



## Information Sheet: Motivational factors in STEM: Interest and Self- Concept



*Jill is finishing the first semester of her first year in high school. She enrolled in algebra at the beginning of the year because it was required. She received high grades on her algebra exams this semester, and, although she never really thought about it before, she is beginning to think that she is good at algebra, and that she likes math. She is also becoming increasingly interested in taking more advanced math courses next semester and she recently asked her mother what kind of career she might pursue with a college degree in mathematics.*

The example above illustrates the importance of interest and self-concept for the pursuit of STEM-related goals. *Self-concept* is a person's self-perceptions of their abilities in a domain (e.g., I am good at algebra) that often includes an affective component (i.e., I like math). Self-concept is reflected in the above example as Jill's self-perceptions of her math ability. At the beginning of high school, Jill did not consider herself to be good at math, nor did she particularly like it (i.e., she had low math self-concept). Her self-concept in mathematics developed as a result of achievement experiences in algebra – her high self-concept reflected in her thinking that she was good at math, and enjoyed it (Marsh, 1990). Her self-concept, in turn, increased her interest in pursuing more advanced math courses and a career related to mathematics. *Interests* are defined as relatively stable individual preferences (Hidi, 1990). This example is illustrative of the importance of interest and self-concept for directing effort toward achievement in STEM.

### Why are interest and self-concept important for understanding gender differences STEM achievement?

Interest and self-concept are related to the choice of pursuing STEM study and achievement in STEM (Eccles, 1994; Eccles & Wigfield, 2002). Pervasive gender differences, favoring men, are found in STEM-related interests and self-concept, including academic fields such as natural science and mathematics (Ackerman, Bowen, Beier, & Kanfer, 2001; Simpkins, Davis-Kean, & Eccles, 2006; Lippa, 1998, 2005; Schiefele, Krapp, & Winteler, 1992; Watt, 2006). These gender differences are reflected in the number of men versus women in STEM related study, and STEM occupations: women still earn fewer degrees in engineering and natural science than men, and women are relatively underrepresented in STEM-related careers such as engineer, computer programmer, or as STEM faculty members (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007; Lackland & DeLisi, 2001).

### How does interest and self-concept develop?

Interest and self-concept develop through a reciprocal relation with achievement. That is, achievement in a domain influences self-concept, which in turn influences interest in the domain, which in turn influences the pursuit of additional achievement experiences (and the cycle continues; Guay, Marsh, & Boivin, 2003; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006). In addition to interest and achievement, other complimentary (i.e., non-competing) determinants of self-concept have been identified (Skaalvik & Skaalvik, 2002). These are:

- (a) Causal attributions: whether students attribute success or failure to their own action, or to external factors or chance. For example, if Mary does well in physics, and attributes her

- success to her aptitude and hard work, her physics self-concept is more likely to be positively affected than if she were to attribute her success to having an easy instructor.
- (b) Reflected appraisal: how students think others perceive them including peers, family, and role models. For example, Jane is more likely to develop an engineering self-concept if she perceives that her parents think she has an engineer's skill set and temperament.
- (c) External and internal frames of reference: involve comparing one's own abilities with the abilities of peers (e.g., I am a little better at science than Jim). Internal frames of reference involve comparing different abilities within one person. Internal judgments are made independent of judgments based on external frames (e.g., I am better at math than English). Internal and external frames simultaneously influence the development of self-concept. For example, Lisa may be a poor math student relative to her peer group (external), but may have a relatively high math self-concept because she perceives that she is better at math than English (internal).

Internal frames of reference help explain how gender differences in self-concept develop. Research shows that girls generally have a balanced ability profile (i.e., roughly equal verbal and math abilities), whereas boys generally have higher math abilities than verbal abilities (Halpern et al., 2007). Although a balanced ability profile may be an advantage for many tasks, the breadth of women's abilities relative to men's will potentially negatively affect women's self-concept and interest in STEM disciplines. This is because when judgments about self-concept are made through internal frames of reference, achievement in one area will negatively affect self-concept in another (Marsh & Hau, 2004). Alternatively, men's more narrow ability profile, when aligned with STEM-related fields, will serve to strengthen their STEM interest and self-concept.

External comparisons are also important for the development of STEM-related interest. Specifically, when students perceived that they did not "fit in" with their classmates in STEM courses, interest in the topic was negatively affected (Lee, 1998). Research on the development of self-concept also reinforces the importance of external comparisons (Marsh & Hau, 2003). Specifically, the average achievement of a comparison group (i.e., peer students in class or in the school) negatively affects the self-concept of an individual student, especially if that student is below average relative to his or her peers (termed the "big fish little pond" effect, BFLPE; Marsh, 1990).

### **What can practitioners do to influence the development of STEM-related interest and self-concept?**

The antecedents of STEM-related interest and self-concept can help inform practitioners about interventions for positively affecting interest and self-concept in STEM.

- Achievement in a domain is one of the most important precursors to interest and self-concept in that domain. Accordingly, practitioners should incorporate achievement opportunities in STEM, especially for girls and women (e.g., encouraging students to participate in laboratory research, incorporating hands-on laboratory experiences into classroom activities).
- Recognizing and rewarding students for achievement in STEM will also foster interest and self-concept.
- The development of interest and self-concept in STEM is also a function of perceptions of others, such as parents and role models, who are influencers. Parents and role models can let children know that they are perceived to have the skills and temperament necessary for STEM.
- A well-managed classroom, where STEM material is targeted toward the interests of both girls and boys, will potentially increase achievement, self-concept, and interest in STEM.

- Classrooms where students feel free to ask questions and interact with instructors will foster interest and self-concept in STEM. In class activities that require interaction between instructors and students will help foster open learning environments.
- Classroom environments where students feel they "fit" will also increase self-concept and interest in STEM. Providing forums where students develop relationships with one another (e.g., small group work) may serve to increase sense of belonging while, at the same time, providing students additional peer support.

Research on internal and external frames of reference paints a potentially confusing picture of how to bolster self-concept. Because self-concept is negatively influenced by the achievement of peers, should practitioners recommend that high achieving students not enroll in difficult courses with other talented students? Likewise, because achievement in one area negatively influences self-concept in another, should practitioners interested in bolstering STEM self-concept discourage achievement in any area other than STEM? These solutions seem neither logical nor warranted. Rather, awareness of the influence of external and internal comparisons on self-concept leads to the following recommendations:

- Bolster the STEM self-concept of students taking difficult courses (or in a high achieving track) by discouraging competition in the classroom.
- Congratulate students when they succeed in STEM courses or activities and encourage discouraged students to look at the situation with perspective (e.g., reminding students of the complexity and difficulty of the material).
- A solid STEM self-concept may also make achievement outside of STEM less likely to affect STEM self-concept negatively. For example, students who perceive that others see them as a scientist (i.e., reflected appraisal) may be less likely to abandon science when they excel in another area. Providing opportunities to solidify students' STEM self-concepts through science clubs, extracurricular research, or other such activities will make achievement in areas outside of STEM less threatening to the STEM self-concept.

(For a practice-oriented guide on this topic or other ARP Resources, go to:

<http://www.AWEonline.org/ARPresources.aspx>)

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