Introductory Unit, Reading 1

Learning Style Differences

Gender Differences in Learning Style Specific to Science, Math, Engineering and Technology (SMET)

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There are gender differences in learning styles specific to science, math, engineering and technology (SMET) that teachers of these subjects should keep in mind when developing lesson plans and teaching in the classroom. First, overall, girls have much less experience in the hands-on application of learning principles in lab settings than boys. This could occur in the computer lab, the science lab, or the auto lab – the principle is the same for all of these settings – it requires an overall technology problem-solving schema, accompanied by use and manipulation of tools, and spatial relation skills that very few girls bring with them to the classroom on day one in comparison to boys.

Let's look at some of the reasons why girls come to the SMET classroom with less of the core skills needed for success in this subject area. Overall, girls and boys play with different kinds of games in early childhood that provide different types of learning experiences. Most girls play games that emphasize relationships (i.e., playing house, playing with dolls) or creativity (i.e., drawing, painting). In contrast, boys play computer and video games or games that emphasize building (i.e., LEGO®), both of which develop problem-solving, spatial-relationship and hands-on skills.

A study of gender differences in spatial relations skills of engineering students in the U.S. and Brazil found that there was a large disparity between the skills of female and male students. These studies attributed female student's lesser skills set to two statistically significant factors: 1) less experience playing with building toys and 2) having taken less drafting courses prior to the engineering program. Spatial relations skills are critical to engineering. A gender study of computer science majors at Carnegie-Mellon University (one of the preeminent computer science programs in the country) found that, overall, male students come equipped with much better computer skills than female students. This equips male students with a considerable advantage in the classroom and could impact the confidence of female students.

Are these gender differences nature or nurture? There is considerable evidence that they are nurture. Studies show that most leading computer and video games appeal to male interests and have predominantly male characters and themes, thus it is not surprising that girls are much less interested in playing them. A study of computer games by Children Now found that 17% of the games have female characters and of these, 50% are either props, they tend to faint, have high-pitched voices, and are highly sexualized.

There are a number of studies that suggest that when girls and women are provided with the building blocks they need to succeed in SMET they will do as well if not better than

their male counterparts. An Introductory Engineering Robotics class found that while males did somewhat better on the pre-test than females, females did as well as the males on the post-test following the class's completion.

Another critical area of gender difference that teachers of SMET should keep in mind has less to do with actual skills and experience and more to do with perceptions and confidence. For females, confidence is a predictor of success in the SMET classroom. They are much less likely to retain interest if they feel they are incapable of mastering the material. Unfortunately, two factors work against female confidence level: 1) most girls will actually have less experience with SMET course content than their male counterparts and 2) males tend to overplay their accomplishments while females minimize their own. A study done of Carnegie Mellon Computer Science PhD students found that even when male and female students were doing equally well grade wise, female students reported feeling less comfortable. Fifty-three percent of males rated themselves as "highly prepared" in contrast to 0% of females.

It is important to note that many of the learning style differences described above are not strictly gender-based. They are instead based on differences of students with a background in SMET, problem-solving, and hands-on skills learned from childhood play and life experience and those who haven't had the same type of exposure. A review of the literature on minority students and SMET finds that students of color are less likely to have the SMET background experiences and thus are missing many of the same SMET building blocks as girls and have the same lack of confidence. Many of the SMET curriculum and pedagogy solutions that work for female students will also work for students of color for this reason.

Bridge Classes/Modules to Ensure Core Skills

Teachers will likely see a gap in the core SMET skills of female and minority students for the reasons described above. Below are some solutions applied elsewhere to ensure that girls and women (and students of color) will get the building block SMET skills that many will be missing.

Teachers in the Cisco Academy Gender Initiative study assessed the skill levels of each of their students and then provided them with individualized lesson plans to ensure their success that ran parallel to the class assignments. Other teachers taught key skills not included in the curriculum at the beginning of the course, such as calculating math integers and tool identification and use. Students were provided with additional lab time, staffed by a female teaching assistant, knowing that the female students would disproportionately benefit from additional hands-on experience.

Carnegie-Mellon University came to view their curriculum as a continuum, with students entering at different points based on their background and experience. Carnegie-Mellon's new frame of a "continuum" is purposefully different than the traditional negative model in which classes start with a high bar that necessitates "remedial" tutoring for students

with less experience, stigmatizing them and undermining their confidence. Below is a list of ideas and suggestions that will help ALL students to succeed in the SMET classroom.

1. Building Confidence

How do teachers build confidence in female students who often have less experience than their male counterparts and perceive they are behind even when they are not?

1) Practice-based experience and research has shown that ensuring female students have the opportunity to gain experience with SMET, in a supportive environment, will increase their confidence level.
2) Bringing in female role models that have been successful in the SMET field is another important parallel strategy that should be used to assist your female students in seeing themselves as capable of mastering SMET classes: if she could do it, then I can too!
3) Consistent positive reinforcement by SMET teachers of their female students, with a positive expectation of outcome, will assist them in hanging in there during those difficult beginning weeks when they have not yet developed a technology schema or hands-on proficiency and everything they undertake seems like a huge challenge.

2. Appealing to Female Interests

Many of the typical SMET activities for the classroom appeal to male interests and turn off girls. For example, curriculum in robots often involves monsters that explode or cars that go fast. “Roboeducators” observed that robots involved in performance art or are characterized as animals are more appealing to girls. Engineering activities can be about how a hair dryer works or designing a playground for those with disabilities as well as about building bridges. Teachers should consider using all types of examples when they are teaching and incorporating activities in efforts to appeal female and male interests. Teachers can also direct students to come up with their own projects as a way of ensuring girls can work in an area of significance to them.

Research also shows that there are Mars/Venus differences between the genders and how each engages in technology. Overall, girls and women are excited by how the technology will be used – its application and context. Men will discuss how big the hard drive or engine is, how fast the processor runs, and debate the merits of one motherboard or engine versus another. These are topics that are, overall, of less interest to most females.

The Carnegie-Mellon Study took into account the differences of what engages female students and modified the Computer Science programs’ curriculum so that the context for the program was taught much earlier on in the semester and moved some of the more technical aspects of the curriculum (such as coding) to later in the semester. Authors observed that the female students were much more positive about getting through the tedious coding classes when they understood the purpose of it. Teachers should ensure

that the context for the technology they are teaching is addressed early on in the semester by using real world stories and case studies to capture the interest of all of their students.

3. Group Dynamics in the Classroom

Research studies by American Association of University Women and Children Now have found that most females prefer collaboration and not competition in the classroom. Conversely, most males greatly enjoy competition as a method of learning and play. Many hands-on activities in technology classes are set up as competitions. Robotics for example, regularly uses competitiveness as a methodology of teaching. Teachers should be cognizant of the preference of many girls for collaborative work and should add-in these types of exercises to their classes. Some ways to do this are by having students work in assigned pairs or teams and having a team grade as well as an individual grade. (See Reading 2 on Cooperative Learning.)

Another Mars/Venus dynamic that SMET teachers should be aware of occurs in the lab where male students will usually dominate the equipment and females will take notes or simply watch. Overall, male students have more experience and thus confidence with hands-on lab equipment than their female counterparts. Teachers should create situations to ensure that their female students are spending an equal amount of time in hands-on activities. Some approaches have been: 1) to pair the female students only with each other during labs in the beginning of the class semester so that they get the hands-on time and their confidence increases, putting them in a better position to work effectively with the male students later on, 2) allot a specific time for each student in pair to use the lab equipment and announce when it's time to switch and monitor this, and 3) provide feedback to male students who are taking over by letting them know that their partner needs to do the activity as well.

4. Moving Female Students from Passive Learners to Proactive Problem Solvers

The main skill in SMET is problem solving in hands-on lab situations. For reasons already discussed regarding a lack of experience, most girls don't come to SMET classes with these problem-solving skills. Instead, girls often want to be shown how to do things, repeatedly, rather than experimenting in a lab setting to get to the answer. Adding to this issue, many girls fear that they will break the equipment. In contrast, male students will often jump in and manipulate the equipment before being given any instructions by their teacher. Teachers can address this by such activities as: 1) having them take apart old equipment and put it together again, 2) creating "scavenger hunt" exercises that force them to navigate through menus, and 3) emphasizing that they are learning the problem solving process and that this is equally important to learning the content of the lesson and insisting that they figure out hands-on exercises on their own.

Research has also shown that females tend to engage in SMET activities in a rote, smaller picture way while males use higher order thinking skills to understand the bigger picture and the relationship between the parts. Again, moving female students (and the non-tech-savvy student in general) to become problem solvers (versus just understanding the

content piece of the SMET puzzle) will move them to use higher order thinking skills in SMET.

Finally, many teachers have reported that many female students will often want to understand how everything relates to each other before they move into action in the lab or move through a lesson plan to complete a specific activity. The female students try to avoid making mistakes along the way and will not only want to read the documentation needed for the lesson, they will often want to read the entire manual before taking any action. In contrast, the male student often needs to be convinced to look at the documentation at all. Boys are not as concerned with making a mistake a long the way as long as what they do ultimately works. The disadvantage for female students is that they often are so worried about understanding the whole picture that they don't move onto the hands-on activity or they don't do it in a timely fashion, so that they are consistently the last ones in the class to finish. Teachers can assist female (and non-tech-savvy) students to move through class material more quickly by providing instruction on how to quickly scan for only the necessary information needed to complete an assignment.

5. Role Models

Since the numbers of women in SMET are still small, girls have very few opportunities to see female role models solving science, technology, engineering or math problems. Teachers should bring female role models into the classroom as guest speakers or teachers, or visit them on industry tours, to send the message to girls that they can succeed in the SMET classroom and careers.

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