hira & Hynes, 2015) are all places where makerspaces are beginning to surface with more regularity. Of particular interest is increasing the presence of girls and underrepresented youth participation in makerspaces. Since girls and minorities are underrepresented in middle school makerspaces (Hira & Hynes, 2015) (Baron, Tan, & Greenberg, 2017) (Cross, 2017) perhaps the consideration what kinds of makerspace offerings of tools, projects and technology needs to be considered. Maker activities that may be more appealing to the interests of girls and underrepresented youth. Offering maker activities that include fashion and programming, such as e-textiles, may be a way to interest girls and underrepresented youth into a traditionally male dominated culture.

By offering more diverse activities, in makerspaces, in the middle school years when students are most likely to lose interest in science (Tofel-Grehl, et.al., 2017) perhaps they will become more engaged and interested in pursuing STEM related professions when they have had a change to

"tinker" with a maker activity that is more relatable. Research is showing that the engagement of girls and minorities in makerspace activities, early in their educational career, may positively increase student attitudes toward STEM careers and, if students indicate early that they are interested in a STEM field, they are 3.5 times more likely to earn degrees in physical science and engineering (Buechley, Eisenberg, et. al., 2008). Further exploration of the relationship of how e-textiles may attract girls and underrepresented youth to makerspaces, which in turn could pique an interest in future STEM professions is worth more in depth research. .

Statement of the Problem

The NMC/CoSN Horizon: 2017 K-12 Education Report notes that the National Science Foundation (NSF) recently granted $1.5 million for five "early-concept grants with the aim of cultivating new approaches to making in STEM education." One of the grants examines the role that makerspaces play in improving participation from underrepresented youths in STEM subjects (pg. 40). Barton, Tan, & Greenberg (2017) also report that there are gaps in "achievement and interest" in science, technology, engineering, and math (STEM) subjects among youth who grow up in poverty or are from lower-income communities. As the maker movement continues to grow and be more accessible to students, either in school or in after-school programs, it is of the utmost importance to increase interest and participation in these makerspaces by girls and other underrepresented youth if there is a correlation to increased interest in STEM professions. A study of the literature shows that there seems to be some validity to the relationship between engagement in maker activities, in middle school for this population, and that it is likely to increase interest in STEM subjects which may ultimately improve the numbers of girls and underrepresented youth who then go on to pursue STEM professions. (Taylor, 2016) Currently there is very little research based on e-textile use in

makerspaces and their impact to attract underserved populations (other than white males). Considering makerspaces are still relatively new to schools additional research, both qualitative and quantitative data collection, would give a much more complete and in depth picture of this relationship. (Creswell, Plano Clark, 2011, pg. 151)

Purpose

This purpose of this mixed methods study will address middle school girls and underrepresented youth ages 11- 14, engagement in e-textile activities in a makerspace as a conduit to increase interest in STEM classes and future STEM professions. A convergent parallel mixed methods design will be used. This is a type of research design in which qualitative and quantitative data are collected in parallel, analyzed separately, and then merged. (Creswell & Plano Clark, 2011) In this study, qualitative-closed ended data instruments such as interest surveys for STEM Career Interest Survey (STEM-CIS) (Appendix A) and Makespace interest survey (Appendix B) data collection will be used to discuss the theories of constructionism (Papert & Harel, 1991) and learning in a community of practice (Lave & Wenger, 2018). Constructionism or the building of knowledge through "hands-on" learning or *making* suggests that the learner, when engaged in constructing or making, gains knowledge. (Ackerman, 2001) Tangentially, learning in a community of practice (CoP) (Wenger-Traynor, 2018) will positively influence and increase the interest in STEM fields for middle school girls and underrepresented youth (ages 11-14) participating in a after school club. The qualitative data collection will include, interviews, observations, journaling and artifacts which will help to explain the interest in e-textile activities in a makerspace for middle school girls and underrepresented youth at the after-school club. The reason for collecting both quantitative and qualitative data is to corroborate the findings. (Creswell, Plano Clark, 2011)

Research Questions

1. (QN) How does involvement with e-textiles in a makerspace relate to interest in STEM fields/professions for girls and underrepresented youth at an after-school club?
2. (QL) How does interest in pursuing STEM classes in high school or STEM professions in college change for girls and underrepresented youth involved in makerspaces activities using e-textiles in an after-school club?
3. (MM) Does working with e-textiles in a makerspace environment help to increase interest in STEM classes and pursuing a STEM profession in college? (Does the qualitative data help explain the initial quantitative phase of study?)

Limitations

Some potential limitations of this study may be a small sample size that does not have enough girls or underrepresented youth. Frustration with learning new skills such as sewing or coding may initially discourage students from being increased interest in STEM subjects/professions. There may be too large of a student-teacher relationship which may have students waiting with unanswered questions which may also be frustrating (it may also allow them to try something on their own, or talk with other students to find an answer) Students of middle school age may not be able to understand the relationship of working with e-textiles to STEM fields.

Chapter II: Literature Review

> There is anecdotal evidence (Butler personal communication; Hass n.d.) that where the circulation of knowledge among peers and near-peers is possible, it spreads exceedingly rapidly and effectively. The central grounds on which forms of education that different from schooling are condemned are that changing the person is not the central motive of the enterprise in which learning takes place. The effectiveness of the circulation of information among peers suggests, to the contrary, that engagement in practice, rather than being its object, may well be a *condition* for the effectiveness of learning. (Lave & Wenger, 2016, pg. 93)

Introduction

The growing implementation and use of makerspaces in communities and schools (most often in library spaces) as a way to interest students in meaningful learning has not been lost on the science, technology, engineering, and math (STEM) populace. Long dominated by white males there is interest in having makerspaces be more inclusive.(Barton, Tan, Greenberg, 2017) Additionally, Barton, Tan, & Greenberg (2017) note that the Maker Movement specifically the use of e-textiles, may be a possible way to further increase involvement girls and underrepresented youth in making.

The review of the literature will offer a brief examination of how the engagement in makerspaces by girls and underrepresented youth, specifically using e-textiles, may serve to increase interest in STEM subjects as future professions. The research will show that the quantitative data reflects the current interests and engagement of girls and underrepresented youth. The research related to the qualitative data discusses the use of e-textiles and how they not

only engage in, but how it may affect interest within this population, potentially pursuing STEM careers. Finally, the recent research indicates that working in makerspaces with e-textiles may increase the engagement and interest of underrepresented youths in participation of STEM subjects as well as future interest in STEM fields.

Broadening Participation in STEM through science class

Current research is attempting to understand vocational interests of Hispanic, African-American, and White students in Hira & Hynes (2015) article *Broadening Participation in Engineering: Making in the K-12 Classroom Following an Interest-Based Framework*. A survey of 570 6th-8th grade urban middle schooler found that females and students whose primary language is Spanish, showed a higher interest in artistic and social themes while males and African Americans scored higher on areas related to the Realistic scale (pg. 4). Considering the social and artistic nature of makerspaces, this research, along with the constructivist theories of Papert and Wenger's social learning theory, support the idea that makerspaces may be the venue that will not only engage more girls and underrepresented youth in makerspaces but increase their interest in STEM. This research specifically looks at bringing *making* into the classroom, but this could also support students making in after-school venues as the "process of learning not only takes place within an individual, but also in the environment that the individual is exposed to." (Hira & Hynes, 2015, pg. 5) While this paper posits that social and artistic themes may engage underrepresented populations the research does not explore the characteristics of certain cultures that may make these makerspaces more enticing to these makers, or what other types of maker activities might align with STEM.

A few years later Utah State University was interested in finding out if e-textiles in the classroom would improve interest in science class. Their effort to diversify the "pipeline of prospective STEM workers" and fill what they call a "participation gap" led to them to find what they call an "identity gap" of "underrepresented groups who struggle to see themselves as STEM professionals. (Tofel-Grehl, Fields, Searle, Maahs-Fladung, 2017) This study also showed evidence that engaging students in middle school was important. This was the first "controlled, comparative study of e-textiles and traditional electronic curricula in classroom science." Findings suggest that the group working with the e-textiles may have social support from connections with teachers, family, and friends. They also conclude that this kind of engagement (with e-textiles) converge with "qualitative studies that have described increased engagement with underserved populations, including urban youth and American Indian youth." (Tofel-Grehl, Fields, Searle, Maahs-Fladung, 2017) These finding certainly indicate the need for further study for e-textile makerspaces both in and out of the classroom.

Cross's (2017) dissertation, while focusing on "makerspaces in schools as an application of constructivist learning in schools," proposes research that early engagement in makerspaces supports the play and exploration that exposes children to the "identity of a mathematician, explorer, architect, historian or physicist allows children to explore these 'hats' without negative repercussions." (pg. 28) She suggests that these opportunities might lead to earlier STEM interest. Cross comments that the "masculine garage-style set up" of makerspaces may be potentially off-putting to females (and I would proport underrepresented youth). However, with more user-friendly coding software (like Scratch, from MIT, or Hour of Code) and activities that have their roots in crafting, like the Arduino LilyPad (kits that contain sewing projects that use conductive thread and a programming component to make an e-textile). These activities may

make makerspaces more enticing for females and other underrepresented youth according to her research because of the more artistic, social, and historically female craft component.

E-textiles in Makerspaces as opportunity to engage girls and underrepresented youth

As far back at 2008, Buechley, Eisenberg, Catchen, & Crockett introduced the use of the LilyPad Arduino in their presentation in Florence, Italy *Using Computational Textiles to Investigate, Engagement, Aesthetics and Diversity in Computer Science Education.* While not specifically addressing the STEM fields (a relatively new phenomenon) in their article, they discussed important factors about why e-textiles might be engaging to a wider range of diverse people and ultimately increase interest in computer programming. They proposed that textiles, particularly clothing, play an important part in societal roles. The close ties that clothing/textiles have with a person's gender, religious belief, and class (to name a few) make it an activity that might reach a wider audience than just white males. Paramount to those findings were three other important findings that may affect the involvement of girls and underrepresented youth early in STEM, makerspace activities. A study at the University of Virginia indicated that 1) "early personal preference and interest is more predictive of career choice than performance on traditional measures of achievement like standardized tests" 2) if students, as eighth graders, expected to earn a degree in physics or engineering they were 3.5 times more likely to do so, and finally, 3) students will "seek out and continue to participate in activities they enjoy, and that a peer culture, which does not support achievement, can have a strong negative affect." (pg. 427) Students that were involved in the e-textile experience had positive experiences with peers, were engaged in cutting-edge technology while working on a projects that were important to their everyday lives as well as having the ability to personalize it. (Buechley, Eisenberg, Catchen, &

Crockett, 2008, pg. 429) Further studies could add validity to this study as well as help to further understand the relationship between e-textiles and STEM.

Working with e-textiles to increase interest in STEM fields

Since working in apparel design utilizes a lot of mathematics as well as spatial design, it seems like a logical connection to potential STEM activities. In Apple, Smith, Moon & Revelle's (2016) article *Teaching Modules Using E-Textile Activities to Engage Female Middle-School Students in STEM Interest* they facilitated a project whose goal was to introduce activities which were rooted in traditionally female domains: sewing, crafting, fashion, and apparel design. Again, their research showed that middle school is a critical time to engage and retain students' interest in STEM. The four different modules offered students differentiation in complexity as well as the opportunity to personalize the projects. The results indicated that students had a more favorable view of STEM after they completed their projects. Because of this positive relationship with e-textiles and makerspace activities, further investigation to corroborate these findings is warranted.

Chapter Summary

This literature review has examined the attempts to understand what kinds of maker activities may be more inclusive of girls and underrepresented youth in makerspace activities. While there is a gap in the literature to confirm specific needs, there is indication that there needs to be more research to understand how to increase engagement using e-textiles as well as how it can positively impact increased interest in STEM. Also, understanding what kind of a relationship is emerging between makerspaces and its effect on STEM engagement would be noteworthy. Working with e-textiles in makerspaces has begun to show that girls and underrepresented youth are more interested and engaged in makerspaces especially when there

are more “historically female” craft like maker activities. The research may also indicate that this interest and engagement in e-textile makerspace activities may boost STEM engagement in girls and underrepresented youth. More research is needed to corroborate the current findings.

Chapter III: Methodology

Introduction

The overall purpose of this mixed methods convergent parallel design (Creswell, 2011) is meant to better understand how to engage middle school age girls and underrepresented youth (ages 11-14) in makerspaces in hopes that it will increase their interest in future STEM fields. Currently there is an inequity in the number of girls and underrepresented youth in makerspaces. (Barton, Tan, & Greenberg, 2017) By increasing interest in makerspaces offerings that include "interest-driven, student-centered projects with hands-on materials and digital fabrication technologies" or e-textiles, the intention is to attract "non-dominant" groups to participate in these makerspaces. (Tofel-Grehl, Fields, Maahs-Fladung, Searle, 2017) The engagement in more "traditional domains like sewing, crafting, fashion, and apparel design" have been shown to be more interesting for underrepresented populations like girls and minorities. (Apple, Smith, Moon, Revelle, 2016) Additionally, research indicates that middle school is a critical time to engage and retain interest for students. If there is to be growth in STEM fields and professions by girls and underrepresented youth interesting them as early as middle school is important. (Barton, Tan, & Greenberg, 2017) (Buechley, Eisenberg, Catchen, & Crockett, 2008) (Cross, 2017)

This study will be conducted using interest surveys, questionnaires, individual interviews of students engaging in creating e-textiles in makerspaces. Finally, journals and artifacts made by students, will be displayed, shared and discussed with each participant and the group as a whole. (Creswell, 2018., pg. 212)

Research Design

Conducting a convergent parallel mixed methods study (Creswell, Plano Clark, 2011, pg. 77) will be the "best way to answer the following research questions because it will collect and then analyze, two independent strands of qualitative and quantitative data in a single phase." (Creswell, Plano Clark, 2011, pg. 116). The timing of the research design, beginning at the start of the study, with the quantitative strand, a closed-ended survey followed by the qualitative strand, followed by open-ended interviews and journaling of the participants involvement in the makerspace activities. These will happen at the beginning, middle, and end of the study. The end of the study ends (after eight weeks) and participants will take the same closed-ended survey to see if they have differing opinions since the beginning of the study. Both of these strands will have equal weight (Creswell & Plano Clark, 2011, pg. 65) This multiphase combination timing is conducted over three or more phases and works best for this mixed methods convergent parallel design. (Creswell & Plano Clark, 2011, pg. 66) Because the two strands will be converged and analyzed for any convergence, divergence, contraindications, or relationships between the two data sets (Creswell, Plano Clark, 2011, pg. 116) the use of the convergent parallel method will allow for a better understanding of how the qualitative and quantitative data will support the findings that girls and underrepresented youth will be more interested in makerspaces if they are able to engage in e-textile activities and ultimately an interest in STEM. The convergence of the qualitative and quantitative data will help to answer the following research questions (Creswell & Plano Clark, 2011, pg. 163):

1. (QN) What is the interest and current engagement of girls and underrepresented youth in STEM related makerspace activities?

2. (QL) How does interest in pursuing STEM classes in high school or STEM professions in college change for girls and underrepresented youth involved in makerspaces activities using e-textiles in an afterschool club/camp?
3. (MM) Does working with e-textiles in a makerspace environment help to increase interest in STEM classes and pursuing a STEM field in college? (Does the qualitative data help explain the initial quantitative phase of study?)

Population & Sample

The population for both the qualitative and quantitative phases of this study will come from all middle school students ages 11 -14 from an upper middle class, diverse community with a total population of over 950 in the middle school. The population of middle school age students ranging in ages from 10 - 15 years of age, have the following demographic breakdown: 83% White, 4.5% Black or African-American, 0.14% Native American, 6.3% Asian, 0.01% Pacific Islander, 2.84% other races, 2.56% from two or more races, 13.29% Hispanic or Latino of any race. (United States Census, 2010) Students identified as Black or African American, Native American, and Hispanic or Latino of any race make up approximately 18% of the middle school population.

The school, as a whole, is representative of the population that the sample will come from. The quantitative strand will be a convenience sample since participation will be voluntary coming from sign ups in the library. (Creswell, 2015, pg.144). Students go to the library before school, during lunch (when the library does not have an academic class in session), and after school, so the middle school librarians will announce/advertise the after-school club and encourage students to sign up (recruitment for both qualitative and quantitative will be the same as stated above). The size of the sample will be limited to no more than fifteen students (N=15)

since there will be only two teacher-facilitators. (This may be adjusted for future club/camp/workshops in order to accommodate more students and increase the size of the sample. If the club is able to run for a second time, the total sample size could double to up to 30 students total (*N*=30) (assuming no one enrolls again). Selecting a non-probabilistic group of girls and underrepresented youth may be selected for the qualitative strand. (Creswell & Plano Clark, 2011, pg. 174) But, depending on the size of the group (ten or less) the sample size will stay the same for both strands. Having a smaller group (and only girls and underrepresented youth) to interview should not limit the study. (Creswell & Plano Clark, 2011, pg. 181)

Procedures

1. Select at most, 15 middle school students who are interested in being involved in an e-textile makerspace after-school club. Students will be made aware of the after-school club for e-textiles makerspace activities that will be offered for 8 weeks, 1 hour sessions each. (Since the middle school is predominantly white with approximately 18% ethnically diverse population the hope is that girls and underrepresented youth will show more interest because the offering is a non-traditional makerspace offering.) (Creswell, Plano Clark, 2011, pg. 118)
2. Obtain permissions from parents of minors (Appendix A)
3. Obtain IRB permission from NJCU observing all appropriate timeframes (online link).
4. Obtain site permissions from Human Resources of the school district and receive permission to conduct said study and have it approved by the local Board of Education.
5. Parallel questions for both qualitative and quantitative data set collection, from two sources will include: (Creswell & Plano Clark, 2011, pg. 181)

a. (QN) Interest survey *The STEM Career Interest Survey (STEM-CIS (*Appendix B) (permission letter as needed - Appendix C) will be given to all participants on day one of the program.

b. (QN) Interest survey (related to makerspaces, and makerspace activities interest & knowledge) will be given to all participants on day one of the program. (Appendix D)

6. (QL) Data sources will include:

a. (QL) Interviews: 2-4 unstructured, open-ended interviews that will be audiotaped and transcribed. This will occur on day one of the program (beginning, at four weeks, and at the end of the club, week 8) Questions (incomplete list) (Appendix E)

b. (QL) Ongoing self-reflection about their artifacts in a journal, either online or in a paper journal about their session. This may include writing or drawing about what they did and questions they might have, frustrations, "wonderings" etc. Questions and comment related to STEM will be asked at each session.

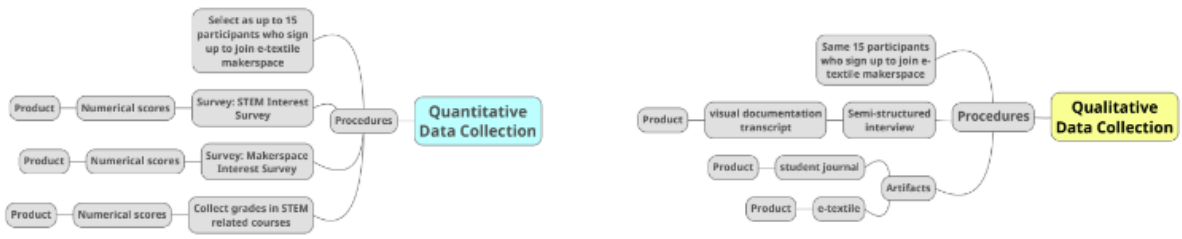
Table 1
Research Questions, Data types, and Data Source

Research Question	Data Type	Data Source
What is the interest and current engagement of girls and underrepresented youth in STEM related makerspace activities?	QN	STEM Survey (Appendix A) Makerspace Survey (Appendix B)
How does interest in pursuing STEM classes in high school or STEM professions in college change for girls and underrepresented youth involved in makerspaces activities using e-textiles in an afterschool club/camp?	QL	Open-ended Interview Questions (Appendix C) Journal entries/student artifacts

Does working with e-textiles in a makerspace environment help to increase interest in STEM classes and pursuing a STEM field in college?	QN QL	Survey (Appendix A) (QN) Open-Ended Interview (Appendix B) (QL)

Table 1

Figure 1.0 Diagram for a Study of Qualitative and Quantitative Data Collection Using Convergent Parallel Design (Creswell & Plano Clark, 2011, pg. 118)



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7. Data collection issues (as noted in Creswell & Plano Clark, 2011, pg. 240) would be considered and addressed (ie: selecting inappropriate individuals, obtaining unequal sample sizes, potential bias, collecting two types of data that do not address the same topics)
8. QN data would be analyzed and compared with original pre-survey questions an classified as to whether there was support for increased (decreased, or no effect) interest in STEM subject and a potential interest in STEM professions.
9. QL data would discuss any themes and student perceptions of their experience with e-textiles and their feelings of engagement and interest in what they did and how it might

have an impact on future engagement in makerspaces and STEM classes or future professions. (Creswell & Plano Clark, pg.118)

10. The QL and QN results will be merged: Procedures would include "cross tabulation qualitatively derived groups with quantitative variables, with the products as a matrix relating qualitative themes to qualitative variables." (Creswell & Plano Clark, pg.118)
11. Interpretation procedures will "consider how the merged results will produce a better understanding" of the QN & QL data combined leading to a discussion of the final results. (Creswell & Plano Clark, pg.118)
12. Data analysis issues (as noted in Creswell & Plano Clark, 2011, pg. 240) would be considered and addressed (ie: inadequate approaches to converge the data, making illogical comparisons of the two results, utilizing inadequate data transformation approaches and inadequate statistics to analyze)
13. Interpretation issues (as noted in Creswell & Plano Clark, 2011, pg. 240) would be considered and addressed (ie:not resolving divergent findings, not discussing mixed methods research questions, giving unequal weight to data, not interpreting in an advocacy or social light, not relating stages in a multiphase study, noting/discussing irreconcilable differences)

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Appendix A

Sample 2. Participants are Minors/Graduate Student as Researcher

Dear Parent/Guardian:

I am a graduate student in the (Name) Department at New Jersey City University. I will be conducting a research project under the supervision of (Faculty Mentor here) as part of my master's thesis concerning how children make decisions and develop strategies when playing games. I am requesting permission for your child to participate in this research. The goal of the study is to determine how strategy development changes as the children mature.

Each child will be invited to play a game during the recess period and will be led to a quiet corner of the recess yard. Any child who expresses a desire not to play will be escorted back to the main area of yard immediately. While playing the game, each child will be asked a series of questions and will be videotaped. I will retain the videotapes at the conclusion of the study. To preserve each child's confidentiality only first names will be used to identify individuals. The videotapes may be viewed by other researchers when the data are presented at a professional conference. All data will be reported in terms of group results; individual results will not be reported.

Your decision whether or not to allow your child to participate in this study will have absolutely no effect on your child's standing in his/her class. At the conclusion of the study a summary of the group results will be made available to all interested parents. If you have any questions or concerns please contact me at 201-555-5555 or you may contact (Faculty Mentor) at (Phone) or Dr. Beimnet Teclezghi, Chair of NJCU Institutional Review Board, at 201-200-3139 or email bteclezghi@njcu.edu.

Sincerely,

Karen J. Cotter

Please indicate whether or not you wish to have your child participate in this study by checking the appropriate statement below and returning this letter to your child's teacher by February 1, 20XX.

- ❑ I grant permission for my child _____ to participate in this study.
- ❑ I do not grant permission for my child _____ to participate in this study.

_____ _____

Parent/Guardian Signature Date

_____ _____

Signature of Principal Investigator Date

Appendix B

(Submit permission form if needed Appendix B)

The STEM Career Interest Survey (STEM-CIS) measures interest in STEM classes and careers, particularly in middle school students. Leveraging social cognitive career theory, the STEM-CIS contains four subscales: science, technology, engineering, and mathematics. The STEM-CIS is a 44-item survey that uses a 5-point Likert scale.

The linked site provides both the STEM-CIS and its documentation.

Authors provide instrument validity and/or reliability information.

[NOTE: Fee or membership is required to access.]

http://stelar.edc.org/instruments/stem-career-interest-survey-stem-cis

Appendix C

Letter Seeking Permission to Use Survey/Questionnaire Tool

April 26th, 2018

Name: Karen J. Cotter
Institution: New Jersey City University
Department: Educational Technology
Address: 2039 Kennedy Boulevard
City/State/Zip: Jersey City, New Jersey, 07930

Dear Sir/Madam:

I am a doctoral student from New Jersey City University writing my dissertation titled *How the use of Makerspaces Impacts the Well-being of Middle School Students,* under the direction of my dissertation committee chaired by Dr.Carnahan, who can be reached at 908-246-2683. The New Jersey City University IRB Committee Chair can be contacted at xxx-xxx-xxxx or by mail at 2039 Kennedy Boulevard, Jersey City, New Jersey, 07930.

I would like your permission to use the Development of the Australian Student Well-being survey/questionnaire instruments in my research study. I would like to use and print your survey under the following conditions:

· I will use the surveys only for my research study and will not sell or use it with any compensated or curriculum development activities.

· I will include the copyright statement on all copies of the instrument.

· I will send a copy of my completed research study to your attention upon completion of the study.

If these are acceptable terms and conditions, please indicate so by replying to me through e-mail: kcotter@njcu.edu

Sincerely,

Karen J. Cotter
Doctoral Candidate

Appendix D

These are two surveys that could be used in whole, or in part as pre/post survey for the participants:

Makerspace interest survey

https://www.surveymonkey.com/r/L8JQCH6

Makerspace interest survey

https://www.surveymonkey.com/r/WH7Y6HS

Appendix E

Individual interview questions may include:

1. What activities interest you the most and why?
2. Do any of these activities have a cultural feel? If so, why, why not, and how could they?
3. Do you feel that being involved in these activities has changed the way you participate in, or feel differently about, your classes (specifically STEM classes)?
4. Have you seen any change in grades since you began working at the e-textile makerspace activity?
5. Any other comments or insights?