April 30, 2017

Miami University
501 East High Street
Oxford, Ohio 45056

Dear Dr. Marek Dollar, President Crawford, and Dr. Crawford:

The subject of our report is to investigate the topic of the low retention rate of female students in the College of Engineering and Computing at Miami University. Our research in this report determines the reason for this occurrence and possible solutions that will decrease the gender gap in the field at Miami.

We would like to thank you for working with us and realizing the need for change in the engineering program at Miami University. If you have any questions, please feel free to contact us.

Sincerely,

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Women in Engineering at Miami University

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Executive Summary

The lack of women in engineering is a universal, complex problem that doesn't have just one correct solution. Miami University has the opportunity to aid in solving this problem. We came up with three alternatives Miami has to solve this problem which include creating programs to get younger kids in the local area to think about a future in engineering. By starting young in schools, girls can have a different perception of engineering as a future career. Miami can also create a course or develop some kind of curriculum to teach current students in the department the issues surrounding gender diversity in engineering, helping to change perceptions at Miami. Miami can also choose to do nothing and continue their current efforts, hoping for good results.

We judged our alternatives based on the following criteria: cost, will it solve the problem, how long will it take for results, can we actually do it, and desirability. Based on the criteria, we evaluated our alternatives and recommend including gender diversity as part of the engineering curriculum due to its feasibility and low cost. Our conclusion was reached through primary research from a survey on engineering perspectives, as well as an interview with Clark Kelly, Director of Communications for the College of Engineering and Computing. Our secondary research involved researching statistics, as well as finding studies done on the issue.

Introduction

According to the National Girls Collaborative Project, females make up only 15% of the workforce in the engineering discipline (National Girls Collaborative Project, n.d.). This is a startling statistic, considering the fact that females make up nearly 50% of the workforce. Although the small percentage of women in engineering is an issue that has been brought to national attention, it is important for the issue to also be emphasized at a local level. If Miami University is able to change the way that females view engineering and computer science and bring a change on campus, it can set an example for universities around the country to follow.

We, as female engineers ourselves, understand the situation and have directly experienced being one of the only females in a class. We are ready to help implement change. Through our research, we believe that this can be done by debunking the stereotypes that exist and by changing the perspectives that females may hold. When this is done, girls will be encouraged to consider engineering as a viable career and as a field that is not just for males.

In our report, we will discuss the problem further with statistics, the reasons for this problem, as well as some possible solutions specific to Miami. We hope that you take our suggestions into consideration. Imagine the national significance that would occur if Miami University became one of the first universities to have a nearly equal percentage of male and female engineers.

Problem Background

In context of Miami University, a survey was created and conducted in order to prove or show that the problem was happening at a local level. The survey was conducted among the student body of Miami University and included people of all majors. Seventy total responses were collected and analyzed. The survey consisted of eight simple questions, some questions relating or referring to answers given by the responders.

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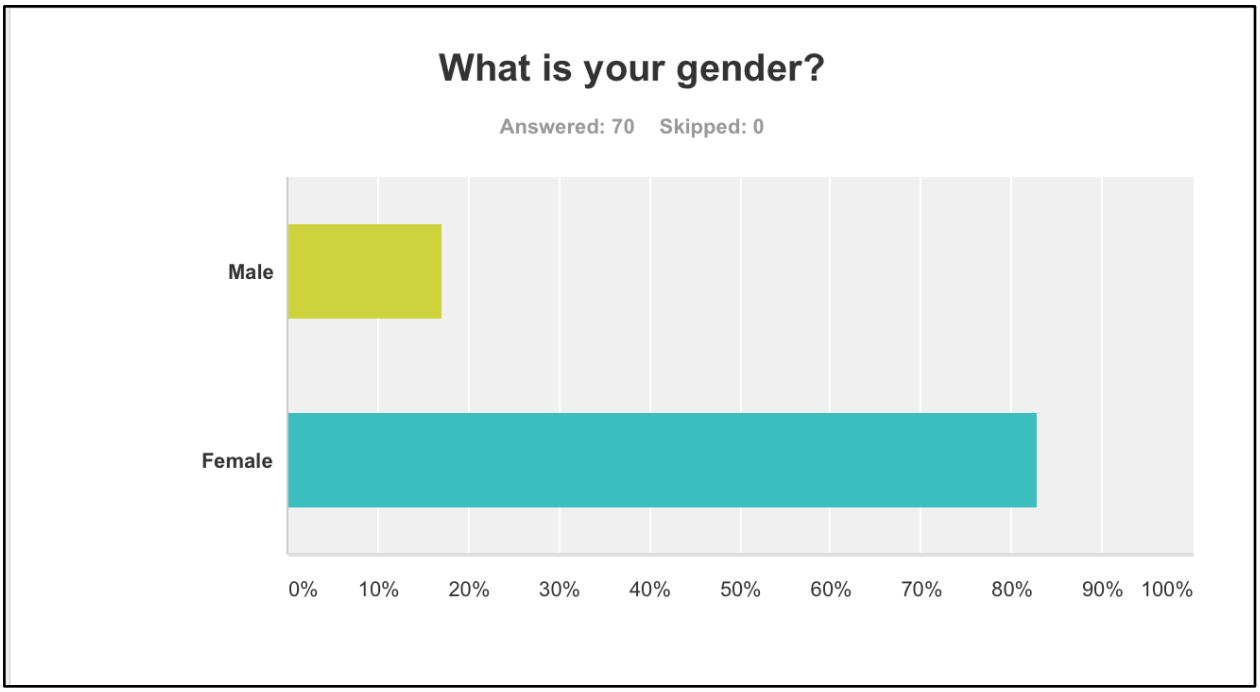

Figure 1 *Survey – What is your gender?*

Out of the seventy people who took the survey, 83% responses were from females. People were then asked if they are currently in an engineering field or if they had ever thought about joining the engineering field.

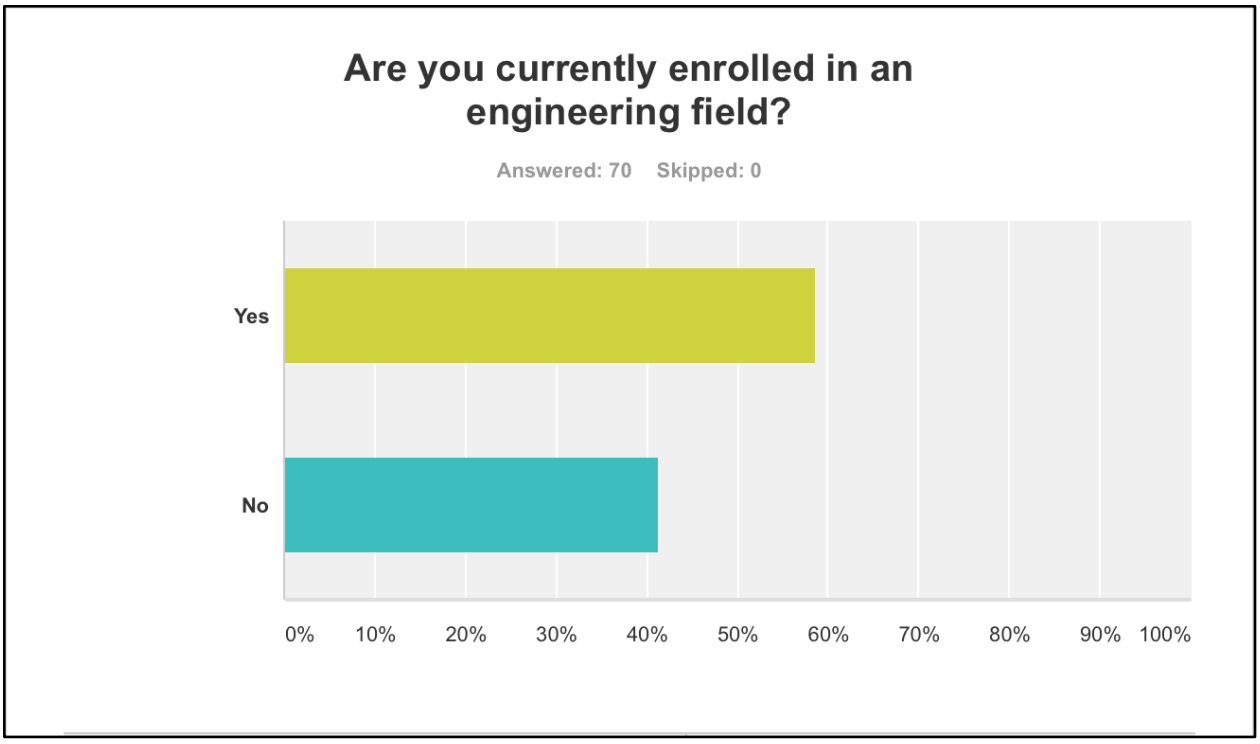

Figure 2 *Survey – Are you currently enrolled in an engineering field?*

Out of the seventy responses, when asked if they had ever been interested in an engineering field, 60% of the responders answered yes. If people answered “yes” to currently being in the engineering field, they were then asked if they had ever been discouraged from continuing in the field and their responses were recorded.

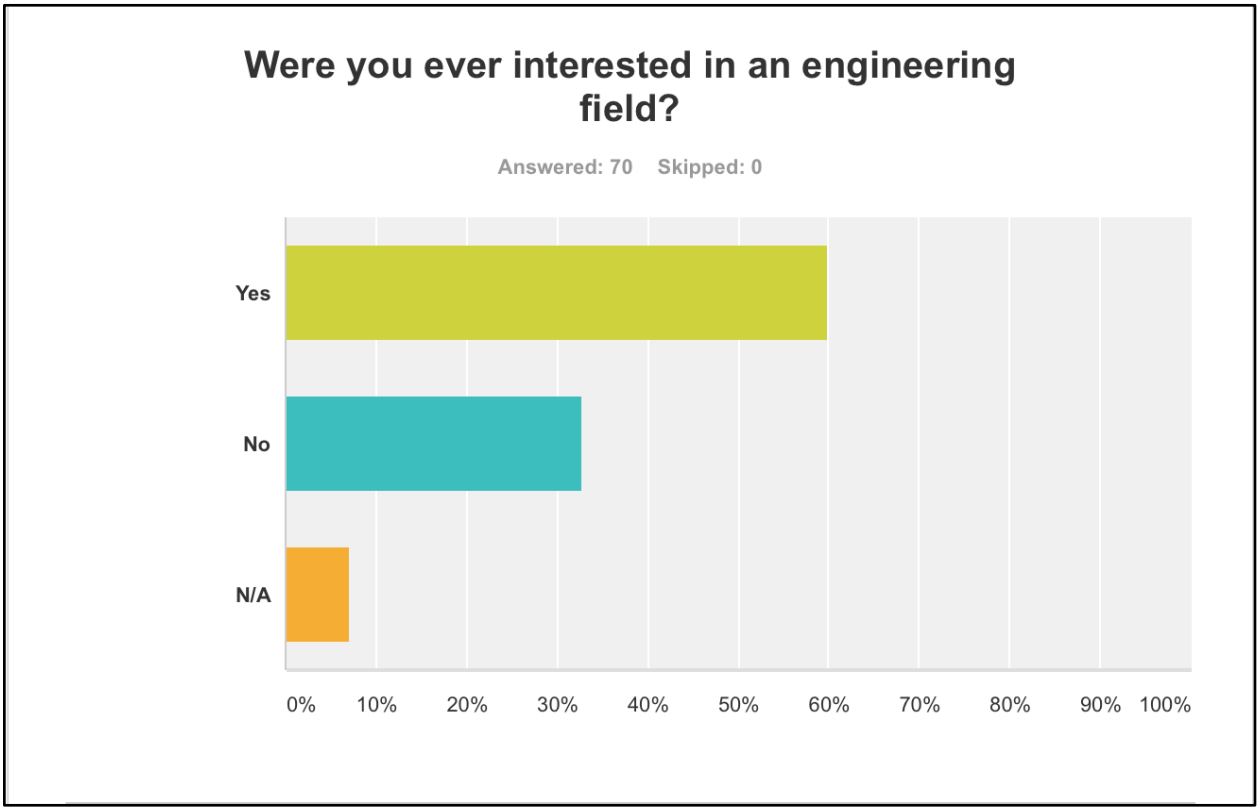

Figure 3 *Survey – Were you ever interested in an engineering field?*

Out of the seventy responses, when asked if they are currently enrolled in an engineering field, 59% of the responders answered yes. If people answered “yes” to ever being interested in an engineering field, they were asked why they weren’t currently pursuing a major in the engineering field and their responses were recorded.

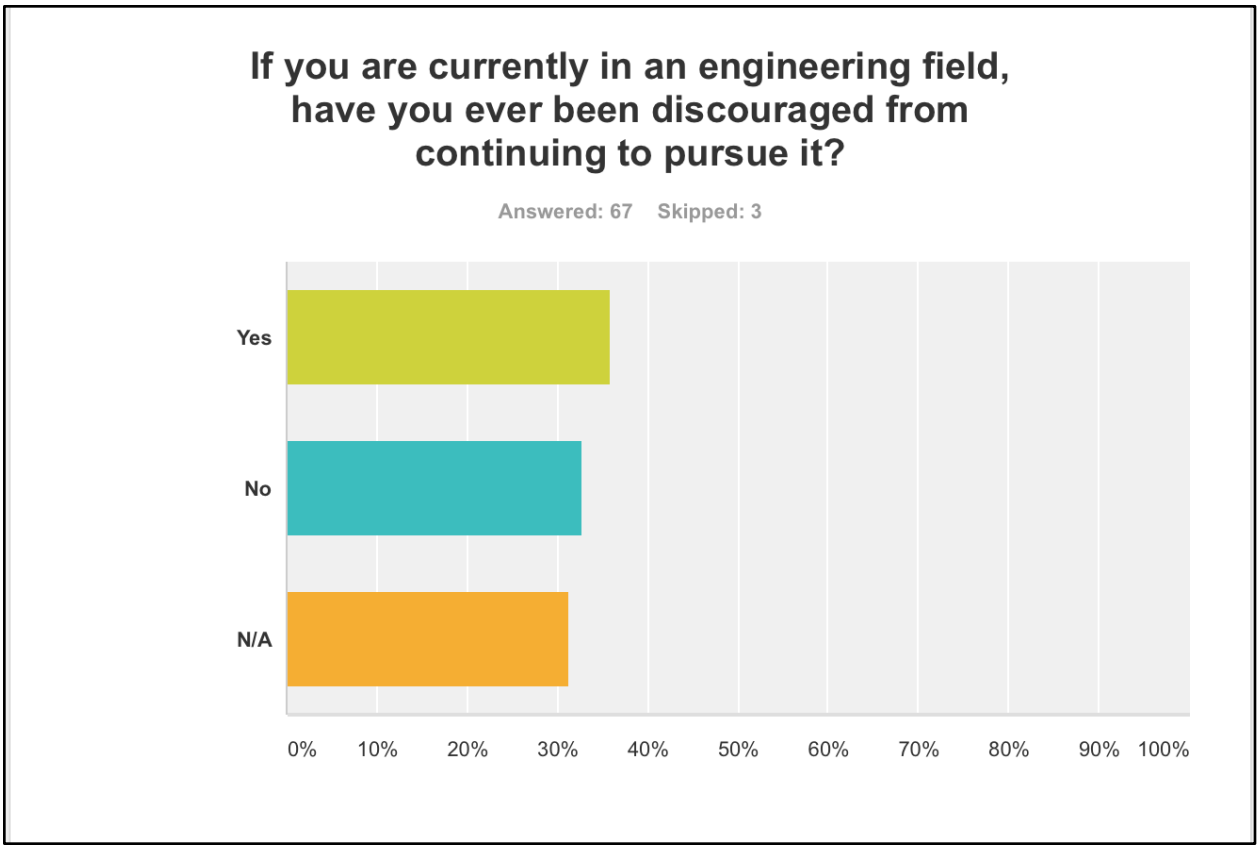

Figure 4 *Survey – If you are currently in an engineering field…*

When females were asked if they had ever been discouraged from continuing to pursue a major in the engineering field, 36% of the responders answered yes and then proceeded to give specific details. One of the most common responses stated that there is a lack of support from faculty and peers. Another common response stated that stereotypes and peers of the opposite gender create an alienating environment full of sexism. One last common response stated that there is a lack of representation of females in this field.

Criteria

We have gathered criteria for how we will answer questions to possible solutions about increasing the number of women in engineering specific to Miami.

Criteria One - Cost:
We've determined that the cost of implementing these alternatives is a prime concern for what Miami University may want to choose moving forward. By "cost" we mean the financial burden to implement the alternatives we investigated, rather than opportunity cost.

Criteria Two - Will it solve the problem:
Another criteria for evaluating the alternatives is how effective they are in yielding results. Therefore will implementing our ideas lead to more female representation in the STEM fields.

Criteria Three - How long will it take for results:
Going along with evaluating the alternatives for effectiveness, we've determined there may be effective long-term solutions that don't yield much short-term results. So we are addressing whether each alternative provides a long-term solution, short-term solution, both, or neither.

Criteria Four - Can we actually do it:
We also need to determine how feasible each alternative is. Miami needs to know whether the alternative we propose is within their scope of execution.

Criteria Five - Desirability:
We want to know how desirable each alternative is to the students.

Methods

In order to validate our statement and come up with a solution, we conducted two types of research. For our primary research, we created a survey that was distributed among girls of different majors. The results of the survey are shown above in the Problem Background section. This survey helped us see how girls, which included girls who are currently in the field, were in the fields and changed major, or were never part of the field, at Miami felt towards engineering. In addition, we did an interview with the Director of Communications at the College of Engineering and Computing, Clark Kelly.

For our secondary research, we looked for possible audiences who would be able to help us facilitate change on campus and in the engineering school. This secondary research also included looking at nationwide statistics on women in engineering, as well as a study done by Google and Gallup titled "Trends in the State of Computer Science in U.S. K-12 Schools".

Overview of Alternatives

Alternative One:
One alternative is to start early at the K-12 school level. Miami University already has great organizations on campus that allow college students to connect with kids of a wide-range of ages in the Oxford area. These clubs, such as Code To Learn and Girls Who Code, help to encourage younger children to pursue a degree in engineering and computer science. However, even more can be done to promote change in Oxford.
For example, in the area of Computer Science, the study done by Google and Gallup found that only 40% of schools reported offering a Computer Science class (Google & Gallup, 2016). This reflects that students are not being exposed to the engineering field at a young age. Additionally, most public schools require Math, Science, History, and English for students. However, courses such as Introduction to

Engineering or Computer Programming are not among the required. Therefore, Miami University should encourage the Talawanda school district to offer more engineering and computer science courses.

In addition, more engineering and science extracurricular activities can be added to Talawanda's school curriculum. Many school districts around Ohio have a robotics team. If Talawanda takes steps towards creating such a team, it can help encourage kids to get involved in engineering. Other possible clubs include Science Olympiad, Math Team, or Hour of Code. These clubs do not just have to be restricted to high school students, but can additionally be made available for a younger age group. This will help to support girls early on in school so that as they grow older, they will feel more comfortable participating in math and science.

Alternative Two:
Another alternative to increase the number of women in engineering at Miami University is to include a course on diversity in the curriculum. This doesn't necessarily mean creating a brand new course to teach engineering students about diversity in the field, but it could just be adding material that highlights topics of diversity in the field and at Miami. For example, everyone in the college of engineering and computing is required to take a sprint course their first semester called CEC 101. This course highlights the different fields within engineering and the various clubs and programs offered to engineering students at Miami. It serves as an introduction to the department. It might be in the best interest of the university to put the diversity curriculum in this course. This way all engineering students are being educated about diversity in engineering, not just the students who are considered a minority in the department.

It is important to teach all students about diversity because those who are not minorities in the field aren't always aware of issues for people who are. Through education, Miami can make all students aware of potential issues women face in engineering. This can help change the behavior between students that may be the reason women aren't going into engineering.

Alternative Three:
The final alternative is to not make any kind of change to the way Miami University is trying to get more women in the engineering field. Miami is already pursuing initiatives to get more women in their engineering programs. For example, they have started SEEC which stands for Socially Engaged Engineering and Computing with the knowledge that women tend to go into fields with a big humanitarian focus. The SEEC initiative includes a new Humanitarian in Engineering and Computing Minor, Grand Challenge Scholars Program, and the Miami University Center for Assistive Technology (MU CAT). Since this program is new, there's very little data proving that it's working on getting or keeping women in the field.

While Miami is already working on creating this change, there may be more the university can do to increase the rates faster, creating a bigger change.

Evaluation

Each alternative was evaluated in comparison to survey results and research studies. The evaluation consisted on stating the pros and cons of each alternative based on the criteria in order to recommend the right one.

Evaluation of Alternative One:
Alternative one provides a solution for students at the K-12 level. This could help encourage younger children, especially girls, to pursue a degree in engineering and later on feel more comfortable participating in math and science.

Cost
Alternative One requires the involvement of Talawanda. Therefore, the burden of the cost is on the school district to implement change. Many school districts around the country do understand the need for computer science and engineering courses at the K-12 school level. However, according to Gallup and Google, nearly half of schools stated that is was not a high priority in their school district. The three main reasons were: time must be devoted to other courses, there are no teachers available, and there is not enough money to train/hire a teacher (Google & Gallup, 2016).

In addition, the cost to buy equipment for extracurriculars requires a lot of money. However, Miami University can offer computer labs for Talawanda clubs and college students can volunteer to teach after-school courses and activities. All this will dramatically reduce cost.

Will it solve the problem
Alternative One will very likely yield results. According to Girls Who Code, "65% of Club participants are considering a major or minor in Computer Science because of the club" (Girls Who Code, n.d). In addition, they found that "93% of Summer Immersion Program participants said that because of the Summer Immersion Program, they now want to major in, or are interested in computer science" (Girls Who Code, n.d). These numbers are good indicators that the program can also be successful at encouraging Talawanda students to pursue engineering/computer science degrees at Miami University.

How long will it take for results
Alternative One will address a long-term solution. The results of changing Talawanda's school curriculum will not be seen immediately, but rather over time, as the program continues to grow. In a couple of years, Oxford will see an increase in girls who participate in math and science fields as a result of expanding engineering classes and activities.

Can we actually do it
Alternative One is very feasible. There already exists clubs where Miami University college students get involved with children in the local school district. Even more can be done by expanding these programs. Therefore, the foundation has been laid, all that needs to be done is to build upon what already exists.

Desirability

Alternative One has a very desirable outcome. There is nothing that can go wrong when you expand engineering and computer science at K-12 schools. Knowing how to engineer and program are important skills to have, no matter what field an individual pursues in college. According to Google and Gallup, the Bureau of Labor Statistics stated that the Computer Science industry has grown 38% in the past decade and is expected to continue to increase in the coming years (Google & Gallup, 2016). With the ever-increasing prevalence of technology in our daily lives, we must adapt school curriculum so that the younger generation can be ready for a future in technology.

The fact that the program is targeted towards younger students is also desirable. AAUW notes a true statement that "Engineers are made, not born" (Belec, 2015). Emphasizing this mindset to girls at a young age is important, because they will have more faith in their ability to pursue an engineering/computer science field. As girls grow older, stereotypes begin to develop, especially during middle school. Females begin to believe that math and science are fields that are meant for men. As shown in the figure below, girls are more likely to be interested in computing fields at a younger age. When they get older, their interest is dramatically reduced.

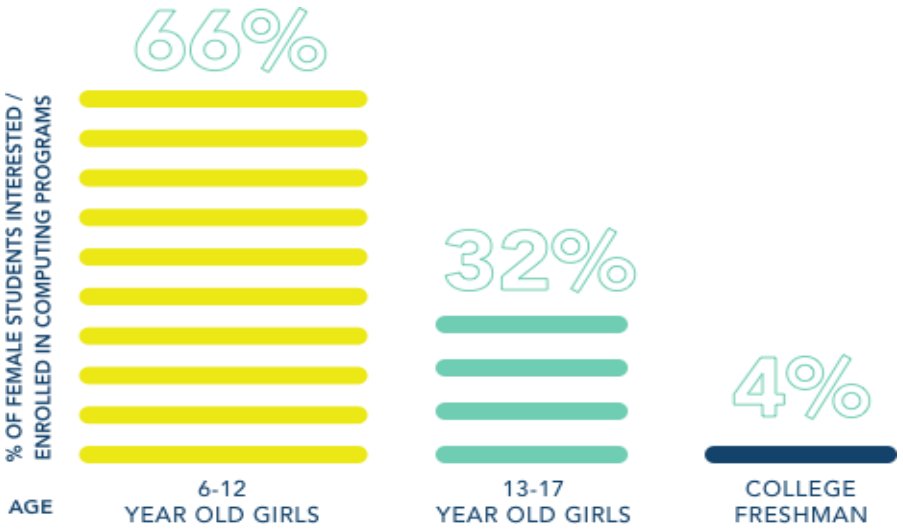

Figure 5 *Girls Who Code*

Oftentimes, girls need a role model, so they understand that they are not alone. This is where Miami University college students get involved, especially in the clubs mentioned above. When young girls see others in the profession, they will be encouraged the pursue the field after they graduate high school. Therefore, if Talawanda and Miami University work together, a huge difference can be made on the perspective girls hold on engineering. With Miami University's involvement and encouragement, local students will be motivated to attend Miami and in turn increase the number of female students in the engineering program.

Evaluation of Alternative Two:
Alternative Two provides a solution for students that are already at the university. This could help to keep them in their engineering discipline and increase the retention rate of women in engineering.

Cost
The cost for implementing Alternative Two would only be a slight increase if an increase at all. Because Alternative Two suggests adding curriculum to an already existing course and not adding a completely new course or spending money on developing completely new programs, the financial cost should be low.

A faculty member, probably whoever is already teaching the CEC 101 course, would have to add to the curriculum and work with the Dean and department heads to help develop the learning outcomes that goes along with adding in the topic of diversity. Because the course highlights opportunities at Miami specifically, the instructor would also need to be in contact with the overall University's staff that focus on increasing diversity and have knowledge of programs related to diversity at Miami University. This wouldn't add to any financial cost, just time of university employees.

Will it solve the problem
Alternative two would most likely yield results. Women leave engineering school insecure about their technical skills because when male classmates give them a hard time and professors provide little encouragement, it creates emotional distress even though their academic abilities do actually carry them through school. The program can be successful at encouraging current students to continue pursuing engineering and/or computer science degrees at Miami University since it would help promote a heterogeneous image in engineering.

How long will it take for results
Alternative Two would be a good short-term solution. This alternative to the problem would create awareness for students who are already in the field. Implementing awareness and a short-term solution, could lead to bigger changes and bigger results in the long run.

Can we actually do it
Alternative Two is very feasible. There already exists an introductory course offered by the college of engineering and computing called CEC 101. Including a diversity lecture would help expand the program since it would educate students about diversity in engineering, not just the students who are considered a minority in the department. With some kind of course already existing, it makes this alternative feasible since all that has to be done is built upon it.

Desirability
Alternative Two has a very desirable outcome. Creating awareness among the current students would lead to a change in attitude, making girls/women more comfortable in their environment and feel as if they have some kind of support. Campaigns have helped show that the environments where women learn and work need to be improved in order to achieve a sense of belonging and purpose.

Evaluation of Alternative Three:
Alternative three does not provide a new solution or a way to solve the problem. It does not make any kind of change to the way Miami University is getting women into the engineering field.

Cost
Because Alternative Three doesn't require the addition of any new programs or initiatives there are no additional costs to the College of Engineering and Computing or Miami University apart from the costs they are already putting towards increasing the number of women in engineering.

Will it solve the problem
Alternative Three would mean the College of Engineering and Computing and Miami University would not add any additional programs or initiatives to increase the number of women in engineering. Therefore the only way this alternative would solve the problem is if the programs like Socially Engaged Engineering and Computing (SEEC) that the College of Engineering and Computing have already put into place work in increasing the number of women in engineering at Miami University.

Unfortunately because the programs are so new there are no statistics or data to prove programs like SEEC are working and solving the problem. Most likely the existing programs will help draw women into engineering once they attend Miami University, but probably won't work to the effect of increasing the rate of women to approximately 50% of the college.

How long will it take for results
Because Alternative Three looks to existing programs to solve the problem, they're already in place. But this doesn't mean programs like SEEC are yielding any results yet. They will most likely yield long-term results, so the College of Engineering and Computing probably won't see a consistent increase in the rate of women in engineering from this alternative until about 5 years out.

This can be frustrating as there aren't more immediate changes happening. Ideally the College of Engineering and Computing would think both long-term and short-term in terms of their strategy to solving the problem. We believe if the programs already in place are carried on properly through advertisement and support, they can aid in solving the problem long-term. However this alternative doesn't account for any short-term solutions.

Can we actually do it
Alternative Three is feasible to implement because everything's already in place with current support and approval from the College of Engineering and Computing and the University.

Although these programs are already being implemented, they can only be successful when supported fully for a long period of time. This meaning the programs in place can't die off or fade away when faculty positions change and funding needs change. The only way to truly implement this alternative is to continue doing the same programs and initiatives for a number of years until they can start to work effectively in solving the problem. Otherwise, the programs will fail and the problem will remain if not get worse.

Desirability

While the programs in place already have a generally positive response from current students and faculty at Miami University, it can't be known how long the desirability will last. This is why we suggest a solution to the problem that acknowledges the short and long-term time period. Because these programs will take so long to show any real effect in increasing the number of women in engineering at Miami, it may seem like Miami isn't doing anything after a year or two, while we wait for results. Students are usually only at Miami for 4 or 5 years, so the ones who support it now won't yield the benefits of the programs. This can give the illusion that the university isn't doing anything to address the issue even if they are.

Conclusion and Recommendation

Women's intellectual potential needs to be fully utilized and more needs to be done to encourage girls to pursue an engineering education. They need to be shown that the path to a career in an engineering field is open for women and it offers them the opportunity to engage in some of the most exciting realms of discovery and technological innovation.

As shown in the figure below, there are nearly half as many female computing graduates today than there were in 1984.

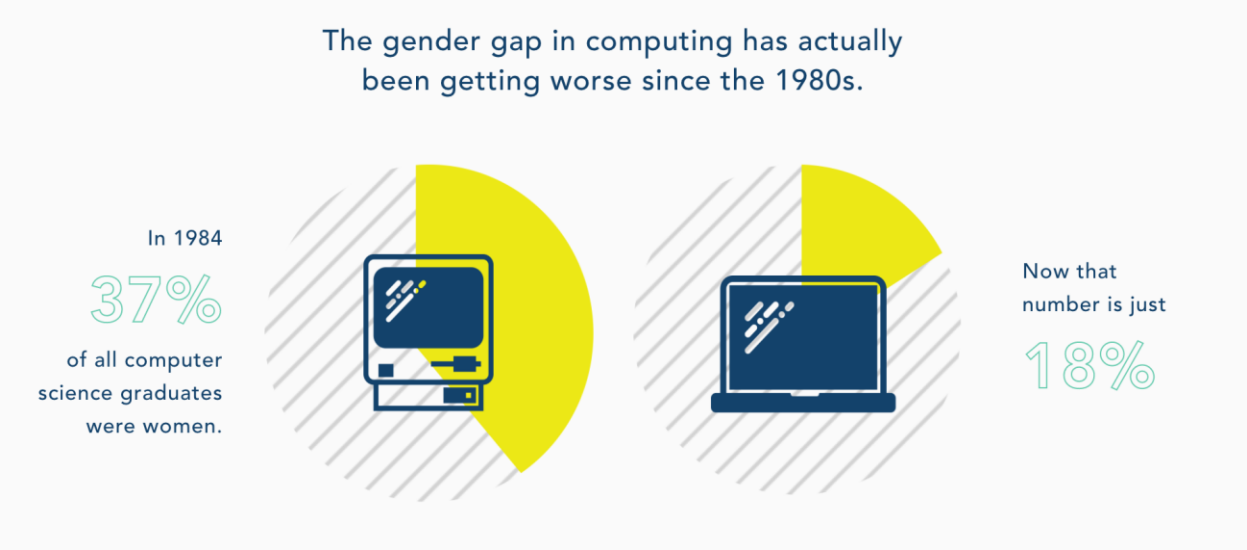

Figure 6 *Girls Who Code*

Clark Kelly also gave us concrete proof of the significant amount of women switching from engineering. These indicate that this is a real problem at Miami.

After doing an evaluation of the criteria against the alternatives, we've come to the conclusion that Alternative 2 is the best. This alternative is the least costly and will have immediate results. Its implementation will have a direct impact on current Miami University students and will help to change the perspectives that both females and males have on engineering. Therefore, we believe that adding the topic of gender diversity to the existing class CEC 101 will help to alleviate this issue. As a result, the

next steps to take are add a diversity section as part of the engineering curriculum and further build the engineering clubs a Miami. We appreciate you taking the time to read our report and we hope that you will help us to make Miami University even better.

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