Gender Differences in Problem-Solving Strategies in Engineering & Computer Science

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ABSTRACT

Throughout education past high school, it has become common for more males to take classes regarding engineering and computer science than for females too. However, this gap does not only begin to form when students are registering for classes; this gap could start to become apparent throughout these students' high school education. My research focuses on looking for where this gap forms through the lens of problem-solving strategies. Through this, this paper discusses if there are any similarities / differences in problem solving strategies between males and females in high school who have shown interest in Engineering and/or Computer Science. I used a survey method discussing different approaches to problems and how often these approaches are used by the participants. Through data analysis, I could recognize a couple major findings. This includes that although both males and females claim that discipline is one of the most important skills in problem solving, when cross checked with the multiple-choice questions, while 80% males responded that they had discipline when approaching a difficult academic problem, 87% females said they only felt that they had discipline sometimes. From the free response questions, I found that females value collaboration much more often than males, matching the results from the multiple-choice questions. This research provides insight for further research focusing on finding where the prevalent gap becomes apparent in high school students between the number of males versus females who sign up for engineering and computer science courses.

Introduction

Through personal experience of being a high school student interested in the fields of Engineering and Computer Science and knowing multiple people pursuing higher education within these fields in college, I have noticed a few stereotypes that I used to believe were fake. This includes that in most of the Engineering and/or Computer Science classes that people that I know have taken in college, there are always very few females enrolled in the class compared to males. However, even though not as severe, I have noticed this trend in my engineering and computer science related classes since the beginning of high school. Through this observation, I wanted to see if this difference in the number of males and females was just something I noticed, or something that has been researched to be true. Through my initial research I found that most, if not all, research regarding this topic was based on identifying that there is a large difference between the number of females and males in these classes and on how to prevent this regarding those in elementary school. From this, I was able to identify a huge gap in the research in terms of identifying where this gap starts to become apparent in students' formative years. I found that high school education was the last few years of students' formative years before entering college, making them the most crucial years in determining what classes they enroll in during college. Through this knowledge, and the minimal research on high school students, I set on trying to start identifying how this gap becomes apparent by beginning with a small section where I might be able to see these differences, being problem solving strategies. This is with my hypothesis that there are at least some differences between problem solving strategies between high school males and females interested in engineering and computer science. From

my findings on differences and similarities in these students' problem-solving strategies, this will provide further insight into future research on high school students in different categories, all with the goal of determining where this gap between the genders becomes apparent, which will most likely occur in multiple different smaller sections, such as one being the first one, I will be researching, problem solving strategies.

Literature Review

There already is a stereotype on gender disparity regarding engineering and technology education throughout all levels of education, whether it be middle school, high school, or university level. However, most of this research is surrounded around those in higher education, past high school level leaving other age groups of kids and the gender disparity in STEM regarding them to not be researched as well. Along with this, the research that is done regarding this topic no matter which age group is directed towards, usually surrounds differences in interests and career outlook between boys and girls and for STEM fields in general, with no direct view at engineering and technology fields. This leaves the question of why these opinions of the kids analyzed for career outlooks and interests think that they will land up differently than boys and if this problem of one gender being more prevalent in engineering and technology fields has caused a difference on how high school students learn in these classes and clubs at schools. A factor that could be affected by this is how highschoolers think and problem solve and if there is a difference in these ways of thinking in boys versus girls.

According to Clemencia C. D. Cohen, a doctoral candidate at Princeton University, "Very young boys enjoy watching Bob the Builder, so maybe it's time for Ellie the Engineer" (Cohen, 2009, p. 1). This quote basically can present the problem of why boys have a much larger presence in the field of engineering is not low retention but is that women are not being attracted to engineering from a young age. This can be seen in how shows made for kids are very different for those aimed at boys than the ones aimed at girls. As it can be seen in the quote, a very well-known kids show is *Bob the Builder* which is also mainly directed for a male audience. However, this is unlike the general types of shows that have been directed towards little girls for a very long time. This could cause women to be less willing to give engineering a try unlike boys who are much more willing as they grew up watching more engineering focused kid shows and being exposed to the field much more. Moreover, this journal revolves around research regarding those in university level education and why the stereotype of less enrollment for women compared to men exists as an underlying problem could be what is taught from a young age.

Along with this, Francisco O. Ramirez and Naejin Kwak, professors at Stanford, "Although women's share has increased in both fields of study, women have less access to engineering than natural science" (Ramirez & Kwak, 2015, para. 1). This journal reports on how much access women have to the STEM fields compared to the other STEM fields. However, this journal also has researched on those in higher education and through a broad perspective of all STEM fields in general. The authors do bring up how women specifically have less access to engineering than natural science at the university level showing that it is not just a stereotype of there being a higher prevalence of men in engineering fields, rather it is a fact that as people go into university, the gap between women and men in engineering and technology fields, widens.

Furthermore, according to Jill M. Bystydzieński and Adriane Brown, in their journal published by the Johns Hopkins University Press, they state that "Our findings indicate that the girls' perceptions and choices are influenced by the presentation of engineering on websites, at career fairs, and through other venues designed to attract young women to engineering"(Bystydzienski & Brown, 2012, p. 1). Throughout this journal, although the authors did end up concluding that girls' perceptions of engineering were affected by basically advertisements they saw, all this research revolves around how the girls are influenced in terms of their future college major decision. This was as the particular focus group for this research involved those girls who are looking for colleges to apply to. This can also be represented in how the findings they got were through college spam

emails, college fairs, etc. Essentially, this journal aimed at the audience with the age group transitioning from high school to college in most of their last phase of decision making for what they want to do as a career.

Moreover, the trend of research regarding this topic surrounding career outlook and particular age groups can be seen in an article written by Melanie Kinskey. In this she writes that "To prepare our classrooms to be equitable and meet the needs of the NGSS, we must rid our students of the idea that STEM careers are more suitable for males than females" (Kinskey, 2020, p. 1). This quote demonstrates how for stereotypical thinking of one gender being more prevalent than another in a career to be changed, it needs to be done beginning from working on altering this thinking during kids' formative years. This includes elementary school kids which Kinskey specifically focuses on. Along with this, this source connects with how there needs to be more representation of engineering for products directed to little girls as this journal article discusses the need for female representation in schools.

However, the article identifies a need for a different type of problem-solving strategy for this problem and articulates a method, but Kinskey's goal is to fix the problem with showing equal pictures of both women and men being represented in STEM careers. This in fact is in correlation with career outlook and fixing the problem. However, what I intend to look at is regarding how the increasing prevalence of men in engineering and technology fields has already affected those who have been growing up while this prevalence has been emerging. The focus group in this situation is high school students, which much existing research does not cover as most research currently is more revolved around what the problem is and how to fix it, rather than how it has affected kids' thinking in this generation of current high school students.

Methodology

Material List

-   Google Forms - platform used for survey
-   Google Sheets - platform used for data organization & analysis
-   Gmail - platform used to send out survey

Method

The method chosen for this research was a questionnaire approach to determine how high schoolers who either are enrolled in a computer science and/or engineering club and/or are enrolled in a computer science or engineering class offered at School problem solve. This survey also determined if there were any distinct similarities or differences in boys' and girls' problem-solving strategies, as well as differences between those in technology related clubs and classes within looking at the comparison between genders. Questionnaires can be described as "A formulated series of questions by which information is sought from a selected group, usually for statistical analysis; a document containing these" (Oxford, 2007, para. 1).

Dispersion of Survey & Informed Consent
This survey will be distributed by contacting the teachers who teach the engineering and computer science classes as well as the presidents of the clubs related to these topics. This is so, the survey can be done through class time or club time as it is short and can be done at the end of class. In terms of informed consent, each participating individual will receive consent forms suitable for their age. In these consent forms, the individuals will be able to get a description of the research study and their contributions to the study. Along with this, it is noted in the forms that their participation is completely voluntary and if they choose to withdraw from the study, there will be no consequences. Lastly, even though there is no identifiable information being asked for in the

survey, all survey responses will be entered into a locked spreadsheet until the research study is completed, where it will be deleted once the study is done.

Description of Method

The google form used begins with two identification questions to help with the comparison of the results from the rest of the questionnaire. This includes asking about gender identity and grade level to help with categorizations of responses per grade level and comparisons between genders on the answers determined. The third question asks about the duration of time the student usually spends on homework per week. This question would be used to see how similar all the students are who are taking the survey, which is more of an informative question. The fourth question asks the student to mark which clubs and/or classes related to computer science and engineering they are enrolled in at School. There is a specific list of all the courses offered in order to make it easier for the individual to simply mark which ones they are a participant of.

Moving on, the fifth and sixth questions ask about the student's approach to solving a difficult problem and strategies the student uses to manage time in an effective manner. These are listed as Likert scale multiple choice questions, just as the ones mentioned so far. For both these questions, the answer choices listed provide a variety of different and effective methods high school students usually use for these exact purposes. The survey then moves onto asking the student about how they would handle a setback/failure when trying to solve a problem. This question provides multiple possible options including just taking a break and giving it some time to adjust a strategy. Within this there are multiple more options allowing for the student to be able to describe their strategy in the best way possible. Following this, the questionnaire asks the student of what resources they would typically use when solving a problem, with many different resources such as textbooks and online research listed as options.

The survey then goes on to ask two free response questions. The first one inquires of a situation when the student has encountered a particularly challenging problem within the academic work given in the club or class the student is in and how the student approached it, followed by the outcome of this situation. The second one asks the student to discuss their opinion on the most important skills for problem-solving. This allows the student to be open with what they want to say, especially to see if the student's response matches a previous multiple-choice question regarding which problem solving strategy the student uses. The questionnaire then goes on to question the student's emotion when faced with a problem they are not sure of how to solve. This question lists multiple choices with different feelings the student could possibly feel in such a situation. The next question in this survey queries on strategies the student uses to stay focused and motivated when working on a difficult problem. This is a multiple-choice question which essentially double checks the free response question listed earlier on the topic of a situation when the student was faced with a difficult problem, their approach, and the result of it. Further, the last two questions include a multiple choice on how interested the participant is in certain fields, along with a short answer question regarding the participant's predicted future career path.

Alignment

The type of data my method will generate can be quantified as qualitative data and quantitative data. This is as the results can be formulated into tables to see a trend in a certain group of people and the results can also be compared as to if certain results are grouped under certain categories of problem-solving strategies. These groups can then be compared between the different students who participated in the survey. However, my data will answer the research question of if there are any differences or similarities between problem solving strategies in the field of engineering and computer science between two groups of high school students.

Defense for Method

The research in my field which pertains to the STEM field which I am researching usually researches for outputs and effects in life. This includes numbers of each gender in STEM classes in higher education and career outlooks. Those are looked at through the lens of proportions of men to women in certain career fields such as engineering and computer science, and the difference in these proportions between careers. As this is the case, the little research on why there is such an outlook of men being more prevalent in technology fields mostly all surrounds the usage of surveys. This can be seen in the academic journal *Explaining the Gender Wage Gap in STEM: Does Field Sex Composition Matter?*. This journal looks at why there is a gender wage group (Michelmore & Sassler, 2016), trying to find a reason which is essentially what this research paper is looking to do. Other methods that could have been used were tests and group projects. However, these were deemed to be less effective than the usage of a questionnaire. This is as the tests would consist of real-life situation problems to work out which comes with biases consisting of the different life experiences each participant has gone through and how that could affect their response to the questions. Along with this, the group project method also consisted of biases. This is as each group would be given a problem to figure out, whether it be theoretical or a mathematical approach problem. However, this method consists of the problem of differing skill levels across the participants and whether the participants would be completely compliant to working with the randomized group partners. In the end, this resulted in the questionnaire method being the most effective method to use to collect the data needed for this research paper.

Findings

Table 1. Female and Male Responses to Question 1 (F - Female, M - Male)

How often do you use each of the following strategies to approach solving a difficult problem?	Hardly Ever	Seldom	Sometimes	Often	Very Often
Breaking it down into smaller parts	F: 0, M: 2	F: 1, M: 1	F: 5, M: 4	F: 6, M: 5	F: 3, M: 3
Asking for help from teachers or classmates	F: 0, M: 2	F: 3, M: 1	F: 5, M: 5	F: 6, M: 6	F: 1, M: 1
Researching and gathering information	F: 1, M: 1	F: 1, M: 2	F: 4, M: 3	F: 6, M: 5	F: 3, M: 4
Trying different strategies	F: 1, M: 1	F: 3, M: 3	F: 3, M: 5	F: 4, M: 4	F: 4, M: 2
Taking breaks and coming back to it later	F: 0, M: 3	F: 1, M: 2	F: 4, M: 4	F: 5, M: 5	F: 5, M: 1

From this table, the most noticeable trend lies in the "Trying different strategies" section. In this, most of the girls either chose "often" or "very often". However, for this same question, most boys chose the option "sometimes". This turns out to be a relevant difference because of the number of boys vs. girls that chose each option. This is as about 53% of the girls chose "often" or "very often". This is while for the boys, the majority of the responses leaned towards "sometimes" (33%) and "often" (27%). Otherwise, for every other category in this question, both the responses for females and males all lean towards the same option on the Likert scale.

Table 2. Female and Male Responses to Question 2 (F - Female, M - Male)

How often do you use each of the following strategies to manage your time effectively?	Hardly Ever	Seldom	Sometimes	Often	Very Often
Creating a schedule or to-do list	F: 0, M: 3	F: 0, M: 2	F: 2, M: 4	F: 2, M: 2	F: 11, M: 4
Prioritizing tasks	F: 0, M: 0	F: 0, M: 0	F: 0, M: 1	F: 9, M: 6	F: 6, M: 8
Setting deadlines	F: 0, M: 1	F: 1, M: 1	F: 2, M: 3	F: 5, M: 4	F: 7, M: 6
Eliminating distractions	F: 1, M: 3	F: 3, M: 2	F: 4, M: 7	F: 4, M: 2	F: 3, M: 1
Using time management apps or tools	F: 6, M: 6	F: 3, M: 4	F: 2, M: 1	F: 2, M: 1	F: 2, M: 3

A main trend that can be seen from this table, in terms of the first category, "Creating a schedule or to-do list", an overwhelming 73% of girls (11/15) chose "very often" for creating a schedule or to-do list. This is while in the same question, the greatest number of male participants either chose "sometimes" and "very often". In this, the boys, 4 chose "very often", while 4 chose "sometimes". Along with this, in the same category, when looking at which option for most participants chose next, 33% of the boys chose "hardly ever" or "seldom", compared to the 0% of girls that chose either option. Other than this, in the "Prioritizing Tasks" category, 60% of females chose "often", while 53% of males chose "very often" and 40% chose "often". Moreover, for the "Eliminating Distractions" section, for females, the majority of the responses are split upon "sometimes" and "often" with 27% of responses in each. However, in the same category for males, most of the responses lean towards "sometimes" with 47% of responses, while only 13% for "often".

Table 3. Female and Male Responses to Question 3 (F - Female, M - Male)

How often do you use the following strategies to handle setbacks or failures when trying to solve a problem?	Hardly Ever	Seldom	Sometimes	Often	Very Often
Reflecting on what went wrong and learning from it	F: 0, M: 0	F: 2, M: 1	F: 4, M: 3	F: 8, M: 6	F: 1, M: 5
Seeking support from others	F: 0, M: 2	F: 1, M: 2	F: 6, M: 3	F: 7, M: 6	F: 1, M: 2
Persisting and trying again	F: 0, M: 0	F: 0, M: 0	F: 4, M: 0	F: 9, M: 12	F: 2, M: 3
Adjusting your approach or strategy	F: 0, M: 0	F: 1, M: 1	F: 4, M: 2	F: 6, M: 11	F: 4, M: 1
Taking a break and coming back to it later	F: 0, M: 1	F: 1, M: 3	F: 4, M: 6	F: 5, M: 3	F: 5, M: 2

In this table, there are 2 main trends. One being in the "Adjusting your approach or strategy", the female responses include 40% of responses being for "often" with the rest of the responses being split out between "sometimes" and "very often" with 4/15 responses in each. However, for the males, there are 73% of responses for "often" leaving most of the rest of the responses (2/15) in the "sometimes" category. Along with this, a minor difference that can be seen in the "Taking a break and coming back to it later", is for the female responses, the majority of the responses (67%) are in the "often" and "very often" category, with most of the male responses leaning towards "hardly ever", "seldom" and "sometimes" with 67% of responses. The rest of

the data in the other categories are much more similar with many of the responses for each being in similar categories in males and females.

Table 4. Female and Male Responses to Question 4 (F - Female, M - Male)

How often do you use the following resources when solving problems?	Hardly Ever	Seldom	Sometimes	Often	Very Often
Textbooks	F: 4, M: 6	F: 3, M: 3	F: 4, M: 3	F: 3, M: 2	F: 1, M: 1
Online Research	F: 0, M: 0	F: 0, M: 0	F: 0, M: 1	F: 8, M: 6	F: 7, M: 8
Class Notes	F: 1, M: 2	F: 0, M: 3	F: 4, M: 1	F: 8, M: 6	F: 2, M: 3
Teacher Guidance	F: 0, M: 4	F: 1, M: 2	F: 10, M: 4	F: 4, M: 3	F: 0, M: 2
Peer collaboration	F: 0, M: 1	F: 2, M: 0	F: 3, M: 3	F: 6, M: 6	F: 4, M: 5

In this trend, there is one minor trend and one major one. This minor one is in the "Class Notes" section, where the females have 27% of responses in the "sometimes" category and 53% in "often". This is while, in the same category, for males, even though 40% of responses are "often", only 6% of responses are "sometimes". The major trend in this table is for the "Teacher Guidance" section where 67% of female respondents said "sometimes", with only 27% of males chose "sometimes", with another 27% who chose "hardly ever".

Table 5. Female and Male Responses to Question 5 (F - Female, M - Male)

How often do you feel the following ways when faced with a problem you don't know how to solve?	Hardly Ever	Seldom	Sometimes	Often	Very Often
Excited and motivated to find a solution	F: 2, M: 1	F: 3, M: 1	F: 4, M: 2	F: 5, M: 9	F: 1, M: 2
Confused and unsure where to start	F: 1, M: 0	F: 1, M: 2	F: 3, M: 10	F: 9, M: 2	F: 1, M: 1
Anxious and overwhelmed	F: 1, M: 3	F: 1, M: 9	F: 4, M: 3	F: 8, M: 0	F: 1, M: 0
Curious to learn and explore different possibilities	F: 2, M: 0	F: 2, M: 1	F: 3, M: 5	F: 6, M: 6	F: 2, M: 3

From this table, it can be seen that there are 2 major differences between the data collected from females and that from males. First, in the category "Confused and unsure where to start", 60% of females responded with "often", while 67% of males chose "sometimes". Second, in the category "Anxious and overwhelmed", 53% of females answered "often", with 60% of male responses being "seldom".

Table 6. Female and Male Responses to Question 6 (F - Female, M - Male)

How often do you use the following strategies to stay focused and motivated when working on a difficult problem?	Hardly Ever	Seldom	Sometimes	Often	Very Often

Breaking the problem into smaller tasks	F: 0, M: 1	F: 1, M: 3	F: 4, M: 4	F: 6, M: 3	F: 4, M: 4
Rewarding yourself for progress	F: 0, M: 0	F: 1, M: 7	F: 6, M: 3	F: 6, M: 4	F: 2, M: 1
Setting goals and milestones	F: 0, M: 1	F: 0, M: 0	F: 3, M: 4	F: 10, M: 7	F: 2, M: 3
Seeking support or encouragement from others	F: 1, M: 3	F: 3, M: 4	F: 5, M: 4	F: 6, M: 3	F: 0, M: 1
Visualizing the end result	F: 2, M: 2	F: 1, M: 1	F: 0, M: 0	F: 5, M: 3	F: 7, M: 8

In this table, differences between data can be seen in the first three categories. To begin, in the "Breaking the problem into smaller tasks" category, 40% of females chose "often", with only 20% of male respondents for "often". Along with this, in the "Rewarding yourself for progress" section, respondents responded "sometimes", "often", or "very often", with 93% of responses in either category. However, most of the male responses are "seldom" with 47% of responses. Lastly, in the "Setting goals and milestones", 67% of females responded with "often", while 47% of males responded with "often".

Table 7. Female and Male Responses to Question 7 (F - Female, M - Male)

How interested are you in the following school subjects?	No Interest	A Little Interest	Average Interest	Very Interested	Extremely Interested
Science	F: 0, M: 0	F: 0, M: 0	F: 7, M: 4	F: 5, M: 6	F: 3, M: 5
Engineering	F: 2, M: 0	F: 5, M: 0	F: 1, M: 3	F: 4, M: 5	F: 3, M: 7
Computer Science	F: 2, M: 0	F: 2, M: 2	F: 3, M: 1	F: 5, M: 6	F: 3, M: 6
Mathematics	F: 3, M: 3	F: 2, M: 0	F: 4, M: 1	F: 4, M: 4	F: 2, M: 7

Throughout this table, the data presents a relatively equal distribution between the interest levels between the different school subjects in regards to males versus females.

Table 8. Female Responses to both Short Answer Questions

	Describe a time when you encountered a particularly challenging homework problem. How did you approach it and what was the outcome?	What do you think are the most important skills for problem-solving?
Response #1	Whenever I had a challenging homework problem in engineering, I would first look over my class notes, then use online resources to help me. If that didn't help, I would ask my peers for help. Usually, I would find the solution to the problem after these	I think the most important skills for problem-solving are critical thinking, analysis, and creativity.

	steps.	
Response #2	I asked my friends and did research online. After getting frustrated, I took a break and came back to it.	Reflection, open to asking for help, and breaking down problems.
Response #3	A time I encountered a challenging home work problem was in my honors engineering class and in order to solve it, I broke the problem down in sections and found what I could. After that I wrote down all my unknows and slowly tried to list out the possibilities I had, to find those unknows. When I was still stuck I tried looking at online resources to help me solve the problem. In the end I was able to break down the problem in small parts and solve it with the help of online videos.	I believe the most important skills for problem solving are being able to identify what the main goal of the problem is and corner what your trying to figure out, and break down the problem in small section and slowly try to figure out each section. These help a lot in problem solving.
Response #4	Using notes and previous lessons or practice problems. The outcome was being able to solve the problem	Skills such as focus, critical thinking
Response #5	Recently in a physics class, I was absent when the teacher introduced problems for a new unit. Doing the homework was really confusing at first, but I just watched a video of the steps on how to do the first problem and learned the general approach to the problem. I then used same/similar approach for the rest of the problems.	I think backtracking to the fundamentals (and fully understanding them) is really important to moving forward in a difficult problem.
Response #6	When I was doing my math homework this semester I encountered a problem that I had not learned very well. I tried to solve it but I got frustrated, so I stepped	The most important skills for problem solving are researching, communication, and regulation.

	away, reflected, and came back to it 30ish minutes later. I had adjusted my strategy, looked through the notes, and tried again until I got frustrated again. Then instead of taking a break I looked up help videos from several sources and used these examples to help me understand and complete the math problem.	
Response #7	i approached it by comparing to classwork notes, onlien videos, or textbook exercises. I tried to understand the basics or understand a problem similar to the original problem	grit, analysis, and discipline
Response #8	One time I had a challenging homework problem, I looked back at the class notes at problems that were similar and were already solved. This helped me solve my issue	critical thinking
Response #9	Writing assignments in general are challenging for me. However, I approach most, if not all, writing assignments by first making an outline, then a do-it list of what needs to be done for the assignment, and lastly set my own deadlines to have the assignment ready by the actual deadline. This approach has always worked for me, and helps me break down the assignment into smaller parts.	I think the most important skills for problem-solving is defining the problem, creativity/analyzing, and adaptability.
Response #10	I researched sample problems online and watched YouTube videos explaining the concepts to better understand them. Then, I tackled the problem again until I was able to solve it.	Perseverance in the face of challenges, being open-minded enough to consider various ways to solve a problem, and a willingness to learn new material.

Response #11	AP chem homework problem solved through peer collaboration. The outcome was successful because we not only figured out the solution but we found a different method for solving.	Collaboration, persistence, adjusting strategy.
Response #12	I approached it by asking my parents, since they're skilled in programming and computer science. They'd help me to the best of their ability, and it would result in me figuring out how to solve the problem by seeing it from a different perspective.	I think resilience, adaptability, and communication are some of the most important skills for problem-solving, especially in the field of computer science.
Response #13	When I encountered challenging homework, I first did some online research on that topic, watched videos or read articles related to it, and took notes. I revised all my notes after and then went back to the homework, and tried to answer most of the questions. If I still didn't understand, I would ask for help from my friends or teachers and finish the homework with all the correct information.	Active listening, collaboration, critical thinking, decision-making, planning, research skills, and time management are the most important skills for problem-solving.
Response #14	In my AP Stats class, I was approached with a difficult frq that we had never learned in class. When collaborating with my neighbors and doing research, we were able to solve the problems and get it right.	Effort, determination, and hardwork
Response #15	When I didn't understand the new stats concept, I called one of my friends and we worked on the homework together. I better understood the concept after this.	perserverance

As for the question on the left regarding the approach to a challenging homework problem, it can be seen that throughout the responses, the main approaches include peer collaboration, online resources, and class notes. For the question on the right regarding the most important skills for problem solving, I found that most of the responses heavily leaned towards the skills of collaboration and discipline when problem solving.

Table 9. Male Responses to both Short Answer Questions

	Describe a time when you encountered a particularly challenging homework problem. How did you approach it and what was the outcome?	What do you think are the most important skills for problem-solving?
Response #1	There was a rather difficult problem that I had in Calc C. I approached it by writing down all the variables down and seeing what formulas may work to solve the problem. I then tried to optimize the problem to fit any of the formulas that may work and solved from there.	Drive to solve, ability to use different strategies, patience, ability to know when to take a break and come back to it.
Response #2	Many times if there is a difficult problem I generally reach out to friends and peers first for help. After that, I will contact the teacher. This has happened many times, especially in math-based classes where small mistakes can have large outcomes. I seek peer help because a majority of the time i am able to get the help I need.	The ability to identify a problem, break it down, find the problem, then think of ways to fix it.
Response #3	Often many project based assignments can be difficult to me, whether it is just getting started with knowing what to research or just finding ideal ways to format information. One approach I have to solving these roadblocks is researching projects that already exist to give me ideas on how I would continue with the project, doing this often leads to inspiration and allows	When attempting to solve problems that are difficult one things to understand is that there are inherent mistakes to be made, which can lessen the frustration when you do come across a roadblock, continuing to be inspired and have the determination to solve the problem is the most important, and any way to stay focused whether it is finding assistance or taking a break can be

	me to progress forward with a task that needs to be finished.	useful methods to help solve problems.
Response #4	I initially tried to solve it with my limited knowledge. Then, I used online resources to acquire more knowledge and re-attempted the problem. As a result, I was able to successfully solve the problem.	You should never give up when you're trying to solve a problem.
Response #5	I came across a diffcult calculus problem and wasn't sure how to solve it, so I consulted it with my friends and we worked it out together, ultimately solving the problem. It exemplifies the importance of hearing out others when working on a problem your stuck on .	I think that the most important skills that you can have when problem-solving are to be open-minded to different possible perspectives and solutions, and being cognizant of the importance of logical reasoning.
Response #6	I just kept at the problem until I solved. I used different strategies as well as researching online to find what I was missing.	Being able to think about the problem in a different context.
Response #7	I reached out to friends for help and collaborated in order to figure the problem out.	Persistence and creativity
Response #8	I watch a youtube tutorial or sometimes I would look at websites that offers the problem that I am currently facing and learn it from there.	Critical thinking, communication, creativity, analysis.
Response #9	Initially I attempted to break it up into separate subtasks with limited success, from there I worked on each subtask I identified this was again met with limited success as at some point I ran out of useable approaches and was just glancing between documents I had open for that assignment. At that point I was unsure of how to proceed, so I took a ~1-2 hour break and occupied myself	I think the most important skills for problem-solving are critical thinking, logic, and persistence.

	with something unrelated to the assignment, during the course of this break I would occasionally stumble upon ideas for how to continue the assignment which I would note down. Upon the completion of my break, I went back to working on it until I finished it, and then I checked it over a few times and submitted it. In the end I did very well on that assignment although I found a number of things I could've done better so I wasn't entirely satisfied with it.	
Response #10	In the past, I encountered a challenging problem in AP Physics 1 and discovered that my answer was 1000 times higher than the expected result. To identify my mistake, I examined my peers' work and compared it to mine. I went through the solution step by step, ensuring that I identified the error. Ultimately, I realized that I had made a small mistake when canceling forces, a error I could only have identified this easily by examining others' approaches.	Understanding what the problem you are trying to solve is. Learning how to create a quick plan to solve that problem.
Response #11	I looked for help online like khan academy videos and it worked	Creativity and persistence
Response #12	I googled it, saw how it was done. I did the problem.	thinking outside the box and using your resources.
Response #13	During AP Computer Science Principles, for a particular project, I had to work to create code for an assignment. I realized that I had missed an initial instruction, and I had to now incorporate the new guideline, but I did not know how. I	Ability to adapt.

	talked to some friends, as well as my father, to successfully navigate the class assignment and improve my problem solving.	
Response #14	For AP Statistics, sometimes I come across problems I don't really understand yet, so I usually contact others in the class such as Ava or Sibrah to try to understand the material.	The most important skills for problem solving are probably critical thinking and patience.
Response #15	During my AP Comp Sci A class in my junior year, my group was working on an assignment together when we realized that we hadn't learned the actual content necessary to complete the code. Splitting up, we each researched on our own before coming together and pooling our collective knowledge to tackle the issue head on.	With a group, the most important skills are easily the ability to listen, step back, and communicate/collaborate effectively. When by yourself, I'd argue the most important skill is patience. Everyone is capable of finding a solution, but the majority of us often think ourselves into a rut with our impatience.

In terms of the question on the left, asking for the approach used in a past challenging homework problem, it's evident that the main approaches throughout the responses include mostly online resources, with the rare mention of collaboration and previous class notes. Regarding the question on the right discussing the most important skills for problem solving, most of the responses surrounded the skills of creativity and discipline.

Discussion

Major Findings

Using statistical analysis, I was able to identify a few major findings by finding the Mode of each data set. In this, one major finding was that females tend to try different strategies when solving a difficult problem much more frequently than males. This was as 53% of the girls said they would most likely try different strategies, while 60% of the males would not usually try different strategies as their optimal approach. This is significant because throughout the other categories in the same question, most of the females and males tended to choose the same option on the Likert scale. Along with this, another major finding was when asked if the individual creates schedule and to-do lists to manage time effectively, 73% of the females said they usually would create these schedules, however, 33% of males said they would hardly ever use that strategy, while no females said they would hardly ever or seldom create those to-do lists.

Moreover, another major finding includes that even though in the short answer questions, a common skill that both females and males said that was important in problem solving was discipline, there is a major difference in the Likert scale question for that. This is as when asked how often the individual would persist and try again when trying to solve a difficult problem, 80% of males said that they often do this, with the rest

of the responses saying that they persist very often. This is while for the females, although the majority of the responses, 60% said they often persist, 27% of the responses said they only sometimes persist and try again. However, throughout the short answer questions, answers relating to 'discipline' were prevalent amongst the respondents of both genders, but only the male multiple-choice responses confirming those results. To further support this, from the survey results, when asked how often one would seek support from others when handling failures, most of the female responses were on the "sometimes", "often", "very often", part of the scale with 93% of responses. This is while, almost half of the male responses were for "hardly ever", "seldom", "sometimes", the significance of this being that not one female answered that they hardly ever seek support from others and only one female said they "seldom" do this. In turn, this further agrees with the short answer questions, which showed that females valued collaboration much more when approaching a difficult problem, while there was little or no mention of collaboration in the male responses to the same question.

Another major finding combines two data set trends which go hand in hand when compared to the short answer question responses. When asked how often one would use class notes and then asked how often one would use teacher guidance, there was a similar trend between the responses of males and females for both questions. This is as for the class notes question, most of the responses from females said they used the notes often or very often, with 67% of responses. This is while, in the same question, the male responses were spread out throughout all the options on the Likert scale, ranging from "hardly ever" to "very often". Along with this, when asked how often one would use teacher guidance when solving problems as a resource, the majority of females - 93% - said they sometimes or often use teacher guidance. This is while, for the same question, most of the boys responded that they hardly ever or sometimes used teacher guidance, while no females had chosen "hardly ever" and only one had chosen "seldom". Both the trends from this teacher guidance question and the previous one about class notes, confirm the short answer questions regarding the approach to a difficult homework problem. This is as throughout the responses; it presents a clear trend of females being more likely to refer to class notes and collaboration than males. This is significant as in the multiple-choice questions just discussed, the data shows that females are much more likely to refer to notes and teacher guidance than males.

Throughout all my findings, it especially surprised me when the trends that I found from the data in the multiple-choice questions, heavily matched the data from the short answer questions. This is as it adds more credibility to the finding that females look towards collaborative learning more than males do when it comes to learning material and working through difficult problems. Lastly, for the question regarding how one feels when faced with a difficult question, my data presents that women feel more confused, anxious, and overwhelmed than men do. This is as for when asked how often one feels confused in this situation, 60% of women said they often feel like this, while 67% of men said they only sometimes feel like that. Along with this, regarding the feelings of being anxious and overwhelmed, 53% of women said they often feel like this, while 60% of men said they seldom feel like this. This shows that females tend to gain a lack of confidence when faced with something more difficult. This can also be supported by a past study done on students studying engineering in university, where it was found that "Throughout college, men and women succeeded equally in the classroom. However, we observed that women started to doubt their problem-solving abilities more than men" (Silbey, 2016, para. 7). This confirms that females feel less confident when faced with something more difficult which can hinder their problem-solving ability as they start to doubt themselves. These results answer my research question. This is as for each participant, they accurately collect information on eligibility, problem solving strategies, and representativeness of a larger population.

Along with this, since in my research question is to find the differences or similarities in problem solving strategies, by my survey including questions about how often a certain problem-solving strategy was used in a multitude of scenarios, I am able to get multiple data points on how someone from a certain gender would most likely solve a problem, versus one from the other gender. Along with this, as I can use the Likert scale in the majority of my questions, it gave the participants an easier path to answering the questions as truthfully as possible. As this allows for greater accuracy in my survey responses, it is able to correctly answer

my research question in terms of the reliability of the data when looking for those specific differences and similarities between the problem-solving strategies. Moreover, since in my research question, it specifically states that it is looking for the differences in problem solving strategies in two specific fields and age groups, my findings can accurately align with that. This is as throughout my survey, not only are there questions determining eligibility for the survey, but it also includes questions such as career interests, which provide a helpful insight on if the participant is an accurate representation of someone interested in the fields of engineering and computer science in high school.

Limitations & Implications

As my research project was based on the population within one high school in my city, this caused the sample size to be a moderate size of 30 participants. Even though this was a decent number to obtain accurate results, the small sample size limits this accuracy. The study only included 30 people because 15 participants were boys and the other 15 were girls. As in my school, there are not many females interested in computer science and/or engineering that participated in this study, it would be very difficult to find more than 15 girls from just my school to complete this study.

Along with this, as access to multiple students from the same grades who took the same classes was limited, the data obtained from the research is from participants with a variety of experience and interest in engineering and/or computer science. Moreover, throughout the qualitative interpretation of the short answer question data, there is always bias from the interpreter. This is as my interpretation of the data may be different from how someone else may interpret it. Since the way I interpreted the short answer question data included obtaining the most common and least common ideas throughout the responses per gender, this reduces the bias factor.

As the findings obtained from this research are from data collected from high schoolers interested in engineering and/or computer science, these findings can provide a benefit to colleges, pre-college programs, and K-12 education. This is as there is little to no current research regarding this topic in regard to high school students and specifically problem-solving strategies. As my findings were able to determine differences and similarities between how women and men might approach an academic situation, educators can use this information to determine how to alter their teaching methods to benefit students in the most effective way possible.

The findings from this paper can be used to further this research and improve our understanding of this situation. Moreover, this research can benefit educators in K-12 education as it can help them determine from an early stage how to best help their students regarding difficult academic situations. As high school students are still within their formative years, the findings obtained and deeply benefit how educators can support their students and provide advice for how to deal with a situation. This is as these findings have been obtained from older children in the K-12 education system and so if backtracked, it can further increase awareness of different ways that children have learned to deal with different types of academic situations.

Lastly, many high school students tend to participate in programs throughout high school in order to provide extra enrichment in a topic that they are interested in. For the programs which regard the fields of engineering and/or computer science, the findings obtained from this research can improve these programs. As these programs are one of the main events where high school students are able to experience some of their last out of school enrichment and developmental experiences before college, this gives way for it to be an important experience to learn important life skills as well. As problem solving is included in every aspect of life, my findings can benefit the curriculum in these programs as well. This is as comprehensive research on different approaches to problem solving that are well versed within many high school students would be trusted methods to try out when stuck in a difficult situation.

Conclusion

Improvements

With the methodology I used for my research study being relatively new to this specific scientific community that this paper relates, and the research being conducted by a high school student, this gives way for many improvements that can be made in the future. This includes conducting research on a larger sample size. This would provide a large benefit to the study as the inclusion of participants from multiple high schools would increase the sample size, which would also improve the accuracy of the results. Through this, the research can become a more controlled study with categories of students who have all taken the exact same classes and/or clubs could improve the reliability of the data and findings. This is as each participant would have very similar high school experiences with academic problems they have encountered in each class. From this, the data received can be categorized further, allowing for more intricate and accurate analysis. Lastly, through their being subconscious bias when interpreting short answer responses, a way to avoid this would be to use a program which can distinguish certain aspects of responses through a fixed process.

Recommendations for Future Studies

Through conducting this research, I´ve found that my findings can not only provide insight into further research in the same topic but have also led to a new question which can be researched further. Even though the larger context of this research paper includes finding differences and similarities between the genders before university level, problem solving strategies are just one subtopic of this which was deeply delved into throughout this paper. However, there can be various other subtopics to be explored in regard to other topics which might be able to show us the gap between males and females becoming apparent in order to further gain insight into the amount of males versus females who enroll in technology classes throughout college.

Moreover, my findings present another problem related to reward systems after completing a difficult academic problem. This is as in my findings, I found that there were much more girls who said they reward themselves for progress in order to keep up their motivation compared to boys. This gives way for further research into why there was a large difference between the females and males when setting up a reward system. Possible ways to research this further include looking into those in middle school and elementary schools to determine if this difference is still prevalent amongst those students. From this, it can be researched further into why younger students might also or might not have this trend as well.

Acknowledgments

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