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Creating a Future with Female Coders; Supporting Women Through Community

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CREATING A FUTURE OF FEMALE CODERS; SUPPORTING WOMEN THROUGH COMMUNITY

by

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A Creative Thesis Submitted in Partial Fulfillment
Of the Requirements for a Degree with Honors
(New Media)

The Honors College

University of Maine

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Advisory Committee:
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Abstract

"In the last two decades, the proportion of women earning bachelor's degrees in computer sciences has declined from 28% to 18% (NSF/NCSES 2015c), even though the proportion of freshmen women declaring a computer sciences major when first enrolled in a 4-year institution has remained stable (at about 20% in recent years)" (NSF, Retention of Women in Computer Science). My undergraduate capstone aims to lessen the amount of women dropping out of computing fields by creating a sense of community. The key components and benefits of community that I targeted were peer support, shared experience, confidence and interest. I approached each of these topics on their own, and created a website to bring together the different parts of the project. I have benefitted greatly from what I have learned over the course of this project, and my hope is that this will be passed on to those who engage in the project.

Acknowledgements

I want to thank the women in my life who got me to this point. My mother, for raising me to be fearless. The authors who taught me that I am a warrior and to fight for what is right, rather than what is easy. My teachers, who pushed me to reach higher and dig deeper. My peers, who got me through my education, one class at a time. My friends, for supporting me through the lows in my life. And all the amazing women I continue to meet who inspire me and show me the worlds that are there to pursue.

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The Project's Inception

When setting out to do a New Media capstone and Honors thesis, I knew I wanted to spend my year doing something that would drive me to learn, create, and find meaning in the path I had chosen for my education and career. My undergraduate experience leading up to this year had been difficult and I would often wonder if I was in the right place. I started out in computer science, and experienced self doubt unlike never before. I didn't think I was smart enough, I didn't think I could code, and when I eventually switched from a major to a minor, it felt like a failure. Yet in New Media I found my place. For the first time, I started to enjoy coding. Code became a tool for greater ideas, a challenge that was worth facing.

In Computer Science, I was able to get through my classes with the support of one particular woman, a year older than me, who would sit down with me and explain the concepts I wasn't understanding. More than that, she made me feel like I belonged in those classrooms, and gave me the confidence I needed for the classes where I would be the only woman in the room. When I started my New Media classes, I became that person. There wasn't the same gender disparity, but it was often the men in the room who would take on the technical role of projects. I saw in many of the women in those beginning classes the same self-doubt that I had experienced. I became the person that some of these women would come to when they were feeling lost and overwhelmed in a coding project. It was by no effort of my own that I took on this role, besides being willing to help anyone that asked.

Whether it was teaching introductory coding that attracted me or supporting those who I saw going through struggles I myself had gone through, any time there was an opportunity to take on this kind of role in the following years, I took it. There was one semester that I helped TA one of the New Media classes that focused on introductory coding. The summer after my junior year, I developed and ran a workshop session on wearable technology for middle schoolers. Multiple times in my classes I had to design exhibits for the Maine Discovery Museum. There have also been many times where I have just taught a friend how to program a website. I don't think it's teaching in particular that I enjoy, but I like showing people that coding is more accessible than they realize, and that there are so many amazing things to do with technology. That's something that I continue to learn, every time I approach a new language or system or hear about a new area of computing.

When I got to the point where I had to choose a project for my thesis and capstone, I knew I wanted to do something like this. At first I wasn't sure if my target audience should be high school girls who are thinking about what they wanted to do in college, or college women who were already in computing and needed support. With high school girls, it would be easier to introduce the accessibility and extraordinary capabilities of technology, though women starting college in computing fields often need to learn this too. When I thought back about my own undergraduate experience, how I had overcome certain challenges and found a way to be happy using computing in my education and career, I found that college women were the right audience for me. There's a lot of focus right now on getting young women and girls into STEM, and I wanted to focus on keeping them there.

My Research

Look at any graph of the gender disparity in computer science and you'll see a steady drop in women in the computer science industry since the 1980's. Steve Henn of NPR (Henn) researched when and why women stopped coding, and found it had less to do with anything like a general disinterest, and more to do with a steady push of computers as a "boy's toy" with the rise of personal computers in American homes. The marketing was so strong, it became a part of the culture. So when women going into college started a degree in computer science, they were already a step behind, almost like they had missed an introductory class. This was very similar to my own experience with computer science. Starting in my first class, I already felt behind, like I had missed something. I managed to get primarily A's in my classes, but I hated coding. Not only did I feel that I was bad at it, I never had a project that made me want to code or a problem I found worth solving. I was always told that I could do anything I wanted with a computer science degree, but the problem was that I never saw anything that I would want to be. It wasn't until I switched to New Media and started coding projects that were interesting to me that I began to enjoy coding and was able to see the kind of job I would want to get in the future.

A study done by the National Science Foundation called "Retention of Women in Computer Sciences Programs" outlines the importance of being able to rely on same-sex peer support. It shows that women prefer to get help from other female classmates, and

that retention rates are higher when there is a higher proportion of women in the department. This was something else that I experienced. I got the majority of my help in classes from that one female classmate, who was often the only other woman in the class.

This same study also shows that a successful strategy universities have used to increase the rate of retention of female students is “expanding the required first-year computer science courses to include social impacts of computer science and creative, real-world applications” (NSF, Retention of Women in Computer Science). In my research, I asked women about their experience with coding in computer science classes. Many said that they didn't enjoy a lot of the coding they did in classes. One woman gave me the response that she doesn’t like to code just to code; coding is interesting when the problem she’s trying to solve is interesting.

There are two big reasons why it matters that women get into technology fields. One, the technology field is good for women. One of the big issues that affects the gender wage gap is flexibility with work hours. Careers often reward those who can work the traditional nine to five in an office. As women start to have children, they tend to reach a plateau in increases in wage and promotions. The technology field is one that tends to have the freedom to provide flexibility in work hours and location, and reward based on work quality rather than how often an employer sees an employee. These qualities in a career can make it easier for women to achieve a healthy balance with work and home life ("Women in Computer Science").

The second reason is that technology industries need women if they’re going to understand their female users. Melinda Gates addressed this in an interview/article, pointing out how technology has failed to account for its female users and calling for

more women to join the field. Her example was a health app Apple came out with that did not account for menstruation, something that is very relevant for a large percentage of the population (Hempel). The lack of women is a detriment to the technology field and it shows in its products.

Some of the most helpful information I received was in talking to women at the university. I learned about programs like UC Berkeley's "Beauty and Joy of Computing," which was successful in getting a more balanced gender ratio in the classroom, and the Grace Hopper Celebration of Women in Computing, the world's largest meetup of women in technology. A few women talked to me about how men and women act differently in computer science classrooms. There is a tendency for women to doubt whether they're cut out for the field, while still getting good grades, and men "playing it off cool," while getting lower grades. In general, I got a lot of resources and tips for starting my project from talking to these women. Deemphasizing coding and emphasizing social good and problem solving was a big one.

Besides helping me with starting out my project, these conversations were helpful to my understanding of my own experience in computer science. As they described the problems women have in these fields, I felt like they were talking about me. I realized that the things I went through in my first couple years were not uncommon, and that it was never about me not being good enough or smart enough. Recognizing that helped me to overcome the feeling of failure I still had, and really value the place I am at now in my career and education, knowing that I have the capacity to do any of it if I have the interest.

Association for Computing Machinery - Women's Chapter

This year Stacy Doore, PhD candidate at UMaine, started a student chapter of ACM-W, a group for women in computing. I joined this group at its inception, and it has been beneficial to me and to my thesis project. In ACM-W meetings, I got to meet women from different computing degrees, undergraduate and graduate level, and hear about their experiences with computing. I also got to take part in several events. One was a panel at the Maine Discovery Museum, during Maine Science Festival. This was all women from UMaine, in computing or engineering fields, talking about what makes us passionate about what we do, and our experience getting there. Taking part in this event inspired some of the work I did for my project.

I went with ACM-W to the New England Celebration of Women in Computing (NECWIC) in Portland. While there I was able to meet a lot of interesting women in the computing and technology field, and see the different kinds of work they do. There was one talk that brought up a lot of interesting information about female technical undergraduate students. The research this person had done showed that women have a strong tendency to perceive a lower level of success for themselves than is accurate, while men perceive their performance as better than it actually is. Later in the conference, I presented a poster on what I was working on for this project (see Appendix A).

Being in ACM-W was the first time I really was surrounded by a group of women interested in computing. It helped me understand a lot about my experience as a woman

in computing thus far, and it's given me a better idea of how to deal with what is to come in my career or any further education. Having this community of women has been really important to me this year, and I think it would have been crucial to my experience as a younger student.

The Project Brand

The brand I came up with for this project is COCO, short for Coders Collaborative. The secondary title is "women helping women." The logo contains a hot cocoa cup, which is a play on the programming language Java. My approach with this logo was to create something that was somewhat feminine and inviting, with softer curves, without relying on female stereotypes. I stayed away from pink, as well as more masculine color schemes like red and black. I tried to design a logo that would appeal to the many different types of women in the field of computing. The logo may appear by itself in black, with color and texture and the title "coders collaborative," and as just the cup with the title and secondary title. The cup may also appear by itself as a watermark.

Figure 1 - Basic COCO logo, Leopold; Figure 2 - COCO logo with color and title, Leopold; Figure 3 - COCO logo cup with title and secondary title, Leopold

Methods to Accomplishing Community

After my committee meeting first semester of this year, I decided that my focus for this project would be on community. It can often be difficult for women to establish a sense of belonging in their first classes in computing fields. Though there is a lot of focus right now on encouraging women to join programs like computer science, there often isn't a support system available to them when they get there. I tried to identify the key aspects of community, and target each of them in different ways that would come together on a website. The components that I identified were peer support, confidence, shared experience and interest.

Peer Support

My goal was to create a system of support for women starting in computing fields. I want to connect women through social media, groups like ACM-W, opportunities like Grace Hopper, and through a local network based on a sticker initiative.

Social Media:

I created a Facebook group to connect women to one another. It is a closed group, meaning anyone can find it and see who's in it, but only members can post and see posts.

I created a cover photo for the group, and a QR code to publicize it.

Figure 4 - Facebook group cover, Leopold; Figure 5 - Facebook group QR code, Leopold

Groups and Opportunities:

ACM-W is a great, already established community at UMaine. I think it is a great foundation for my project, and I hope that when I graduate, it can in some way continue through them. I want to connect women in the COCO community to groups like ACM-W, that have resources to take the initiative beyond the local network. I also want to connect women to opportunities, like the Grace Hopper Celebration, by putting all that information on the website and posting it to the Facebook group when it becomes relevant.

Sticker Initiative:

I printed stickers to promote Coders Collaborative. Using these stickers, women can identify other women in computing to talk to and get support from. Women often don't get to meet the women in computing outside of their classes, which is often very few. The goal of this initiative is for women to be able to walk around and see all the women who, in different stages and areas of education, are connected to computing, and

be able to walk up to them. The instructions that come with the stickers read: “Put these stickers on a laptop, water bottle, or other belonging, to show that you are a collaborative coder, a woman devoted to helping women. It will signal to other female coders in the COCO community that they can approach you for help or advice, or just to talk.”

There are three different stickers. Two of them have the logo as a central point, though with different designs. The third is a business card sticker, meaning it is a sticker on the front, and text on the back. The front is a design of a quote that says “Our language is primarily for expressing human goodness and beauty. Yasunari Kawabata,” with the word “programming” above “language.” The idea for designing a quote like this came from how the UC Berkeley named their intro to programming class “The Beauty and Joy of Computing” and achieved a gender balance in the class. The use of the quote aims to convey coding languages as beautiful and emphasize social good. The combination of fonts was used to give the words a modern and elegant look, while hinting at computing with the computer themed font of the word “language.” The background image used for the quote is a combination of images of nature, which was to show coding as more than robots and computers, but something that can interact with the natural world. The colors are cool and calm to take the stress away that might come with one’s idea of computing.

On the back of this sticker are the logo, title, and subtitle, instructions, and QR codes for the website and the Facebook group.

Figure 6 - Sticker front, Leopold; Figure 7 - Sticker back, Leopold

Figure 8 - COCO logo sticker with title, Leopold; Figure 9 - COCO logo sticker reverse color, Leopold

Confidence

Though confidence is not always deeply entwined in community, I identified it as an important part of the retention of women in computing. Whether it's dealing with

imposter syndrome (not being able to internalize their qualifications or accomplishments), or that feeling that they missed an introductory class somewhere along the way, it is crucial for women to have confidence in their abilities to feel like they belong in computing. The issue of confidence can involve things like interest and relative experience, but I think the best way to build confidence in one's ability to code is just by coding.

I believe the best way to get people coding is to give them problems worth solving. I never felt like I could code until I entered New Media and started coding projects that were interesting to me. For this part of my project, I worked with a New Media class for introductory coding, creating and testing tutorials. I hoped that by completing a tutorial, the students would learn some basic coding techniques or computer knowledge, and recognize that they are capable of more than they realized.

For my first tutorial, I made use of the javascript library Blockly to create an interactive webpage. Blockly is a block based coding language, similar to Scratch, that is often used for teaching beginner programming. Block based languages are often used for introductory programming because it allows the coder to make use of simple precomposed coding instructions, and visually understand how it fits together. For example, it's easy to see how code goes inside a loop.

This first tutorial gave a basic introduction to what code is, and the concept of input and output. The beginning of the tutorial read: "Code is a set of instructions a computer follows. It's what happens between some input (like a mouse click) and an output (like whatever is happening on your screen). For example, imagine you scroll down a webpage. The scroll action is the input, the instruction the computer follows is

something like “move everything up,” and the output is the screen showing you the next part of the page. It went on to explain syntax, pseudocode, variables, and loops (see Appendix B).

The second tutorial (see Appendix C) demonstrated how to break down a large project into smaller, more manageable parts. For this tutorial, I stepped outside of my comfort zone by creating videos to show how to create a project. It addressed the topics of working with photoresistors and LEDs, analog and digital, booleans, if/else statements, Arduino and Processing interactions, two dimensional arrays, for loops, and functions. The project was a way to use light sensors to answer quiz questions. The idea is based off a museum exhibit I saw that used light sensors to test the user on their knowledge about reducing their carbon footprint. With this second tutorial, I hoped to gain more interest in the real life use of the project, and test how the format compared to the first tutorial.

I got survey results back from both tutorials, and though I think the first tutorial was better executed, the second was the preferred format. In general, students seemed to have learned a good deal from both. Though there weren’t many women in the class, it seemed like their interest and comfort with coding was stronger than the average New Media 102 class. Both tutorials had their issues, but the feedback was generally positive.

Creating these tutorials was one of the more challenging parts of this project. They weren’t as central to focus of community as the other components, and they took a lot of time to make each one. Nevertheless, I learned a lot in the process of making them. Exposure to learning a google library (Blockly) from the documentation is something that has already helped me in my job search. Also, I think it was good to work with real

students and get feedback. Still, if I were to go back, I probably would have approached this concept differently.

Another part this is connecting students with other learning opportunities through my website. Being able to see the many resources out there may allow them to discover the possibilities that exist with a little bit of computing knowledge, and find what they are passionate about.

Shared Experience and Interest

Another important topic in the idea of community for me was shared experience. When you don't have a lot of women in your classes, it's difficult to find someone to talk to about what you're going through. By connecting to women who have gone through some of the same things you might be going through, you can better understand your position and how to overcome your challenges.

Finding shared experience is natural where community exists, but I wanted to make these experiences accessible to anyone who might not yet have that community. I created a series of video interviews to show women that the problems they're experiencing are common and solvable. The videos address issues like the imposter syndrome, what you can do with coding and technology, and advice for women starting in computing.

Interest is something that easily comes along with these kind of questions. By seeing other people's passion and real life applications of computing, it is easier to find a place where computing is interesting to you. At the panel for the Maine Science Festival, I was inspired by how excited these women got when talking about what they do. Part of what I asked interviewees was what excites them about their field, and what they most liked using technology for.

For the videos, I had Jack Sullivan, a New Media undergraduate, film and edit the interviews. I had a list of core questions that I went off of (see Appendix D), varying with what made sense for each interviewee. The core subjects were what their experiences were in computing classes, what makes them excited about their field, and what advice they would give to a woman starting out in their field. For each interview, we tried to film the subject in a space that they work in. For a few we just had to find a space in the IMRC or another building.

Although I've never liked making videos, this was one of my favorite parts of this project. I learned a lot from each person I talked to. In some of what I felt were my best interviews, the interviewee would touch on all my other questions while answering the first one. Some of the highlights of the interviews were the surprisingly varied advice they all had to give, the interesting and meaningful projects they were working on, and the challenges they faced and how they overcame them.

I hope that seeing these videos allow women to see themselves in others' narratives, but also to be inspired to have these kinds of conversations with their peers. While many of the challenges we go through are similar in nature, there are many solutions women have found to overcome them.

Bringing it Together

One of my challenges was bringing all the separate pieces of this project together. I decided to accomplish this through a website, as well as through sharing pieces of it on social media. The stickers will get out through at least two events that I am participating in. One event is on April 27th, the WiSTEMM First Annual Spring Symposium. I will have a table at the networking event at the end of the symposium. There I will be handing out stickers and information, and talking to women about this project. I will also be presenting this project on May 4th, at New Media night, where I will have a similar setup. The website is coderscollaborative.net.

CLAS Undergraduate Research and Creative Activity Fellowship

I was awarded the Undergraduate Research and Creative Activity Fellowship from the College of Liberal Arts and Sciences to complete this project. The total award was $1000 and was used to pay for stickers, video work, development and design work, domain names, laser cutting and other miscellaneous costs. This award helped me to achieve the scale of this project, as well as a professional look of the videos and website.

Reflections

Looking back on how this project went this year, there were positives and negatives. I learned a lot about myself and how to make a positive change for others. I met a lot of amazing women and made myself take opportunities I would have otherwise let go. I experienced independently working on a large scale project, and eventually how to better manage my time. I think there are ways parts of the project could have gone better, if I had started earlier or tried a different approach or reached out to more people. There will never be a satisfying end to this project, but I hope to see it last beyond my graduation through the people who decide to be part of the COCO community.

Where it Goes From Here

Leaving UMaine, I won't be able to engage much with the COCO community, but I do plan on keeping it going through social media platforms. I plan to keep sharing things through the Facebook group, and if conversations are started, I could see this group expanding to new areas. I have a lot of stickers that I'll be able to leave with the ACM-W, so I hope that that component can continue to expand as new students come into the university.

If I were to take this project further, for example in some higher education, I would be interested in creating a career aptitude-like test to show students the different computing fields that might be of interest to them. I think one of the biggest motivators to

continuing in a computing field is seeing what you would want to spend your life outside of college doing.

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Coders Collaborative, Women Helping Women

Creating a future of female coders; supporting women through community.

Ruth Leopold, University of Maine

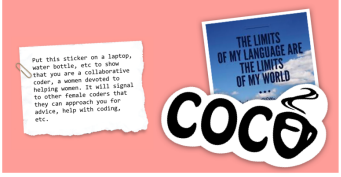
Abstract

"In the last two decades, the proportion of women earning bachelor's degrees in computer sciences has declined from 28% to 18% (NSF/NCSES 2015c), even though the proportion of freshmen women declaring a computer sciences major when first enrolled in a 4-year institution has remained stable (at about 20% in recent years)" (NSF, Retention of Women in Computer Science). My undergraduate capstone aims to stop women dropping out of computing fields by creating a sense of community. The key components of community that I am targeting are peer support and shared experience. My goal is to foster interest in computing and confidence in students' ability to code. This poster will outline my methods to address **peer support, shared experience, interest, and confidence**.

PEER SUPPORT

My goal is to create a system of support for women starting in computing fields. I want to connect women through social media, groups like ACM-W, oppurtunities like Grace Hopper, and through a local network based on a sticker initiative.

I plan to print stickers to promote *Coders Collaborative*. Using these stickers, women can identify other women in computing to talk to and get support from.



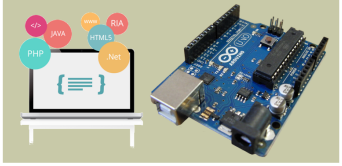
SHARED EXPERIENCE & INTEREST

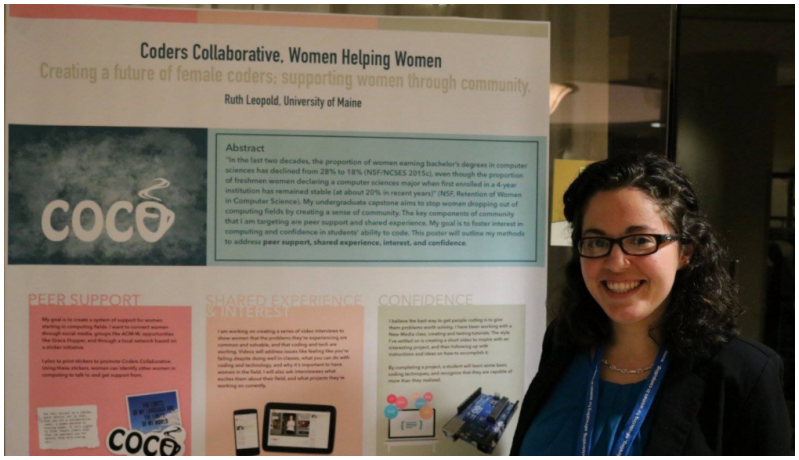
I am working on creating a series of video interviews to show women that the problems they're experiencing are common and solvable, and that coding and tech are exciting. Videos will address issues like feeling like you're failing despite doing well in classes, what you can do with coding and technology, and why it's important to have women in the field. I will also ask interviewees what excites them about their field, and what projects they're working on currently.

CONFIDENCE

I believe the best way to get people coding is to give them problems worth solving. I have been working with a New Media class, creating and testing tutorials. The style I've settled on is creating a short video to inspire with an interesting project, and then following up with instructions and ideas on how to accomplish it.

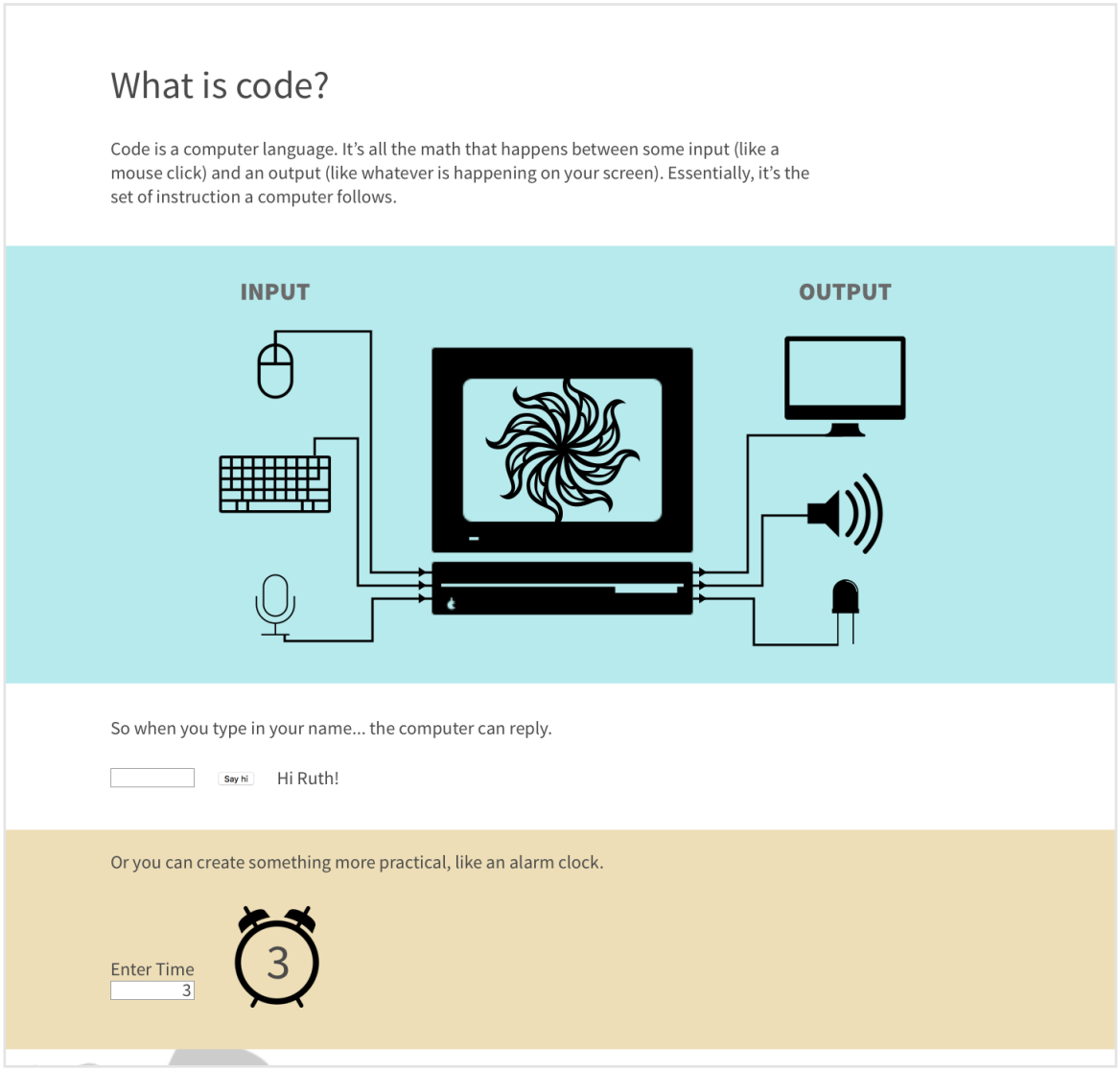
By completing a project, a student will learn some basic coding techniques, and recognize that they are capable of more than they realized.





Appendix B

Link: ruthleopold.nmdprojects.net/blockly%20tutorials/demos/tutorials/tutorial1.html



But the question is... what's happening inside? What does code look like?

There are many different languages, some written, some made up of movable blocks. They all have different syntax, which a set of rules you have to follow when writing it, like grammer. In *pseudocode* (pseudocode is a way to write out code without worrying about the exact grammer of a particular computer language) we can write out what's going on.

```
time = 3
print time
time = time - 1
print time
time = time - 1
print time
ring!
```

So the output of this program is going to be:

```
3
2
1
```

Another important concept is a *variable*. A variable (like x and y in math) hold some kind of value, such as a number or a string of characters, like "what's up?". In this example time is a variable "time" which holds a number. The value of time changes throughout the code.

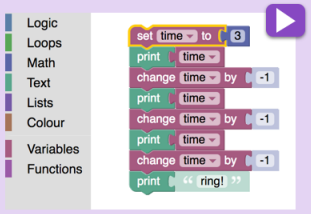
Once you understand how variables can change, you can start to shorten your code with some computer logic. Instead of typing the same thing several times, you can create *loops* that will repeat part of your code multiple times.

The coding language I'm going to use for these tutorials is called **Blockly**. It is similar to Snap and Scratch, in that code is represented by interlocking blocks.

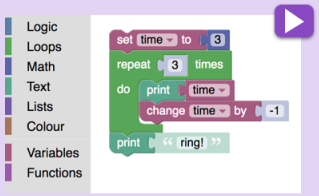
These three sections of Blockly code all do the same thing in different ways. The first is similar to the pseudocode above. The second and third use a "repeat" block. Everything inside this block (to the right of the bright green area) will be repeated as many times as the block says.

In the second, if you change what time starts as, you have to change both the value of time in the first block, and the number of times it's repeated. In other words, if you "set time to" 5, but are still repeating 3 times, it will count "5", "4", "3", "ring".

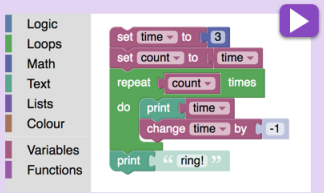
In the third, I added another variable to use in the repeat loop so that I only had to set a number once. "count" is set to be the same as the original value of "time". When time changes later, count is still equal to the original 3.



try changing this so it counts down from 5



try changing this so it counts down from 10



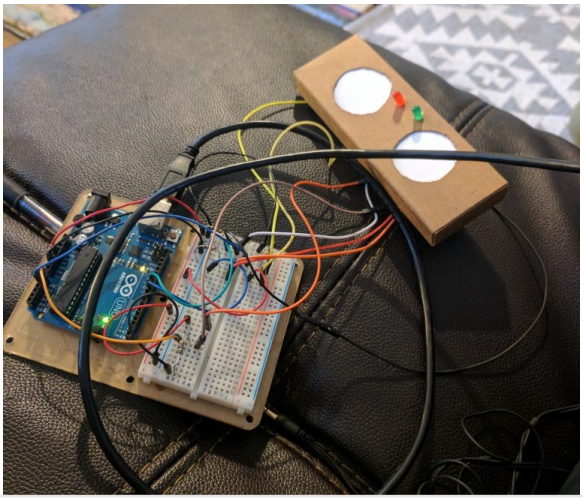
try changing this so it counts down to zero

Next week we'll work more with different kinds of loops and computer logic.

Please fill out this survey to help me improve this and further tutorials!

Appendix C

Link: nmdportfolios.org/rleopold/2017/04/17/tutorial-2/



PART TWO: PROCESSING

More about 2D Arrays: https://processing.org/tutorials/2darray/

Appendix D

Interview Questions:

What is your name and major?

What first made you interested in computing or technology?
How was your starting experience in computing, academically and socially?
Did you ever feel your experience in computing was different because of your gender?
Did you ever feel out of place or have any doubts, or think about switching your major?
What helped you to get past that?

What excites you about tech/your field?
What is your favorite project you've worked on?
What's your favorite application of tech/computing, or combination with another field?

What advice would you give to women starting out in the field?

Author's Biography

Ruth Leopold is a senior in New Media, with minors in Computer Science and Graphic Design. She works primarily in front-end web development and design and is interested in user experience. She is passionate about finding creative solutions to problems involving technology and design. Her goals over the next few years are to learn and be creative as much as she can, and find where she is happiest working in the design and technology world.

Ruth is a member of the ACM-W and hopes to continue working to support young women and girls going into STEM fields. Gender equality is an important issue to her, and will follow her in whatever direction she goes.