Data-driven Engineering Education Practices

Advantages of Direct Mastery Learning Activities

Capsule: Direct mastery learning experiences conducted in a non-competitive environment lead to enhanced levels of psychosocial factors believed to have an impact on the recruitment and retention of females in engineering.

Summary: The research team used a graduate course at Arizona State University in design, engineering, and technology (DET) for nine science education students, who also happen to be K-12 science instructors, to identify and test interventions to assess and increase students' levels of three psychosocial factors they believe affect the (low) participation of females in engineering: societal relevance, tinkering self-efficacy, and technical self-efficacy. The course's instructional design is based partially on Bandura's theories of self-efficacy, which assert that direct mastery experiences can enhance self-efficacy. Three activity formats were used: lecture and discussion, labs, and a final capstone project. Students worked in teams for the latter two formats. Data were collected through surveys, reflection statements, and focus groups. Working in a hands-on, non-competitive environment within the DET framework resulted in raised levels of all three factors in both genders. The research team recommends incorporating this knowledge in K-16 instructional plans to facilitate the recruitment and retention to graduation of students – especially females – in engineering, and in developing and maintaining strong partnerships among elementary, secondary, and university educators.

Definitions: societal relevancy of engineering is "the positive relationship between engineering products and services and how they can improve individual lives and benefit society and the environment"; tinkering self-efficacy refers to one's "experience, competence, and comfort with manual activities"; and technical self-efficacy refers to "individuals' confidence and belief in their competence to learn, regulate, master, and apply technical academic subject matter." (Baker, *et al*., 2007; p. 213)

Implications for Engineering Education: These research results are an example of the (positive) impact the combination of two instructional strategies can have on the ability of students to grasp and own concepts they may perceive as counter-intuitive or otherwise difficult. The most effective instructional plans use activities, interventions, and strategies designed to appeal to one or more of the three basic learning styles – visual, auditory, and kinesthetic – at one point or another during the instructional period. Direct mastery activities involve all three simultaneously. Conducting the activities in a non-competitive environment gives students, especially those with lower levels of technical and tinkering self-efficacy, the opportunity to grow the confidence required for mastery learning.

Reference: Dale Baker, Stephen Krause, Şenay Yaşar, and Chell Roberts (2007). "An Intervention to Address Gender Issues in a Course on Design, Engineering, and Technology for Science Educators." In the *Journal of Engineering Education* 96(3), pp. 213 - 236.

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