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Women in Science: A Course

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Science, technology, engineering, and mathematics (STEM) are considered to be difficult, intense fields that are predominately male. This causes representation issues for young women and girls when they look for role models in different fields of study. There are different ways to go about trying to increase the amount of women entering STEM fields, but one way to continue the encouragement of young girls and women entering and staying in STEM is through increased representation.

In order to fully understand the reason for the lack of women in STEM fields, we first need to look at where the separation begins. To do this, we will begin with looking at the proportions of boys and girls in science and math based classes from kindergarten to twelfth grade. At these levels girls and boys perform equally. The only gaps that appear are due to socioeconomic reasons. However, the amount of boys and girls in classes are not proportionate. Looking specifically in high school, the same rate of men and women take science and advanced classes, but proportionately more men will take the advancement placement exams (National Girls Collaborative Project). In addition to this, men are more likely to take courses structured around engineering and computer science by significantly greater rates. This is consistently seen in college and university degree programs.

Once in college, the separation between men and women grows. By first looking at bachelor degree programs, women's roles in science play a different part. In the biological sciences, such as molecular and cell biology, ecology, and evolutionary biology, a majority of bachelor degrees are earned by women (Macmillan Publishers Limited). However in departments such as math, engineering, and computer science, women make up less then half, with the latter having a rate of less then 1/5th of bachelor degrees (National Girls Collaborative Project). When looking at the all of the people with STEM degrees, women hold only 20 percent of these degrees (Noonan, 2017). This goes on to affect the amount of men and women in STEM jobs.

First, we will look at the global perspective, before narrowing down to just statistics of the American job market. When looking at the research being done on a global scale, only 30 percent of the researchers are women (UNESCO Institute for Statistics). Despite some degrees being held by a majority of women, they hold very few jobs in STEM fields. Women who receive STEM related degrees often go into careers in different fields. Nearly half of the jobs in biological, agricultural, and environmental life sciences and 2/3rd of careers in the social sciences (which are considered non-STEM fields) are held by women (National Girls Collaborative Project). However, once we start looking at engineering and the computer science and math field, we see women hold less then 1/6th and 1/4th of jobs, respectively. Even when breaking down the different fields, the highest representation of women in only at 35 percent in chemistry (National Girls Collaborative Project).

Not only are there fewer women entering STEM fields, women are more likely to leave these careers. Over half of the women who will enter technology related careers leave for a non-STEM career (Catalyst , 2018). This is mostly due to unsupportive and non-stimulating work environments. However, there have been studies that show women are paid less for research they do and they are published less then men (UNESCO Institute for Statistics). Despite being paid less then men, women who work in STEM fields still make more than women in non-STEM fields. This pay difference might be an incentive to stay in STEM related fields, but sexual harassment is prevalent in these fields. Due to the lack of a welcoming culture for women, as well as very few ethical policies that define harassment as misconduct, women are often faced with multiple experiences of sexual harassment (Russell). The act of leaving their career usually occurs about ten years into the job, however one in three of these women plan to leave within a year. This is seen in two technologically advanced countries: the United States and China. In addition to having fewer women in the workforce, the representation of women in positions of power is slightly greater than $1/10^{th}$ (UNESCO Institute for Statistics).

Despite the lack of women in STEM fields, this is an improvement. Over the years more women have entered and stayed in the field in comparison to years past. This may be due to updates in policies in STEM fields that label harassment as scientific misconduct (Russell). There still is, however, a substantial pay gap. In reports that discussed men and women's earnings in STEM fields, it was discovered women make about $4/5^{th}$ of what men do in the same field (Catalyst). Also, in fields where women are more prominent, there is still an issue in representing minority

groups, showing that the problem has not yet been solved. However, according to data from 2015, the gender gap lessened in non-STEM fields between the years of 2009 and 2015, but in STEM fields the gender gap grew (Noonan).

Although there are many different ways to begin to solve the issue of women entering and staying in STEM, representation seems to be the easiest and most effective. Representation helps everyone who sees it, including the groups that are not the target. However, representation has a tremendous effect on those who need it. A simple example of these can be seen in the movie industry very recently. The movies *Brave* and *The Hunger Games* both came out in 2012. These movies featured strong, independent female leads, both of whom used bows and arrows. With these movies, archery became incredibly popular and nearly 3/4th of the young girls and women who took it up said it was because of those movies (Longoria). Not only did these movies encourage women to engage in archery, but they also showed men that women can be excellent archers. It sets a new normal for the sport that can be easily mimicked in different fields.

When a greater diversity of people is shown, everyone benefits. People, who now are able to see themselves in new areas of work, will remain encouraged to stay in fields that interest them. In addition to this, others entering the field, or currently in the field, will be use to, or expecting, more diversity to be present. Representation can be used very easily to encourage women to study, enter, and stay in STEM fields. Young women and girls will be able to see themselves in STEM fields and remain encouraged to enter these fields, if this is what they want to do. In turn, young boys

and men will see equal amounts of men and women in STEM fields and not be surprised, if they enter these fields, to see women in the fields as well.

As seen before, boys and girls perform equally in math and science classes; only in high school does a divide start to happen. The age of children in elementary school levels is a very susceptible age. To try and close this gap, young boys and girls need to see more female representation in STEM fields. This is where my proposal will take place. Because of this gap starting in high school, I propose for an intervention that primarily takes place at the elementary school level.

A way to do this would be to implement an online resource, entitled "Women & Science" for the purposes of this paper, which could be easily used in classroom settings. This resource would be similar to sites such as Khan Academy or Chegg Tutoring, except instead of teaching and assisting with mathematics lessons, this site will teach about the different achievements women have made in STEM fields. Each lesson can contain increasing material in order to adapt to different classroom settings; the same way Khan Academy can have algebra problems and calculus problems. This will make "Women & Science" reach greater audiences as well as a be known as a reliable resource.

However, internet access is not a guarantee for every child in at least the United States. Children, who live in dense urban areas and sparse rural areas, may lack the reliable internet access needed in order to use the site. To solve this, any school or library in these types of areas could contact the support staff for the website and receive paper copies of the lesson plans. This is an effort to ensure all children have the same representation level of women in science in the classroom.

From the Women & Science lessons plans, worksheets and handouts could be made to distribute to all students.

The format of the website would be relatively simple. A user will be able to sort through the site to see just the material that is suitable for elementary, middle, or high school levels. A user can also select different women who have lesson plans about them in order to see the different levels and decide which one they want to use. These lessons could be added to science classes about certain topics. For example, say a science class was being held about physicists, then the user could select Sau Lan Wu, a notable particle physicist who assisted in observing the Higgs boson, and find different levels of lesson plans in order to select the best one for their class setting. The site can also sort all lesson plans based on the field you are looking for. If you wanted to show your class all women mathematicians available on the site, a sorting feature of field would be available.

An example of how this online course could cater to different levels can be seen in the structures of lessons. I will formulate a few lesson plans, very loosely, to show how the course can be adapted to different classroom settings. First we will look at the topic of mathematics. For elementary school levels, you can either select mathematics in order to introduce the names of mathematicians or select lesson plans under each woman in order to teach the classroom. You will then see names such as Hypatia, Wang Zhenyi, Katherine Johnson, Annie Easley, and Maryam Mirzakhani. You can then select each woman's name to see three different subheadings. These subheadings will be entitled with different grade levels in order to teach different students. The information will go from basic and simple to

complex and detailed. In an elementary school level, Hypatia would have information saying she was born in Alexandria, worked on geometry, and was one of the first female teachers of her time. In comparison, a high school level lesson would discuss what she contributed to geometry and number theory as well as her work in platonic philosophy. More information can be said about these intense topics due to high school student's ability to understand them. The lesson plans can also be adapted to use in history classes. Some classes discuss scientific advancements, especially when they were used in wartime. In addition to talking about scientists such as Alan Turning and J. Robert Oppenheimer, lessons on Marie Curie and Lise Meitner could be added.

The best part about an online resource is the availability for it to be updated constantly. Books need to be reprinted and redistributed every few years in order to reflect new information and research accurately; an online resource doesn't. Information can be added as research is done, making it possible for the work of many women to be honored and taught, without the cost of publishing new additions. Also, this would be a free resource, meaning no matter the school or child it is affordable. However, internet access is not guaranteed throughout the United States. Maybe children either don't have access where they live or their families cannot afford reliable internet access. In order to ensure every child having the same resource, schools and libraries could contact the site for either PDFs of lesson plans or physical copies. Not only will lesson plans be available, but worksheets and homework assignments can also be created to assist the teacher. From there they can make copies to distribute to all students, so no child is left out.

Since this resource is similar to Khan Academy, it is very easy to look forward to see the possibilities for success. In 2011, over 45 million people used Khan Academy, it was used in 20,000 classrooms around the world, and over 750 million problems were solved. These numbers don't reflect just English speakers either; numerous volunteers have translated the lessons into 24 different languages (Noer). The company is a non-profit, so all information and homework help is free to anyone who goes onto their website. However, donations are accepted, which is how the company is thriving. Over 16 million American dollars have been raised in order to run the program, making a return of over 1,000% (Noer). This is also just based on data from 2012. A study run in 2013 tested the effectiveness of Khan Academy math lessons in a low-resourced high school in South Africa. For the case study, a Khan Academy video was shown and then a quiz was given to see how well the students retained and understood the information. For the simpler math concept there was a mean score of 2.36 out of 3 (Barman).

It is easy to see how Khan Academy was successful for a simple math lesson. This gives me hope that "Women & Science" would be successful as well. Since the resource is intended to show women in science and not teach complicated scientific principles, it should follow Khan Academy's success rate fairly closely. Also, Khan Academy was easily introduced into a classroom setting with little to no issues, implying the same could be done for my online resource. Especially with the availability of paper copies for low-resource schools, "Women & Science" should flourish as an educational resource for all children.

Even though we are in the 21st century, there is still a gap between men and women entering STEM fields. Even the women, who do enter the STEM fields, tend to leave for non-STEM fields within a relatively short amount of time. My solution to this is a representation-based solution. The development of an online resource can provide young girls and women, as well as young boys and men, the representation they need in order to feel confident in entering STEM fields.

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