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How understanding and addressing the concerns of women students benefits all students

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Studies on the high attrition rate of women students in STEM fields have identified general concerns that can cause women to leave. These include lack of prior experiences with engineering and computing, fears of failing, not fitting in, or being negatively impacted by stereotypes or impostor syndrome, a desire to contribute to society, and worries about future work-life balance. While women may be more affected by these concerns, male students can experience them as well. Thus, attempts to address these concerns benefit all students. The most straightforward ways to tackle these concerns are the same as the primary recommendations found in the physics education research literature for increasing student self-efficacy and constitute principles of good mentoring. Foster a cooperative, inclusive, encouraging environment. Talk openly about concerns and mistakes to help students exchange the fear of failure for a drive to succeed. Provide ways for students to gain experience that is lacking. Emphasize applications to social and environmental issues to increase motivation. Be aware of subtle biases and discredit stereotypes. Acknowledge struggles of the work-life balancing act and promote family-friendly policies. Combined these actions build a supportive learning environment for all students.

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1. INTRODUCTION

An observation in my Fall 2016 class caused me to try to find answers as to why sometimes a class with women students as the majority can feel different than when men are in the majority. When I started teaching a general education, "Descriptive Acoustics" course in 2005, students majoring in speech/communications disorders—a major with predominantly women students—took the course, and the class each semester was at least two-thirds women students. Other students were majoring in music, sound recording, physics, engineering, and a wide variety of others taking it for a general science credit. Over the years, I gained experience teaching the material and changes were made to the class to incorporate active learning and hands-on, real-world activities.[1,2,3] In 2012, the speech/communication disorders department decided to no longer require the "Descriptive Acoustics" course. A side effect of this change was that the class now had a larger number of men than women. I noticed a distinct difference in the class; it felt like the level of questions asked in class by both men and women were at a higher or deeper level. I thought this was curious and wondered what caused it: the change in the student population, the addition of the pre-class learning activities, real-world applications, and/or instant feedback questions during class, or improved instruction from me or teaching assistants. There was no way to know. Then in 2016, the course was again required for the speech/communication disorders students. With the course basically the same as when I had taught it most recently, I was astounded at the changes in my women-majority class that I observed during the first weeks: not only were the level of questions lower and more basic examples requested, but a heightened sense of concern was palpable. This time, the only change was the student population.

After quickly recalculating my approach in class discussions to address the concerns, I began reflecting on why shifting the student majority from men to women made a difference. Personally, I wish everyone could be viewed as a person without any stereotype baggage—an idealistic view, I know. There is evidence that improvements have been made in K-12 education as the number of young men and women who do well in math and science in high school is almost equal. Yet, problems and/or unaddressed concerns exist that keep the number of women working in STEM careers (science, technology, engineering, and math) fairly stagnant at 15-25%—except for biological sciences—even though 57% of the professional workforce are women.[4,5,6]

Reasons why a larger percentage of women (and other minorities) in STEM would be beneficial can be grouped into a few categories. (1) Lost opportunities: Individuals who desired but did not get to pursue a career in STEM have lost opportunities to be part of a workforce that is in demand and well paid. The STEM field in which they are not participating has lost the creativity or perspective that they would have contributed. (2) Increased workforce: As our society advances, more STEM professionals are needed, and an increase in the depth and breadth of the talent pool is advantageous. Both the quality and climate of a profession tend to improve as diversity increases as the diversity usually expands the range of problem-solving approaches, which can improve overall achievements. (3) Equity: Everyone should have equal access to rewards and freedom from favoritism and bias.[7] While most agree with one or more of these reasons, most women students are not yet seeing the opportunities available in STEM fields as viable options.

Many studies have sought to uncover the problems and concerns of women students in STEM. High on some lists are overt discrimination and sexual harassment—both awful things. I am assuming that anyone who cares enough about women students to read this article condemns

and prevents these actions and, thus, focus on more subtle reasons that women students drop out of or do not even consider STEM majors. On average female STEM students have less self-efficacy, are more influenced by fears, and have concerns about STEM not providing enough connections with people or time for family. Examples of each of these types of concerns are discussed in this paper as well as recommendations for addressing them. But first, a caveat.

When lists are made about the difference between men and women, I tend to cringe as they feel like stereotyping. I think such assignment of character traits/preferences/abilities/desires need to be thought of on a continuous scale with two overlapping Gaussian curves. For example, the statement "men thrive in competitive environments and women prefer collaboration" is not 100% true. Instead consider interpreting such a statement in a statistical manner. The probability of finding a woman who is motivated by collaboration is higher than the probability of finding one who is motivated by competition, with the reverse being true for men. The probability distribution functions (i.e., the likelihood of finding a person with a certain characteristic) might look like one of pairs of Gaussians shown in Figure 1. The centers and widths of the Gaussians and, thus, the amount of overlap between the curves for men and women likely vary depending on the characteristic considered. Similarly, the concerns discussed in this paper are not unique to women. Many men share these concerns. Thus, when "women" or "men" are discussed in this paper, please think in terms of trends.

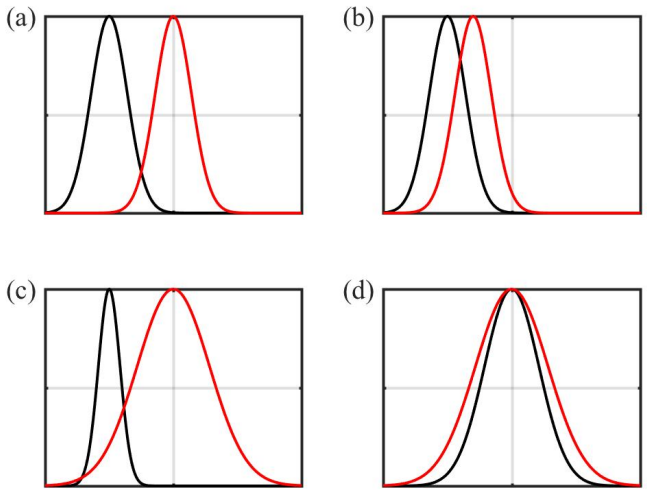

Figure 1 Illustration of possible distributions of character traits/preferences/abilities/desires that might be applicable when discussing gender differences.

To further illustrate the point that men affected by these concerns may be overlooked, consider this numerical example. Eighty men and twenty women begin a STEM program together. At the end of the first semester, ten of each drop out. At the end of the second semester, five of each drop out. Who is left at the beginning of the third semester? How many students dropped out? Which "missing" students will be noticed? While thirty students dropped out, it is likely that with a ratio of 65 men to five women at the beginning of the third semester, it will be more obvious that women have left the program than that the same number of men have left. I feel that the loss of both the men and women students raise the same concerns of lost opportunities and a decreased workforce exist. It also appears that this will become more significant in the future as the overall percentage of young adult men who are beginning but *not* completing college degrees is on the rise. These concerns are even more pressing for African Americans and Hispanics given the low rate of STEM graduates in these racial/ethnic groups.

As the problems and concerns facing female students are discussed, you might notice that many of the recommendations to help women students are similar to those shown by STEM education research to be important factors in engaging all students. Hopefully the ideas presented here help you to see these recommendations in a new light. However, a few more disclaimers are needed: First, I have not performed an exhaustive search of the academic literature on this topic as there are entire journals devoted to education in each field and to women's studies. Instead, I will highlight a few relatively recent and highly informative publications. Second, I have found that collective statements to the class or small groups of students can go a long way towards addressing concerns. I am not recommending you become anyone's personal therapist but rather acknowledging the power you have as a teacher and a mentor to uplift and enlighten. Third, I am not asking anyone to change the world or stop the "leaky pipeline" on their own but rather giving concrete examples of what you can do to help women students (and all students) in your sphere of influence. For convenience, recommendations for helping with each concern are listed in Table 1.

2. SELF-EFFICACY

The first set of concerns or source of problems that tend to plague women students in STEM deal with their self-efficacy. Self-efficacy is the beliefs an individual has about their abilities in a certain endeavor and the likelihood that they will be successful if they attempt it.[8] Low self-efficacy in STEM may result from a general lack of confidence or a lack of prior experience. In addition, a range of fears tends to deter women from efforts to gain self-efficacy. While there are a wide range of fears, the ones that have been identified in a multi-year, multi-institutional study of women in STEM are fear of not fitting in, fear of failure, stereotype threat, and impostor syndrome.[7] For one's self-efficacy to increase, they need to gain confidence, experience, and strategies for dealing with their fears. Recommendations for how teachers and mentors can help with lack of confidence and lack of experience are presented in this section. Fears are tackled in Sec. 3.

A. Lack of Confidence

In general, women are less confident in their abilities and individual accomplishments than men. In a recent book by Katty Kay and Claire Shipman,[9,10] they explore what has been termed a "confidence gap." They review many studies in which women lack confidence and regularly second guess their choices. One study showed that when a test included questions about the likelihood that the answer to the prior question was correct, the average women's score decreased while the average men's score stayed the same; when such personal judgment questions were omitted, women had the same average test scores as men. This continual second guessing drains confidence. Because of this lack of confidence, many women are less likely to tackle challenges and unlikely to apply for or take advantage of opportunities unless they feel 100% qualified. Women generally are less assertive in promoting themselves and their work, which limits the number of women who apply for scholarships, internships, and other confidence-building opportunities.[11] In addition, women tend to undervalue their contributions compared to what they perceive as the contributions of others. While the origin of the confidence gap may lie in societal expectations and pressures on girls to ""be good," "be beautiful," "be smart," etc., bridges can be built over the gap by increasing understanding and helping them overcoming challenges in a positive, encouraging environment; it is important to acknowledge the existence of the confidence gap as a first step in helping women students.

When teachers and mentors are aware of the disparity in confidence, they can work to help individuals increase their confidence. Offer praise for hard work instead of innate intelligence such that students understand they are in your class/program to learn and grow. Set high expectations and assure them that with diligent effort they can succeed. Provide encouragement along the way and be enthusiastic for their progress. Help them see (a little at a time) how they can build on their inherent strengths and develop new skills needed to be successful. Provide information about opportunities along with reassurances that they should apply. Consistent, encouraging, goal-oriented mentoring can help students develop confidence, and thus self-efficacy, one step at a time.

B. Lack of Experience

Most people have had the experience of feeling dumb because someone else knows more about something or is more skilled. For women students in STEM, this is a common, recurring feeling. Most women students have little or no experience in, for example, electronic circuitry or computer programming. Their lives and education up to this point usually did not include the kind of "tinkering," "building," "repairing," "coding," etc. that many of the men in the class did in their teen years. The natural reaction to this situation is "I must be stupid because everyone else is making rapid progress or already knows what to do." In addition, it is intimidating when certain students sound so very smart when speaking about the course material—they know how to speak confidently and appear to use technical words fluently. It takes careful reflection for a teacher or mentor to figure out how to counter the strong negative emotions associated with lack of prior experience.

The main recommendation is to carefully assess what background knowledge and skills may be unintentionally assumed in each lab or assignment. Consider what prior experiences would make it easier for a student to complete each assignment. Ponder the likelihood that some students already have such experience. Then, decide how to provide adequate resources for those who are starting with a relatively "clean slate." Another decision to make is if it is beneficial or not to partner experienced students with novice students. While there are many considerations, it is not useful to have an experienced-novice pairing in which the novice can "complete" the activity by letting the experienced student do all the work. On the other hand, the experienced-novice pairing can be helpful if the experienced student provides guidance and examples of how to do what is asked and then the novice has to complete the tasks on their own. Such careful assessment of each activity is the first step in addressing the lack of self-efficacy arising from lack of experience.

The other recommendation for counteracting the "I shouldn't take this class because everyone else is smarter than me" sentiment is to create a learning environment dominated by a growth mindset.[12,13] Remind students that they are in your class or lab to learn. Provide assurance that it's okay to not already know how to do whatever they have been tasked with. Try to remember and share your experiences with learning these tasks when you were a novice. Encourage discussions and explanations that are clear and straightforward and absent of implications that things should be obvious or easy. Foster a growth mindset by expressing confidence in their ability to learn, setting high expectations and providing encouragement and the resources needed to succeed. Such efforts provide a framework for students to build their self-efficacy related to their ability to succeed in STEM.

Lack of experience (and thus low self-efficacy) can be particularly troublesome for women students as they begin research. Suggestions for creating supportive, effective mentoring environments can be found in Ref. 14. Set attainable short-term goals for each student.

Regularly affirm their efforts. Encourage questions. Help the student catch the vision of who she or he can become through dedicated efforts. Overall, the research advisor needs to ensure that each student becomes an integrated member of the research team in which all respect the learning process.

3. FEARS

The next set of concerns expressed by many women students in STEM deal with fear. An understanding of these fears is important because depression and anxiety are on the rise among college students.[15] According to the National College Health Assessment, Spring 2014, Reference Group Executive Summary,[16] sometime in the prior year, 35% of women and 28% of men students felt so depressed it was difficult to function. In the same study, 60% of women and 42% of men students felt overwhelming anxiety sometime during the year. Such depression and anxiety can make it difficult for students to learn and accomplish all that they would like and need to do.

While sources of anxiety and the triggers for depression are varied, a few fears have been noted as being significant for women students in STEM. The fear of not fitting in and the fear of failure are compounded by stereotype threat and impostor syndrome. It is important to accept that these are deep concerns for many students and to help them be aware that many people experience these concerns. Explanations of each of these fear-based concerns are given along with recommendations for helping students cope with them.

A. Fear of "not fitting in"

It can be hard to be different. It is hard to feel different. Even if you don't feel different, it is hard to feel like others see you as different and as not belonging. In general, people want to fit in, be part of the group, and be accepted for who they are and what they have to contribute. Unfortunately, this does not occur naturally in many situations. Acceptance of people who are different and integrating them into the group usually require conscious effort.

Address a fear of "not fitting in" by creating an inclusive culture. First, expect mutual respect without exception; do not tolerate anything less than positive and professional interactions among those in your classroom or lab. Second, standardize the method used to deliver information to all students. If students need to be part of an informal social network to receive information, those outside the main group are likely left in the dark.[11] Accept that, in general, women need more information than men to feel like they understand what is happening and what is expected of them. It is also important to review all course and department content (text and images) for overt or subtle signals that discourage people who are different from the majority.[11] These steps are essential for fostering a sense of belonging among all students.

B. Fear of failure

The second fear that can paralyze students in STEM is the fear of failure. When someone fails, there are two basic reactions: (1) attribute the failure to internal factors (e.g., lack of ability, personal defects) or (2) attribute the failure to external sources (e.g., bad luck, incompetent professor, stupid test, lack of sleep, etc.).[17] These reactions tend to fall along gender lines with women students taking failures very personally and significantly damaging their self-efficacy: The failures, or other negative feedback, are often seen as signs that they cannot succeed.

To help students overcome a fear of failure, focus on the important role failure can have in the learning process. The first step is to create a safe place to make mistakes and learn from them. You can perhaps mention a recent study showing that when students are asked to predict

the outcome of a demonstration before seeing it, they are more likely to remember what happened especially when their prediction was wrong.[18] It also helps to talk about challenges you or others faced in similar situations and how you/they overcame them. Be aware that a strong, underlying current of competition among students increases the fear of failure. Foster a cooperative environment in which students can talk openly about concerns and struggles and help each other along. (Note: Creating an open, positive atmosphere dominated by a growth mindset is fundamentally different than students whining or complaining, which is not beneficial.) Encourage questions by asking the students questions to see if they understand what they are supposed to do and respond respectfully to their questions. As you incorporate questions into most interactions with students and help them understand the power of learning from mistakes, you provide an environment in which students can exchange the fear of failure for a drive to succeed—a transformation that is essential for cultivating a growth mindset and increasing self-efficacy.

C. Stereotype Threat

In scanning some studies about women students in STEM,[7,11,17,19,20,21] I saw the term "stereotype threat" but did not appreciate what it meant until I read more about Stanford psychologists, Steele and Aronson's study[22] in which they coined the phrase. They sought to uncover why well-prepared, ambitious, confident, middle and upper class African American students did not succeed as well in college as Caucasian students. He found that negative stereotypes sometimes have a strong effect on those who have discarded them and are striving to prove them wrong. When faced with a challenge, the normal fear of failure is compounded with the fear of confirming people's belief in the negative stereotype when they fail. This added layer of anxiety is termed "stereotype threat" and appears to most strongly affect people in areas that they care most about.

Consider, for example, the stereotype that women do as well as men in mathematics up to a certain level but men perform better at higher levels of mathematics. All students in an upper level math class have performed well enough to advance to that point. Then when faced with difficult problems, especially in testing situations where they feel their competency is being judged,[21] the women students are not only challenged and likely experience a fear of failing (both of which are likely shared by the men students), but they also have the extra layer of anxiety that when they fail they will be confirming the dreaded negative stereotype.

Before reading these descriptions, I had never realized that I experience stereotype threats regularly when I consider asking questions at professional meetings, especially when women constitute less than 15% of the audience. I believe many—perhaps most—people experience a nagging concern that their question might sound stupid. But the thought often in my mind is "if this is a stupid question everyone will have expected as much because I am a woman." As I think about this logically, I acknowledge that such thoughts are probably not most people's first reaction; I know in many cases they are likely just glad that someone asked a question. Perhaps now that I have identified this as a stereotype threat and know I am not alone in experiencing it, I can make progress in overcoming this added fear.

There are many stereotypes that college students might be struggling with and that you may need to counteract. While stereotypes depend on a person's background, here are examples of stereotypes commonly held by both men and women, boys and girls in America.

- "Girls/women are not good at math, computer programming, or science."
- "Boys/men are not creative or sensitive."
- "Women should do the menial tasks like washing the dishes or the floor."

- "Women who speak directly are bossy, but men who speak directly are assertive."
- "Men are more competent than women."[23]
- "You grew up poor, so you're not going to be successful."
- "Student-athletes are just dumb jocks."
- "You can't score high enough on tests because you are white."
- "Obese people are lazy."

Any student who has grown up under the shadow of a negative stereotype that they have discarded as false is more likely to experience stereotype threats than students who have accepted the negative stereotypes and, in essence, given up. The more a student cares about succeeding, the more pressure they feel from a stereotype threat.[22,24]

What can a teacher do to help students experiencing stereotype threats? Steele[24] recommends dispelling the stereotype—make sure the students know you do not believe the stereotype. To test this hypothesis, he gave the advanced sections of the General Records Examination in mathematics to two groups of women students who had performed well in their undergraduate mathematics courses. The first group was given the test without any discussion about the study and scored worse on average than men students with equivalent course performance. The second group was giving a pep talk first in which he convinced them that he expected there to be no difference in the average score for men or women. This second group performed as he had described: no gender differences were evident in the scores.[24]

Teachers and mentors can help students overcome stereotype threats. Show you do not believe the stereotype.[20] Exhibit confidence in the student's ability to learn, grow, and complete challenging tasks. Repeat as necessary. Another important point is to avoid reminding a student of their gender, ethnicity, etc. as this may subconsciously confirm your belief in the stereotype. The effect of enforcing a student's identity as a member of a stereotyped group was shown in a study by Shih *et al*.[25] Three comparable groups of Japanese American women college students were given a survey followed by a math test. The survey included questions about general college student issues. The first group had an extra survey question that reminded them of their ethnicity; the second group did not have that question but one that reminded them of their gender; the third group did not have either of these addition questions. The subtle reminder about ethnicity resulted in substantially higher performance on the math test than the other two groups, whereas the group that was asked the gender question had the worst scores. This example illustrates the influence that even a reminder of a stereotype can have on student performance. As a teacher or mentor it is important to express appreciation for individual student's abilities, work styles, approach to problems, etc. As you show faith in your student's ability to succeed, you relieve the added burdens of stereotype threats that hinder performance.

D. Impostor Syndrome

At the junction of fear and low self-efficacy lies impostor syndrome. Impostor syndrome was first defined in 1978 by Pauline Clance and Suzanne Imes.[26] Impostor syndrome typically strikes high-achieving individuals and makes them feel like their accomplishments are inconsequential and the result of dumb luck. Impostor syndrome feeds off of the fears of failure, and sometimes stereotype threats, to convince its victim that everyone else is doing so much better: has deeper understanding, better ideas, better skills, more influence, etc. When impostor syndrome strikes, the fear of being exposed as a "fraud" can feel overwhelming.

The most important thing teachers and mentors can do to counteract impostor syndrome if to shed light on it. Make students aware that many successful people have occasional or constant thoughts of inadequacy. One study[27] estimates that 70% of the world's population has

experienced impostor syndrome in one or more area of their lives. Give tips on how to deal with it.[28] Some suggestions include avoiding "just" and "only" when talking about your work or accomplishments, talking with a mentor or friend about the feelings, mentoring others, and trying to be kind and supportive of yourself. As people learn about this relatively common experience, they are better equipped to separate feelings of impostorship from their self-efficacy.

4. HUMAN CONNECTIONS

In general, women (and many men) desire human connections in their education and careers. Within the context of retaining students in STEM fields, three of the concerns related to interpersonal engagement are how to form connections with others in the field, how to balance work and life, and how a career in STEM can be beneficial to people/society.

A. Interpersonal relationships

As a teacher or mentor, it can be difficult to know how to foster positive engagement among students. For classes, one goal is to help students form successful study groups. Help students understand the reasons why a study group is beneficial. When students do not form their own study groups, it may be necessary for the teacher to provide either a platform, such as messages on the class webpage/online delivery system, to post a general invitation for students to work on homework together. When forming groups for projects or assignments, put two women students in a group, when possible. Hazari *et al.*[20] describes how women students are more likely to contribute to the group if they are not the only woman in the group; something that probably holds for most minorities. If students resist the idea of working in groups, provide examples of how teamwork facilitates success in real-world advances in STEM fields.

On a larger, departmental scale, additional steps can be taken to foster a student-oriented culture.[29] Communal areas for studying or a communal lounge should be a safe environment for all. A tutorial service can be offered and/or student teaching assistants can be trained to understand and respond to concerns described in this paper. It is recommended that women and minorities be given opportunities to be teaching assistants to increase their self-efficacy. A student chapter of a national organization, like the Acoustical Society of America, can facilitate a sense of belonging. Steps that foster a cooperative spirit rather than a highly competitive atmosphere are also suggested, without reducing expectations for success. In scheduling department seminars and in teaching classes, professors can look for opportunities to bring women/minority scientists and engineers in to speak or at least mention their contributions. When efforts are made to make the department more friendly and inclusive, all students benefit, but the women students in particular.[29]

Another suggestion for increasing human connections for students, especially women students, is to provide multiple mentors on different levels. Lower level undergraduates can be mentored by upper level undergraduates who recently took the same classes and experienced the same frustrations. Undergraduate students can be mentored by graduate students as they help with a portion of the graduate students' research. In such cases, the graduate student benefits from the need to explain their work clearly, and they often gain a better appreciation of how difficult it can be to be a mentor. Informal mentorship by other faculty members can also be helpful. For example, a brunch with women faculty members or professionals can provide women students the opportunity to see women successful in the STEM field and give them an opportunity to ask questions they might not feel comfortable asking their official advisor.

B. Work-life balance

For women students who have supportive teachers/advisors, make personal connections with their peers, and have learned to deal with the other concerns discussed so far, work-life, and especially work-family balance questions can still deter women from pursuing careers in STEM. With regards to work-life balance, teachers and advisors can help dispel myths that STEM professionals are single-minded to the exclusion of other interests or relationships by sharing select glimpses into what they or other STEM professionals do when they are not working.

With regards to work-family balance, many women students are concerned with not having time for a family if they pursue a STEM career. Even though work-family balance concerns have typically been attributed to mothers, fathers have recently taken a greater part in child-rearing. The number of stay-at-home/full-time dads and single dads are increasing; this is no longer a concern only for women. A recent Pew Research Center study[30] showed that 52% of working dads and 60% of working moms say it is very/somewhat difficult to balance the responsibilities of work and family. While the work-family questions usually are centered around child-rearing, care of elderly parents adds another dimension to work-family questions that are shared by men and women.

You can help students, especially women students, with concerns they might have about work-family balance by providing examples they can ponder as they make their decisions about pursuing a STEM career. It is important also to acknowledge that there is not a single answer to work-family equation that works for everyone, followed by assurance that many people find ways to make it work. If you do not have examples close at hand, find those who have written about their work-family balances, e.g., recent articles by women scientists published in *Nature* [31,32] and *Science*.[33]

Another way to help with work-family balance questions is to inform students of and be supportive of alternative career paths. The prevalence of telecommuting jobs can alleviate difficulties associated when spouses are figuring out the "two-body" problem. The flexibility to temporarily go to part-time status, if desired, when one's family responsibilities increase can help keep talented people in STEM fields. Their seasons of increased family responsibility pass, and it is much easier to return to full-time employment if one has remained active in the field. Because some people need or desire to take time away from their careers to raise children or other family needs, it is important to support those who attempt to reenter STEM careers. They have time to contribute and progress in their field if given a chance and if they receive support and mentoring as they restart their careers. In the course of my career, I have done all three of these things. I am extremely grateful for those who, at each step of my journey, made it possible for me and my husband to raise our three children the way we wanted and yet for me to be in a position to continue a career in acoustics as they have grown up.

C. Helping mankind

Many students desire a career that benefits individuals or society; often it can be difficult to see how a career in STEM can fulfil that desire to help mankind. To develop students' understanding of how science, technology, engineering and math help people, teachers can incorporate more real-world examples into class discussions, homework problems, and labs. It is important to increase students' appreciation for how much research was required to obtain the technological advances they use daily. Both teachers and mentors can talk about the societal benefits of their current research. Overall, students need help to expand their view of the range of possible career paths that contribute to society and help people.

Table 1 Concerns of women students (and many men) along with suggestions for helping students overcome or deal with the concerns.

Concern	Suggestions for teachers, advisors and mentors	
Lack of Confidence	Have high expectations	
	Set intermediate goals	
	Praise hard work	
	Reassure and encourage	
Lack of Experience	Assess assumed background knowledge	
	Provide adequate resources for novices	
	Foster a growth mindset	
	Avoid implying that concepts/tasks should be easy or obvious	
	Express confidence in their ability to learn	
Fear of "not fitting in"	Create an inclusive culture	
	Expect mutual respect without exception	
	Accept only professional interactions in your class or lab	
	Standardize information delivery	
	Review all content for discouraging signals	
Fear of Failure	Explain the important role failure has in learning process	
	Create a safe place to make mistakes and learn from them	
	Talk about overcoming challenges	
	Encourage questions	
Stereotype Threat	Show that you do not believe the stereotype	
	Express confidence in their ability to succeed	
	Avoid reminding a student of the stereotype trait	
Impostor Syndrome	Make students aware that many successful people feel this	
	Encourage students to	Avoid "just" and "only" when talking about your work
		Talk with a mentor or friend
		Mentor others
		Try to be kind to themselves
Interpersonal Relationships	Put two women in a group when possible	
	Encourage participation in a student chapter	
	Foster a cooperative spirit instead of a highly competitive one	
	Strive for a friendly and inclusive atmosphere	
	Provide peer mentors	
Work-life balance	Share select glimpses into life outside of work	
	Provide examples of women scientists/engineers with families	
	Be supportive of alternative career paths	
	Support reentry to STEM education/careers	
Helping Mankind	Incorporate real-world examples	
	Increase appreciation for technological advances	
	Discuss the societal benefits of your research	
	Expand student understanding of ways to help people	

5. CONCLUDING DISCUSSION

Teachers and mentors can help women (and men) students overcome the concerns discussed in this paper. As these concerns are addressed, the students increase their ability to see themselves as successful in a STEM career.[11] The resulting increased self-efficacy and interest often contribute to increased success.[11] To emphasize that these techniques are not solely suited for encouraging women students in STEM,

Table 2 lists suggestions for increasing student learning compiled from a study of highly effective college teachers across many disciplines.[34] These suggestions, which are in no particular order, are basically the same as those listed in Table 1 to help with the concerns described in this paper. The similarity between these two sets of recommendations leads me to conclude that women students in STEM need teachers and advisors who consciously work to create supportive, inclusive, learning environments, which as stated in the title, ultimately benefit all students.

The task of creating a supportive, inclusive learning environment might seem daunting. Please do not be overwhelmed. I believe that any effort made is better than nothing. Consider beginning with one or two of the suggestions in Tables 1 and 2. Find your own style for implementing the recommendations. Accept that some will come more naturally to your personality than others. Enlist the help of others as needed. Strive to build a collaborative environment with multilevel mentoring. As you demonstrate genuine interest in the students and faith in their ability to learn, your students' self-efficacy will increase as will their ability to see themselves as successful contributors to STEM.

Table 2 Suggestions for increased student engagement and learning from Ref. 34.

Create a rich learning environment
Display interest in student learning and faith in their abilities
Encourage questions
Provide encouragement
Provide nonjudgmental feedback
Stress opportunities to improve
Avoid dividing students into sheep and goats
Encourage cooperation and collaboration
Provide fair treatment and honest evaluation
Encourage learning from mistakes
Teach facts in rich context of problems, issues and questions

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