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Femineer® Program: A Model for Engaging K-12 Girls in STEM

Dr. Kristina Rigden, California State Polytechnic University, Pomona

Dr. Kristina Rigden is the Director of Outreach Programs and the Women in Engineering Program for the College of Engineering at California State Polytechnic University, Pomona (Cal Poly Pomona). In her position, she provides several different outreach programming events to engage K-12 female students to pursue STEM majors and/or careers. Dr. Rigden holds a B.A. in Liberal Studies from Cal Poly Pomona, a TESOL certificate, a M.A. in Teaching with a multiple-subject credential and an Ed.D. from the University of Southern California.

Dr. Mariappan Jawaharlal, California State Polytechnic University, Pomona

Dr. Mariappan "Jawa" Jawaharlal, Professor of Mechanical Engineering at California State Polytechnic University in Pomona, has more than 20 years of academic, industrial and entrepreneurial experience in engineering and is renowned for his innovative, engaging teaching pedagogy. He received the California State University System's highest honor, the Wang Family Excellence Outstanding Faculty Award, as well as the Provost's Award, the Northrop Grumman Award for Excellence in Teaching, and a Fellowship in the Biomimicry Institute. At Rowan University in Glassboro, NJ, he was one of the first faculty members recruited to develop a new engineering program with a $100 million donation.

Dr. Jawa is founder and director of Robotics Education through Active Learning (REAL), a K-12 outreach robotics program that educates thousands each year and culminates in the Annual Robot Rally, the nation's largest robotics event. He also co-founded the Femineers (Female Engineers), which the White House recognized for its empowerment of young women to become engineers.

Since founding an online education company in 1998, Dr. Jawa has developed hundreds of interactive, engrossing learning modules, online tutorials, and CSU course redesigns focusing on bottleneck courses. He has brought many new engineering and robotic products to market from mere concept stages. He also writes columns for The Huffington Post and Medium on various K-12 and higher education topics. A marathon runner and scuba diver, he has completed 25 marathons and has run across the Grand Canyon from rim to rim to rim.

Nicole Gutzke, Cal Poly Pomona

Ms. Nicole Gutzke is the Outreach Liaison with Cal Poly Pomona College of Engineering (CoE). As the Outreach Liaison, she is heavily involved in growing Cal Poly Pomona's PLTW Summer Core Training Institute into a seven-week event that introduces hundreds of K-12 educators to the latest in STEM-related curriculum. As the Outreach Liaison, Nicole helps to recruit, retain, and graduate hundreds of female engineers each year through outreach events. Nicole also provides support for the CPP CoE Femineers™, a program that was recognized by the White House in 2015.

Femineer® Program: A Model for Engaging K-12 Girls in STEM
A Study of Year Two Curriculum: Wearable Technology

Abstract

The Cal Poly Pomona College of Engineering Femineer® Program is a unique and innovative program devoted to inspiring and empowering K-12 female students to pursue STEM majors and careers. Created in 2013, the program enhances the College of Engineering's commitment to support underserved populations by recruiting and graduating increased numbers of historically underrepresented students. The Femineer® Program currently consists of three years of curriculum: Creative Robotics, Wearable Technology, and Pi Robotics. This mixed method research to practice study determined if the Wearable Technology curriculum addressed 21st century learning skills and factors in STEM confidence in the Femineer® students. The results from this study showed that Femineer® students developed programming and circuitry skills, learned how to use tools, and the female students utilized cooperative learning in their environment.

OVERVIEW OF THE STUDY

The Cal Poly Pomona College of Engineering Femineer® Program is a unique and innovative program devoted to inspiring and empowering K-12 female students to pursue STEM (Science, Technology, Engineering, and Mathematics) majors and careers. Created in 2013, the Femineer® Program enhances the College of Engineering's commitment to support underserved populations by recruiting and graduating increased numbers of historically underrepresented students.

Research has shown that men outnumber women in the STEM field. According to the National Science Foundation, 20.5% of Engineering Bachelor degrees were awarded to women in 2004 and 19.8% were awarded in 2014 [1]. This data has shown that women are earning less Engineering Bachelor degrees and there has not been much progress since 2004. The Femineer® Program wants to fix this problem by giving K-12 girls access to STEM curriculum, and the desire and confidence to pursue STEM degrees in university.

The Femineer® Program is a three year hands-on curriculum consisting of a 30-hour project each year: Creative Robotics, Wearable Technology, and Pi Robotics. Creative Robotics focuses on Scratch programming by using the Hummingbird control platform. The robot structure is open-source and includes a controller board, sensors, motors, and real wiring. Wearable Technology concentrates on C programming with an Arduino chip control platform, sewing with conductive thread, and soldering. The focus of Pi Robotics is on Raspberry Pi by using the Python programming language to build a robot and give tasks to the robot to perform. The skills that the Femineer® students are learning in this three-year program entail skills that engineering students are exposed to in college; however, the Femineer® students are able to learn the curriculum through hands-on experience and become confident in these skills before entering college.

A pilot quantitative study was completed with the Creative Robotics curriculum with eight schools, 173 participants, in the 2016-2017 academic year. Some of the findings from this study showed that 92% of participants agreed or strongly agreed that they "enjoyed participating in the Femineer® Program" and 81% of participants agreed or strongly agreed that they "learned to solve engineering problems in the Femineer® Program." With the Creative Robotics curriculum, 78% of respondents agreed or strongly agreed that they "liked programming with the Hummingbird controller." With these positive results, it is important to evaluate year two of the curriculum.

This study will have three student-focused outcomes: 1) engage in critical thinking and project-based learning, 2) learn technical engineering skills such as programming, and 3) have STEM confidence which will be measured with two mixed-method research questions: How does the Wearable Technology curriculum address 21st century learning skills, such as critical thinking and programming? and What factors are involved in identifying STEM confidence in the Femineer® students? These research questions will enable the participation of the Femineer® teacher and students. The Femineer® teacher has been trained on year one and two of the curriculum and she has successfully taught a cohort of 36 female students in Creative Robotics. This will be her first year teaching a cohort of Wearable Technology. This study about 21st century learning skills and STEM confidence will add to the body of research about female high school students in STEM [2].

LITERATURE REVIEW

This brief literature review will examine 21st century learning skills with the outcomes of critical thinking, project-based learning, and programming skills. Elements of STEM confidence will also be presented. This literature review will illustrate the themes of 21st century learning skills and STEM confidence which will build the foundation for the study.

21st Century Learning Skills

The following studies present information on 21st century learning skills. One outcome of 21st century learning skills is the 4Cs of learning and innovation skills: critical thinking, communication, collaboration, and creativity [3]. Another outcome is information, media, and technology skills which cover information literacy, media literacy, and information and communications technology (ICT). The category of ICT includes computer science and coding/programming. The outcome of critical thinking and ICT will be utilized to answer the first research question and is illustrated in the conceptual framework.

Critical Thinking

Critical thinking dates back to the American philosopher John Dewey who defined it as reflective thinking. Dewey defined reflective thinking as "…the ground or basis for a belief is deliberately sought and its adequacy to support the belief examined" [4]. This definition evolved into intellectual abilities and skills by Benjamin Bloom who developed Bloom's taxonomy of educational objectives [5]. Currently, P21 classifies critical thinking as reasoning effectively, using systems thinking, making judgements and decisions, and solving problems [3].

Critical thinking is important to develop in students. The Femineer® Program is able to help students develop critical thinking skills by introducing systems thinking into the Wearable Technology curriculum. This will enable students to discuss their Wearable Technology project and think about how to program the project so it will be successful.

Project-Based Learning

The Femineer® Program encourages students to engage with the curriculum in a hands-on capacity. Hands-on learning helps students process abstract concepts while connecting them to the desired educational outcomes [6]. Using a hands-on approach can help foster 21st century skills and enhance student achievement [7]. Hands-on learning is an integral part of the Femineer® Program.

The Femineer® curriculum is based upon a 30-hour project that students complete throughout the year. With project-based learning, the instructional approach empowers students to work collaboratively to solve a complex problem [8]. In the Femineer® projects, students are working together to program, design and develop wearable technology. In this environment, the students have created their own collective community and are eager to help each other and learn together.

Programming Skills

The 21st century learning outcome of ICT involves coding/programming. This is important since "STEM occupations include computer scientists and mathematicians; engineers and architects; life, physical, and social scientists; medical professionals; and managers of STEM activities" [9]. According to ISACA, the United States will need 1.4 million workers in computer-related fields in 2020 and the U.S. will only be able to fill 29% of those jobs [10]. This shows that coding is becoming a critical job skill of the future. When one learns coding, it can help lay out a plan, evaluate the methodology, troubleshoot problems, and implement a strategy.

STEM Confidence

Albert Bandura's self-efficacy theory will be used to define STEM confidence. Albert Bandura's self-efficacy theory is developed in the field of behavioral change and he states that "…cognitive processes mediate change but that cognitive events are induced and altered most readily by experience of mastery arising from effective performance" [11]. The mastery that arises from this effective performance is defined as confidence. Confidence is the self-belief in people's competence or chance to successfully complete a task [12]. Perceived self-efficacy or confidence in students is defined as the students' beliefs in themselves to regulate their own learning, level of motivation, and master academic activities, which lead to academic accomplishments [13]. Self-efficacy theory is used in this study to help students develop STEM-confidence and is illustrated in the conceptual framework below. From the prior research conducted on STEM-confidence, the variables of STEM-confidence are student views of teachers, comparison to peers among class size, and perceptions of the field as rewarding [14] – [17]. These three variables will be used to answer the research question.

Conceptual Framework

Presented below is the conceptual framework, which builds on the concepts and supports and informs the research (Maxwell, 2013). This framework builds on the different concepts presented to strengthen the study and inform the research questions.

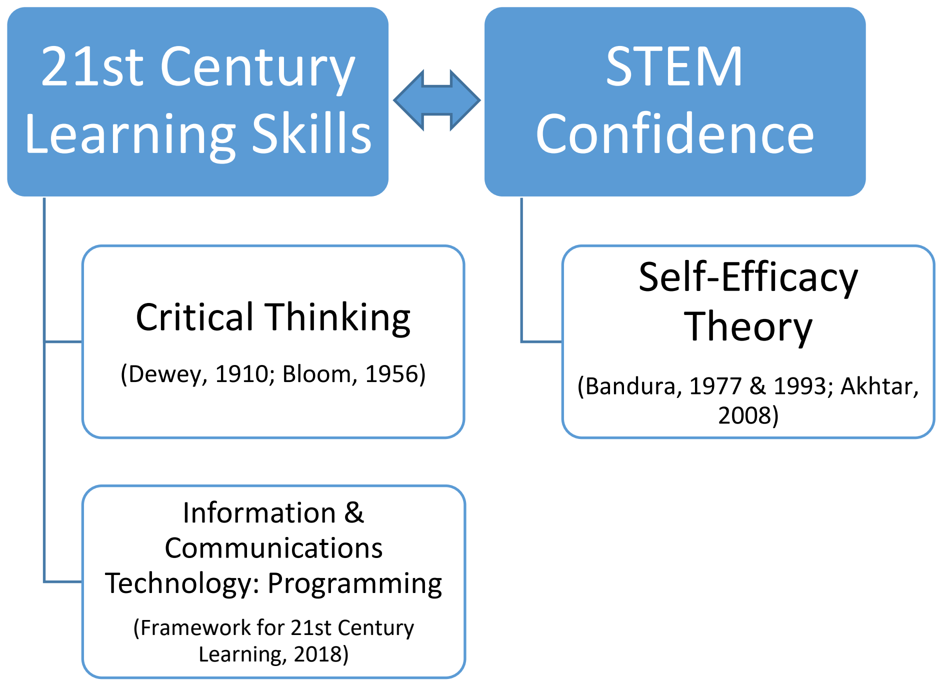

Figure 1. 21st century learning skills and STEM confidence conceptual framework.

RESEARCH DESIGN METHODS

The researcher used mixed method methodology, which enabled comprehensive data to be collected. Mixed method methodology is a combination of qualitative and quantitative research that guides the philosophy and research design [18]. This study utilized observations, interviews, focus groups, document collection, and a survey.

For this mixed method research study, several pieces of data were collected. First, observations occurred in the classroom. The observations consisted of a firsthand encounter. Next, an audio-recorded interview took place with the Femineer® teacher. Audio-recorded focus groups took place with the Femineer® students. The interview and focus groups helped gather the teacher and student's thoughts and opinions of the Wearable Technology curriculum, which cannot be directly observed in a classroom setting [19]. In addition, a pretest and posttest-survey was distributed to Femineer® students. Lastly, document collection of the Wearable Technology curriculum took place.

Sample

The participants were found by purposeful sampling. Purposeful sampling enabled the researcher to connect with participants that provided particular information that was relevant to answering the research questions [20]. The setting for this study was a classroom at a public high school in San Diego County.

Participants

The participants for this study was the Femineer® teacher and Femineer® students who were new to the program and those that have already completed year one curriculum of Creative Robotics. There were 26 Femineer® students that took part in this study. Pseudonyms will be used for the participants.

Data Collection and Instruments/Protocol

This research study is comprised of observations, an interview, focus groups, a survey, and document collection to answer the research question. Multiple methods of data collection were utilized.

Observations

Observations were used during the study to help answer the research questions. The researcher conducted three one-hour long observations in the classroom when the Femineer® students were working on their Wearable Technology projects. Observations gave the researcher a firsthand account of the actions that took place during the class. The observations took place after the pretest survey and before the interview, focus groups, and document collection. The participants were observed and the observer made notes on critical thinking and project-based learning, technical engineering skills such as programming, and STEM confidence. These notes aligned with the conceptual framework.

Interview

One audio-recorded and transcribed interview took place with the Femineer® teacher. The interview was conducted face-to-face and lasted 25 minutes. Notes were taken during the interview. After the interview, the audio-recorded interview was transcribed. The interview took place after the observations. The interview protocol addressed the different types of interview questions to stimulate responses from the Femineer® teacher [19]. With the different types of interview questions, the interview started with an experience question and then moved to knowledge and feeling questions.

Focus Groups

Audio-recorded and transcribed focus groups took place with the Femineer® students. The focus groups were conducted face-to-face and lasted 20 minutes. There were 26 Femineer® students that participated in the focus groups. Notes were taken during the focus group. After the three focus groups, the audio-recorded focus groups were transcribed. The focus groups took place after the pretest survey and observations. The focus group protocol addressed the different types of focus group questions to stimulate responses from the Femineer® students [19]. With the different types of focus group questions, the focus groups started with an experience question and then moved to knowledge and feeling questions.

Survey

A survey was given to the Femineer® students before and after their interaction with the

Wearable Technology curriculum. The same survey was given to the students twice. Twenty-six Femineer® students took the pretest-survey in October 2018 and posttest-survey in March 2019. The survey was given to the students on paper and it took ten minutes to complete.

Document Collection

Submission of documents consisted of the Wearable Technology curriculum. The curriculum was collected from the Femineer® teacher. Although there was no protocol for document collection and analysis, elements of critical thinking and project-based learning, programming, and STEM confidence were analyzed according to the conceptual framework. These documents were used as triangulation to support the participants in the study.

Data Analysis

The data was analyzed using mixed methods to identify 21st century learning skills in the Wearable Technology curriculum and STEM confidence in the Femineer® students. The results of the quantitative pretest and posttest survey were compared to each other and transformed from numeric codes to narrative data so the results were analyzed concurrently with the qualitative data. The survey data; interview transcript with the Femineer® teacher; focus group transcript with the Femineer® students; observation notes; and curriculum was printed out so they were coded. All of the words or phrases about 21st century learning skills and/or STEM-confidence was typed into an excel document with a definition and a page number to refer to the raw data. These words or phrases became the 218 open codes. After color-coding the open codes that were similar, this resulted in 15 axial codes of categories. Similar axial codes were combined which resulted in three selective codes. The researcher used the selective codes to help answer the research questions.

Credibility and Trustworthiness

Triangulation helped with credibility through the interview and focus group transcripts, observations, and documents. In addition, the researcher participated in member checks. Member checks enabled feedback from the participants in the study to gain their insight to see if the researcher captured all of the data accurately (Maxwell, 2013). These elements facilitated credibility and trustworthiness in the study.

Ethics

All participants in the study were given an informed consent form that addressed the details of the study. The consent forms were provided in English and Spanish to the Femineer® students' parents since the students were under the age of 18. The researcher explained the purpose of the study to all participants and set up additional time to meet with participant's parents in case they had any questions or concerns about the study. The researcher promised all participants that their interview responses and focus group responses would remain confidential. The responses were coded under a pseudonym and kept on a password-protected computer in the researcher's office.

FINDINGS

The purpose of the study was to identify 21st century learning skills in the Wearable Technology curriculum and STEM confidence in the Femineer® students. This mixed method study had one Femineer® teacher and 26 Femineer® students. The basis of analysis was developed from the conceptual framework of 21st century learning skills and STEM confidence. The researcher conducted three in-person observations, one in-person audio-recorded interview with the Femineer® teacher and three in-person audio-recorded focus groups with the Femineer® students. Pretest and posttest-surveys were collected from 26 students. The researcher engaged in document collection consisting of the Wearable Technology curriculum which consisted of 146 pages. The data collected from this study addressed the following research questions: How does the Wearable Technology curriculum address 21st century learning skills, such as critical thinking and programming? and What factors are involved in identifying STEM confidence in the Femineer® students?

To answer this research question, the researcher used mixed methods to engage in observations, interviews, pretest and posttest-surveys, and document collection to triangulate the credibility and trustworthiness of the study's findings. The researcher analyzed the data and the findings were constructed to offer an answer to the research questions. Pseudonyms were used for all participants in the study to ensure identities were kept private (IRB-18-148).

Analysis of the Findings

This analysis will address if the Wearable Technology curriculum addressed 21st century learning skills and the factors involved in identifying STEM confidence in the Femineer® students. The findings will be addressed by using the three selective codes from the codebook analysis described in the data analysis section. First, the two selective codes of programming and circuitry, and tools and skills will be described in detail to answer the first research question. The second research question will be discussed using the third selective code of cooperative learning in an all-female environment.

Wearable Technology curriculum

The two selective codes of programming and circuitry, and tools and skills will be used to answer the first research question: How does the Wearable Technology curriculum address 21st century learning skills, such as critical thinking and programming?

Programming and circuitry. The curriculum starts with an introduction of terminology. For example, programming, microprocessors, microcontroller, and algorithms are all defined. The explanations are clearly stated and illustrations are present of the hardware that students will use to execute the projects. Here is a clear explanation of learning how to code taken directly from the teacher's manual:

> For many students, learning how to program is both exciting and scary. Once students have a solid foundation in the different programming blocks, they will be able to create more advanced programs. Some myths surround programming:
> 1. Computer programming is hard.
> 2. It is meant for geeks and nerds.

3. You need certain innate ability to program.

None of this is true. In fact, learning to programming is fun. We make decisions every day: some simple decisions, such as what to eat, or more difficult ones, such as where to invest money. Whether a decision is easy or difficult, we follow logic to arrive at our conclusion. This is pretty much at the heart of programming. So, everyone can learn to program. Becoming an expert programmer requires hard work and practice, just like it takes time to become an expert in in any field. But acquiring basic programming skills is easy and fun. You can easily help your students to overcome the fear of programming by starting them off right.

Some students in your class may speak a second or even a third language. Ask them what languages they speak. Emphasize that we need to speak in English to understand each other, as that is our common language here in the U.S. If we want to go to Sweden and live there for a while, it will be nice to know the Swedish language, so we can communicate with everyone.

Similarly, if we want computers to do what we want, we must communicate our instructions to the computer in a language it can understand. As people can understand different languages, so can computers. The good news is: computer languages, such as C, Python, etc. are easier to learn than human ones. In our class, we will learn Arduino C programming language to communicate with our wearable learning platform. (Mariappan, 2017, pp.65-66)

In the pretest-survey that was given to students, 45% of students disagree or strongly disagree that they can code or program, 48% said they neither agree nor disagree, and only 7% said they agree or strongly agree. In the posttest-survey that was given to students, 52% of students disagree or strongly disagree that they can code or program, 30% said they neither agree nor disagree, and only 18% said they agree or strongly agree. Although the percentage increased from 7% to 18% on students agree or strongly agree that they can code or program, the percentage increased from 45% to 52% on disagree or strongly disagree regarding coding. The students may have not felt confident in their programming skills in regards to the Wearable Technology curriculum.

Another question on the survey asked students about their confidence in engineering skills. Results on the pretest-survey showed 34% of students agree or strongly agree that they have confidence in their engineering skills, 48% said they neither agree nor disagree, and 18% said they disagree or strongly disagree. Results on the posttest-survey showed 40% of students agree or strongly agree that they have confidence in their engineering skills, 49% said they neither agree nor disagree, 7% said they disagree or strongly disagree, and 4% of respondents did not answer this question.

The final project of the Femineer® program approaches a multidisciplinary nature of programming and circuity to make a wearable technology gadget that students can wear and show off. By allowing students to create their own wearable gadget, electronics can become engaging and interesting. Time to work on and develop the final project is woven into the curriculum. The Femineer® teacher commented that she does not feel like she is having to rush through the curriculum in order to accelerate the final project. In addition, none of the Femineer® students remarked that they felt overwhelmed by the content or rushed to finish their project for the class.

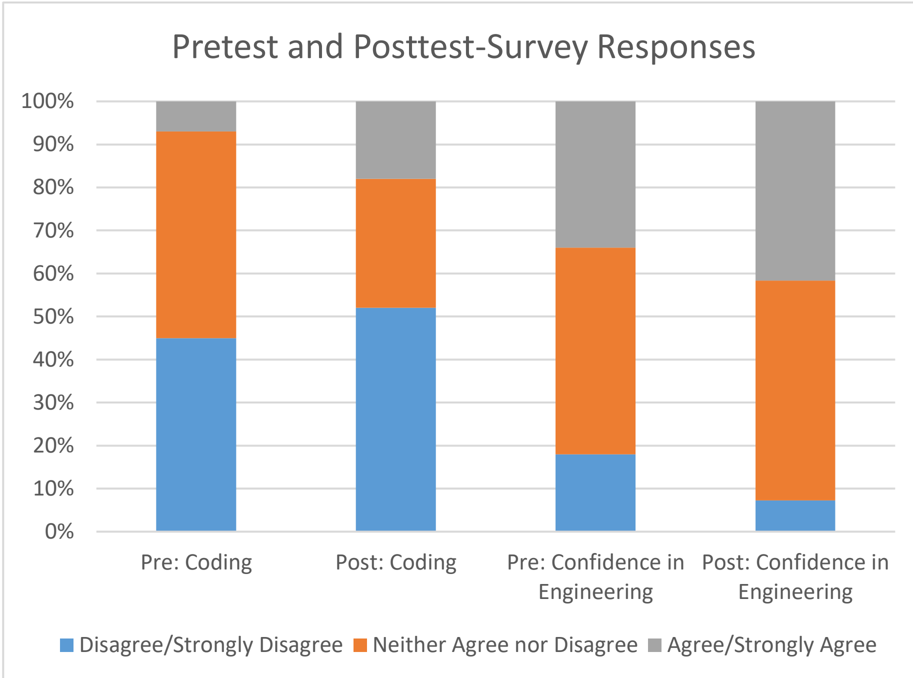

Figure 2. Pretest and posttest survey responses for coding skills and perceived confidence in engineering.

Tools and skills. In the description of the curriculum, sewing is mentioned as an important skill to learn so Femineer® students know how to use conductive thread to sew electrical circuits. There is one unit in the curriculum that describes conductive thread, conductive fabric, needle sizes, and two YouTube video links for a running stitch and a back stitch. Throughout the interview with the Femineer® teacher and the focus-groups with the Femineer® students, several of them mentioned sewing. The Femineer® teacher stated that students were learning the basics of sewing by watching videos and remembering not to cross lines since the circuit will short circuited. A Femineer® student stated that "we also used our sewing skills to critically think about what we're doing." In the focus group, five Femineer® students mentioned the importance of sewing with conductive thread and learning how parallel and series circuits work.

Many of the activities presented in the curriculum have a hands-on component. For example, one of the optional activities is to taste the electricity. The students are told to use a 9V battery and to touch both the terminals of the battery using their finger. Students should not feel anything since dry skin is a poor conductor. Students are then told to lick both terminals of the battery and they may feel a tingling sensation. This is because saliva is a better conductor than skin.

Another hands-on component of the curriculum is learning how to operate a multimeter to measure voltage, resistance, and current. It was observed that each Femineer® student in the classroom had a multimeter and the teacher walked through step-by-step directions of what all the buttons do on the multimeter and how to use it. The students were given the opportunity to measure voltage with a coin cell battery and a 9V battery, measure resistance with a resistor, and current with a LED-coin cell battery circuit. One of the Femineer® students remarked how she learned about different batteries and learned how to make a LED structure. These hands-on components show how students are able to learn how to use the tools and skills to successfully complete the task of the assignment.

In the survey that was given to students, there were four thinking skill questions pertaining to the students and the Femineer® Program. Results from the pretest-survey showed 90% of students agree or strongly agree that they can explain their ideas, 83% agree or strongly agree that they can understand relationships between things, 90% of students agree or strongly agree that they can make a decision, and 90% agree or strongly agree that they can solve problems. Results from the posttest-survey showed 65% of students agree or strongly agree that they can explain their ideas, 83% agree or strongly agree that they can understand relationships between things, 74% of students agree or strongly agree that they can make a decision, and 74% agree or strongly agree that they can solve problems. The results of the pretest and posttest-survey responses are presented to the left.

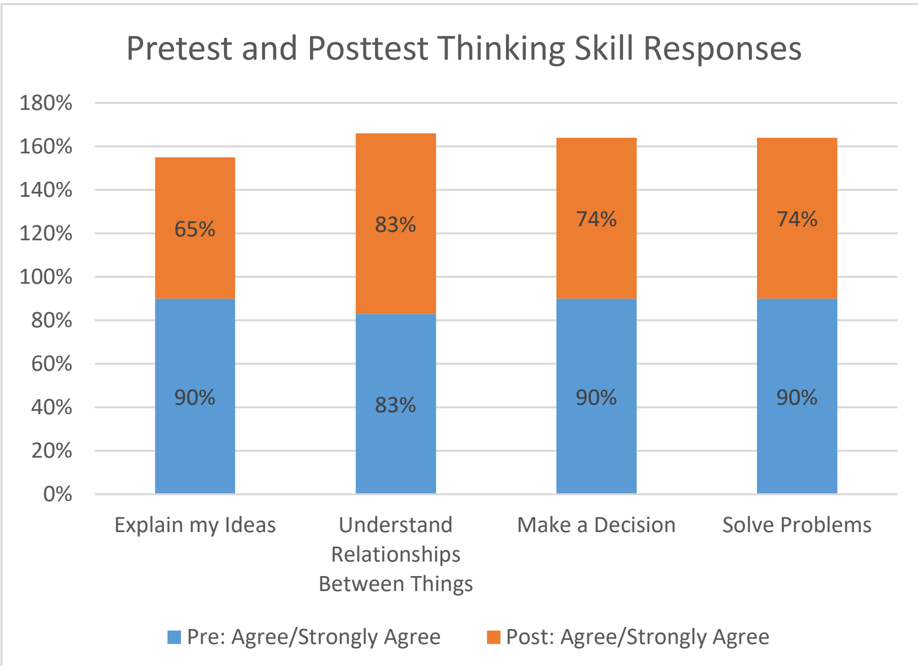

Figure 3. Pretest and posttest responses on the thinking skills of being able to explain my ideas, understand relationships between things, make a decision, and solve problems.

Twenty-first century learning skills were mentioned in the interview with the Femineer® teacher and the focus groups with the Femineer® students. Common definitions and examples of 21st century learning skills ranged from: using technology as a part of the learning process, using Chromebooks, learning what not to do so the item does not break or burn, incorporating technology into something to make it more functional, and hands-on learning experiences. One Femineer® student stated how she believed 21st century learning skills was "where common core is holding us back and over complicating student's lives." Another Femineer® student relayed how the skills she is learning in the Femineer® class are "…things we as youth need to be taught or should be taught in order to thrive and better today's world." Another student said that she is happy to learn about a profession that is male dominated and she finds it fun to know something that the boys in the school do not know, like wiring an LED and how circuit boards work.

STEM Confidence

In order to answer the second research question (What factors are involved in identifying STEM confidence in the Femineer® students?), the third selective code of cooperative learning in an all-female environment will be described.

First, it is important to define confidence. The Femineer® teacher and students had many different definitions and examples of confidence: brave, proud, greatness, believing in yourself, expressing your ideas without being scared, no fear of failure, and being self-assured. One student said “confidence is when you are able to be yourself and don’t let anyone else bring you down. It’s when you’re able to do things that you know how to do without letting anyone tell you otherwise. It means you’re strong and don’t give up.” Another Femineer® student said confidence is expressing yourself and being you no matter how many times someone tells you to change.

The definition of STEM confidence collectively according to the Femineer® teacher and students is being able to communicate your ideas with your peers, keep trying until you succeed, and persevere. Some examples provided from the study population are allowing your imagination to run wild with no limitations, expressing your ideas, messing up and still moving forward, and trusting the process. The Femineer® teacher remarked that STEM confidence is being able to fully understand an engineering concept by seeing it, doing it, and then teaching a peer how to do it. Many of the Femineer® students mentioned that they were able to teach their peers in the Femineer® classroom because it was a welcoming, comfortable, and judgement free environment.

Although one of the interview and focus groups questions specifically asked about learning a female-only STEM classroom, many students discussed their thoughts and perspectives about this while answering the other focus group questions. Some of the Femineer® students commented that they felt more confident to make mistakes around each other, and that the classroom is a different dynamic since it feels more productive. Another Femineer® student said “I am not a total feminist or anything, but it is nice to collaborate with other intelligent girls who share the same interest.” Many of the Femineer® students noted that they wanted to help each other and learn together as a cohort.

This theme of cooperative learning was apparent not only in the interview and focus groups, but also the classroom observations. When the Femineer® teacher was lecturing about the multimeter and how to use it, the female students were quietly writing down the notes and drawing the diagrams that the teacher was drawing on the board. When it was time to work, the students paired up in small groups and began working quickly and quietly. If one student had trouble with something, another student would rush over to help the student with the task.

In the survey that was given to students, there were questions about working collaboratively and being in a female-only classroom. In the pretest-survey responses, 100% of students agree or strongly agree that they can work collaboratively with their peers. Ninety percent of students agree or strongly agree that they feel confident with fellow Femineer® students and 93% agree or strongly agree that they feel confident around the Femineer® teacher. While these percentages are high, only 62% of students agree or strongly agree that they like being in a female-only classroom. The posttest-survey responses show that 95% of students agree or strongly agree that they can work collaboratively with their peers, 91% of students agree or strongly agree that they feel confident with fellow Femineer® students and 100% agree or strongly agree that they feel confident around the Femineer® teacher. In the posttest-survey, 65% of students agree or strongly agree that they like being in a female-only classroom, which illustrates how the experience of being in a female-only classroom has slightly increased from the posttest-survey results.

It is important to point out that Grace Hopper and Ada Lovelace are mentioned in the chapter introduction to show women are represented in STEM fields. But none of the Femineer® students or teacher mentioned these women, nor were they mentioned in the three classroom observations.

Summary of Findings

The Wearable Technology curriculum does address 21st century learning skills, such as programming and circuitry, and tools and skills. The explanation of learning how to program and the type of language that the computer uses is very clear to the students. The students also have time to experiment with circuitry with their final Wearable project since the teacher does not feel like she has to rush through the curriculum right away. The tools like the multimeter and the skills like sewing with conductive thread and fabric are important to the students to know how to use them correctly. STEM confidence seemed to be generated in being in an all-female learning environment of cooperative learning, with the percentage slightly increasing on the posttest-survey results. Cooperative learning was described as the feeling of being welcome, helping others, making mistakes together and not being embarrassed if a mistake was made.

Implications for Practice

The results of this study can inform future revisions to the Wearable Technology curriculum. The curriculum does allow for learning, development, and growth of 21st century skills such as collaboration and creativity [3]. The hands-on component of every lesson in the curriculum empowered students to process abstract concepts [6].

Learning in an all-female classroom led to a cooperative learning environment as the posttest-survey results showed the percentage rising from 62% to 65%. The students wanted to work together in a collective community to learn together [8]. The variables of STEM confidence as described in the literature review are student views of teachers, comparison to peers among class size, and perceptions of the field as rewarding [14] – [17]. The student view of feeling confident around the Femineer® teacher was 93% agree or strongly agree pretest-survey and 100% posttest-survey. The female students in the class did not seem to compare themselves to each other, but did state that they were 90% confident around each other in the Femineer® Program pretest-survey and 91% posttest-survey. Quite a few students mentioned pursuing engineering in university; 82% pretest and posttest-survey. The majority of students mentioned that engineering was a male dominated field and the reason they liked the Femineer® Program was because being in an all-female classroom led to a congenial learning environment.

Recommendations for Future Research

The curriculum did address 21st century learning skills, but more observations would be necessary toward the end of the curriculum unit when students are working on their final project to observe elements of critical thinking. More research would need to be conducted on the impact of the gender of the Femineer® teacher. In this study, the Femineer® teacher was female and all the students were female. It would be interesting to see the dynamic of a male Femineer® teacher in a classroom with all female students.

Conclusion

This study examined year two curriculum, Wearable Technology, of the Femineer® Program and STEM confidence in Femineer® students. The first research question was answered by describing the elements of 21st century learning skills that was in the curriculum, observed in the classroom, and mentioned in the interview and focus groups. The definition of confidence and STEM confidence was depicted within the third selective code of cooperative learning. Recommendations for further study include more observations of the classroom when students are constructing their final project and possibly having a male Femineer® teacher in an all-female classroom.

Acknowledgements

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