

Self-Efficacy and Its Essential Roles in a STEM classroom

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Midwest Regional Noyce Connections Conference

October 30, 2015

Key Questions

1. Why are some students eager to learn and willing to tackle new challenges while others seem uninterested or unmotivated?
2. Why do some students demonstrate high levels of confidence in their abilities, while others seem unsure of themselves?
3. What strategies can you, as a classroom teacher, use to increase your students' confidence to learn new material?

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Social Cognitive Theory

Albert Bandura 1977, 1986, 1997

Three specific contributions:

- ▶ Self-Efficacy
- ▶ Self-Control
- ▶ Self-Regulation

Self-Efficacy

- ▶ How capable or prepared we think we are to successfully perform a given task or behavior.
- ▶ Task-specific; high self-efficacy in one area may not coincide with high self-efficacy in another area.

Self-Efficacy is not the same as Self-Esteem (SKIP)

Often used interchangeably as though they represent the same phenomenon, when in fact they refer to entirely different things.

Self-Efficacy: concerned with judgments of our ability in what we can do. Confidence that we can complete the task before us.

Example: I'm going to solve this word problem.

Self-Esteem: concerned with judgments of self-worth. The sense of value we place on ourselves.

Example: I'm a good-natured person.

Self-Efficacy expectations

Bandura suggests that expectations of efficacy are the major reasons for

- ▶ What activities we select.
- ▶ Amount of effort we put forth.
- ▶ Degree of persistence we show in the face of difficulties.
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High Self-efficacy, Low Self-efficacy

- ▶ **High:** will try harder and persist longer when faced with challenge, will respond better to negative feedback with increased effort and motivation,
- ▶ **Low:** don't expect to do well, and they often do not achieve at a level that is commensurate with their abilities. They don't believe they have the skills to do well so they don't try, give up in the face of difficulty, attribute failure to internal causes (they blame themselves), and experience greater anxiety or depression, question whether or not they complete a task, are more likely to lessen their effort or give up altogether.

Self-efficacy is a big factor in achievement!

- ▶ [●] The connection between self-efficacy and achievement gets stronger as students advance through school. In fact, by the time students are in college, their **self-efficacy** beliefs are more strongly related to their achievement than **any measure of their ability**.
- ▶ [●] If we wish to develop high educational achievement among our students, it is essential that we **begin building stronger self-efficacy as early as possible**.

- How do you develop self-efficacy expectations?

Sources of Self-Efficacy Beliefs — Bandura

1. Past Performance (Mastery Experiences)
2. Vicarious Experiences – Modeling!
3. Social/Verbal Persuasion
4. Physiological & Emotional Cues/States

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Details on Mastery Experiences/Past Performance

- Simply having the raw knowledge, skills, and experience required to successfully reach a goal or to complete a task; this is the source of efficacy he referred to as **mastery experience**.
- In an academic realm, this means having - ideally a positive experience in completing a particular major or a specific course.
- Appropriate foundational knowledge that arise from adequate high school preparation is crucial. For example, mathematics - for those who would be majoring in STEM.
- **Past performance is the single greatest contributor to students' confidence.**

- There is a pervasive gender and ethnic/racial gap in those aspiring to be engineering majors?
- Gowen and Waller, 2002; National Science Board, 2006 – the number of women **choosing** to study engineering is stagnant or, in come cases, dropping

- Is it the **competence** in engineering related domains such as mathematics?
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Jacobs (2005): contends that students **self-concept**, the value they place on excelling engineering and mathematics-related fields and the **social support** they receive from important others are more predictive of student's probability in seeking STEM career.

Marra et al. (2014) and Ponton et al. (2001): to positively impact self-efficacy, educators need to do a better job of of both deciding **what we want our students to master** and to **communicate and reinforce** these decisions **consistently**.

Consider the following all too typical situation. Students practice the application of engineering design principles via industry-based design projects; yet, are tested on memorization of formulas or “plug and chug” type problems.

The educational experience creates one type of mastery experience via a complex design project; yet the assessment communicates an entirely different expectation for what learning tasks are required and valued.

Thus, inconsistencies between teaching and testing are likely to produce confusion, uncertainty, and perhaps stagnation or even decreases in self-efficacy for all students; however, the results may be more serious for women and under-represented students due to their low representation in engineering classrooms.

Therefore: For the mastery experience to be effective, it is essential to align educational experience with assessment.

Details on Vicarious Experiences

- Means watching others successfully perform the task.
- By observing others like themselves perform tasks, individuals make judgments about their own capabilities.
- Perceived similarity: The ability of vicarious experiences to positively affect one's self-efficacy is dependent upon the similarity of the model to one's own abilities and circumstances.

- The visibility of women and minorities in STEM careers and educational settings is of paramount importance for women and minorities.
- Zeldin and Pajares (2000) found gender differences in self-efficacy sources through their qualitative study of men and women who had entered into and continued to succeed in STEM professional careers.
- Their study revealed that men perceived **mastery experiences** as critical to their self-efficacy beliefs, while women **valued vicarious experiences** and **verbal persuasion**.

In their study of the relationship between faculty role models and students' choice of major, Rask and Bailey's (2002) findings suggest a correlation between the number of female faculty in STEM domains and the number of women who pursue careers in these fields.

Further underscoring the importance of role models in encouraging self-efficacy via vicarious experiences are the findings of Nauta, Epperson, and Kahn (1998) in their study of female students majoring in STEM domains. Other studies found similar results regarding the importance of modeling to ethnic or racial minority students in STEM domains (Ferreira, 2001; Good, Halpin, and Halpin, 2000; May and Chubin, 2003; Quimby, Seyala, and Wolfson, 2007).

Details on Social Persuasion

- As a source of self-efficacy, social persuasion refers to the influence, whether overt or covert, of others.
- Needs to be coupled with actual success.
- Teacher's credibility is also an important factor with verbal persuasion.
- Students will tend to discredit a teacher if they believe the teacher does not fully understand the demands of the task being faced.

- Hanson (2007) found that the presence or absence of social support can impact course achievement.
- Further, Zeldin and Pajares (2000) found that supportive faculty were positively related to (women's) self-efficacy in subjects related to studying math – courses that are also related to studying engineering.

- A study distinguished between mentors and role models - by describing that mentors provide social support, while role models serve as examples.
- Social support is identified as one of the **strongest** factors influencing their pursuit of a degree in a technical or technological field.

Details on Physiological States/Cues

- **Physiological States:** the way the student **interprets** the arousal they feel will affect their feelings of confidence
- Sweaty hands or dry mouth are often interpreted as signs of nervousness. Students may feel that such signs indicate they are **not capable** of succeeding at a particular task.

- The most compelling research regarding the impact of physiological states, particularly of anxiety, on the self-efficacy of women and minorities in STEM careers and areas of study is found in the literature on **stereotype threat**.
- First proposed by Steele and Arosnon (1995), **stereotype threat**. refers to debilitating performance anxiety for individuals who are members of a group for which there is a **negative stereotype** related to the task.

- The researchers in Keller's (2007) study initiated a stereotype threat prompt that negatively affected the **mathematics performance** of female **high school students**. These findings are in accordance with those of Kiefer and Sekaquaptewa (2007), who found that the reduction of stereotype threat benefited women's mathematics performance.
- Similar impacts of stereotype threat on STEM performance have been found in under-represented ethnic or racial minority groups (Kellow and Jones, 2008; Ryan and Ryan, 2005).

The Four Sources of Self-efficacy:

Mastery experiences

Vicarious Experiences

Social Persuasion

Physiological Cues

1. Would you share your experience with self-efficacy?
2. Can you pick one and suggest how to use it in your classroom to self-efficacy?

To conclude

1. All four sources of efficacy information are viewed as interacting complexly to influence self-efficacy, and effective interventions make use of a variety of ways in which to enhance self-efficacy and therefore enhance performance.

Although there are many possible explanations for why one could fail, effort and ability are the most likely causes that students report. Good & Brophy, 1986.

Teacher behaviors appear to function as low-ability cues

- ▶ unsolicited help
- ▶ sympathy from a teacher following poor student performance led failing individuals to infer that they were low in ability and to expect failure to continue in the future
- ▶ feedback: the communication of praise following success on easy tasks and the absence of blame following failure on such tasks can lead the targets of these types of feedbacks to infer low ability

Instead Do these

Ability, Attitude, Effort

Let students know that they have the ability to do well

- ▶ **Avoid (the appearance of) unsolicited help.** Take an indirect route to a student whom you believe needs help, visit several students before, and after, you visit your target student. Don't always target the student who needs help.
- ▶ **Help students practice lack-of-effort explanations** when they perform poorly, while drawing attention to something they did correctly. "You know how to use a ruler, but you need to be more careful reading the numbers."
- ▶ **Compliment students on specific skills** they are acquiring. A specific compliment such as, "You really know how to solve a quadratic equation when there are two roots," provides more information to a student than a general comment such as, "Nice job."

Goals

Goals provide a standard against which students can gauge their progress and setting goals can have a substantial impact on student self-efficacy and achievement.

Help students recognize that they are learning new material and making progress.

1. Let students help decide how to break up larger goals into smaller, attainable ones.
2. Seek advice from students about how personally challenging goals are for them. When students seem over or under challenged, consider new ways to align the goals with student interests.
3. Try to state, and have students state, **goals in terms that are sufficiently clear** so progress can be measured.

Hofstra Noyce Program

- ▶ Teachers' Sense of Efficacy Scale (TSES) – Tschannen-Moran & Hoy, 2001
- ▶ Program for International Student Assessment PISA – Ferla et al., 2009
- ▶ Woodcock-Johnson III Tests of Achievement, calculation subtest, (WJ-III; Woodcock, McGrew & Mather, 2007)

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Thank You!