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Engineering Self-Efficacy: What it is, Why it Matters, and How to Encourage it in Engineering Learning Environments!

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EIT Project Team



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EIT Project Goal & Strategies

To create engineering learning environments that support the persistence and success of all students, especially diverse women and minority men, by:

- Tailoring time-effective resources to engineering educators
- Distilling key research findings
- Sharing practical teaching advice
- Delivering convenient live/recorded webinars
- Providing easy-adoption checklists/resources



Catherine Amelink



Dr. Catherine Amelink is Director of Graduate Programs and Assessment in the College of Engineering at Virginia Tech. She has played an active role in educational policy and practice at the K12, department, university, and state level. Her research has been published in several peer-reviewed journals, including the Journal of Engineering Education, the Journal of Women and Minorities in Science and Engineering, the Journal of Women in Higher Education, and Advances in Engineering Education. Most recently her research has focused on the self-efficacy of community college STEM students and she has published in the Journal of Community College Research and Practice. She is an affiliate faculty in both the Higher Education program in the School of Education and the Department of Engineering Education in the College of Engineering. Catherine received her Ph.D. in Educational Leadership and Policy Studies from Virginia Tech in 2003.

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John J. "Jack" Lesko



Dr. John "Jack" Lesko is a Professor of Engineering Mechanics at Virginia Tech and currently serves as the Associate Dean for Research & Graduate Studies. Jack has 20+ years of design and analytical experience as a mechanical engineer, with background in physics, mechanics and system analysis. Jack is also the cofounder and a Principle at PowerHub Systems, a start up in the Virginia Tech Corporate Research Center. Through this startup experience with PowerHub, Jack has initiated problem based learning pilot programs enabled through interdisciplinary experiences, engaging formally in engineering education and entrepreneurial training. Jack is also a Co-PI for the NSF I-Corps Mid Atlantic Regional Node and is an instructor for both the National and Regional training programs guiding technical professionals through the Lean Startup approach.



Margaret Beier



Dr. Margaret E. Beier is an Associate Professor of Psychology at Rice University in Houston, TX. Margaret's research examines the predictors of performance in educational and occupational settings. In particular, she is interested in the effects of examining gender, age, ability, personality, motivation, and self-regulation on a range of outcomes. Her work has been published in top-tier journals in education and psychology including the Journal of Educational Psychology, Psychological Bulletin, Learning and Individual Differences, the Journal of Applied Psychology, and the Journal of Personality and Social Psychology. She is a member of the American Educational Research Association and a Fellow of the Society for Industrial and Organizational Psychologists. She received her B.A. from Colby College (Cum Laude), and her M.S. and Ph.D. degrees from the Georgia Institute of Technology.



Presentation Overview

- What is self-efficacy?
- Why is it important?
 - Gender differences in self-efficacy.
- How does it develop?
- How can educators encourage its development?
- Practical application
- Audience questions and discussion





Self efficacy is: (Check all that apply.)

- The same as having confidence
- Represented by high self-esteem
- Built upon consistent praise
- Best if consistently high
- None of the above



What is Self-efficacy? "I think I can"

Judgment about one's ability to organize and execute a specific course of action necessary to attain a specific goal

- E.g., Rate your confidence that you can. . .
 - Get a ≥ B on your next math exam.
 - Finish your science homework on time.
 - Receive an A on the engineering capstone project.





Is it important?

- Task Motivation
 - Set higher performance goals
 - Expend more effort to reach those goals
 - More resilient and persistent when difficulties arise





Helps Predict Performance



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In general, who do researchers find to have higher self-efficacy in STEM fields? (Check one)

- Women
- Men
- No difference



Important Gender Differences

- In Science, Technology, Engineering, Mathematics (STEM) disciplines:
 - Men have higher levels of self-efficacy, on average than women
 - Exists despite comparable prior performance



 How much does the sex difference in self-efficacy contribute to the difference in engagement in STEM disciplines?

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Self-Efficacy Development

- Self-efficacy can change
- Four sources of self-efficacy
 - 1. Mastery experiences
 - 2. Vicarious experiences
 - 3. Social persuasion (i.e., feedback)
 - 4. Physiological reactions



1. Mastery Experiences

- Provide evidence of the capability to succeed.
 - Successful outcomes boost it
 - Failures lower it
- Integrating mastery experiences
 - Hands-on/active learning experiences
 - Activities that are "just right"



2. Vicarious Experiences

- Involves developing perceptions about one's own skills by observing others
 - If s/he can do it, I can do it!
 - Role models are important
- Integrating vicarious experiences
 - Provide opportunities for students to learn about each other's experiences
 - Invite alumni and advanced students/professionals to share their stories





If you agree with the statement below click your "hand" icon:

"To increase self-efficacy it's important to encourage students by telling them they are doing well, even when they are not."



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3. Social Persuasion (Feedback)

- Others' judgments and support
 - Source matters (influential others)
 - Must be genuine
 - Particularly powerful with mastery experiences



- Ideas for integration social persuasion are:
 - Build relationships with students
 - Encourage persistence when success is possible



4. Physiological Response

- Interpretation of emotional and physiological responses (butterflies in the stomach)
 - Anxiety & fear of failure
- How to address physiological responses:
 - Openly discuss anxiety related to academics as a common phenomenon
 - Discuss strategies for managing physiological responses
 - Study strategies
 - Exam preparation strategies





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Accuracy is Important

- Too high \rightarrow students set themselves up to fail
- Too low \rightarrow students will not try

Mastery experiences \rightarrow Self-efficacy \rightarrow Higher Goals



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Self efficacy is (check all that apply):

- The same as having confidence
- Represented by high self-esteem
- Built upon consistent praise
- Best if consistently high



Self-Efficacy Key Points

- Reducing differences in self-efficacy may increase the #s and diversity of STEM students
- Self-efficacy leads to effort, persistence, and performance and can influence success in STEM
- Good news: Educators can influence the development of student self-efficacy





FOSTERING SELF-EFFICACY



Special thanks to Dr. Julaine Fowlin, Instructional Designer, Holy Names University, Oakland, CA



How many years have you been teaching?

- 1 year
- 2-5 years
- 5-10 years
- 10+ years



The Instructor's View on Self Efficacy

- What does "self-efficacy" look like?
- How do I construct a syllabus?
- Crafting the environment
- Outside of class



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Action Check-list (www.WSKC.org/EIT)

Influence	Questions
Vicarious Experiences	 Do I provide enough evidence to my students that other people with similar potential have succeeded in this course so they can too? Are TA's trained to be cognizant of self-efficacy issues and to provide support accordingly by sharing some of the ways they were able to succeed?
Mastery Experiences	 ✓ Do I sequence my lessons from simple to more complex? ✓ Do I make it clear how to be successful in the course? ✓ Do I provide students with strategies that they can use to monitor their understanding? ✓ Do I have some means of assessing the current level of students in my course?
Social Persuasion	 Do I proving feedback for incorrect work in way that students will still maintain their confidence in successfully achieving the subject matter? That is, they will try harder and not see the results as a lack of their ability? Do I emphasize common mistakes to let learners know that the errors made are not unique to them? Is my feedback genuine, encouraging students to aim feasibly higher like from a C to a B+ rather than expecting a jump to an A? Do I provide a link between the content and student's degree end goals?
Physiological Response	 ✓ Do I integrate engaging activities in my course that will peak students' interests and satisfaction? ✓ Do I try to minimize students' frustration with challenging concepts?
General	✓ Do I provide opportunities for students to work in groups and learn from each other? 26

Strategies for Educators: Overview

Influence	Strategies
Vicarious Experiences	 Peer Teaching – multilevel teaching sessions where students teach each other fundamentals <u>Train and employ senior level undergraduate TA's</u> Exposure to URM Department Alums to the classroom to discuss their experience in the same curriculum
Mastery Experiences	 Scaffold test/homework problems: Include more basic problems with <u>complex problems</u> Spiral curriculum
Social Persuasion	 Compare answers anonymously in class and identify common errors Emphasize the creative and real world application of the subject matter Orienting faculty to the sensibilities of others
Physiological Response	 Build rapport with student. Be empathic, open, approachable Clickers and polling Noting resources collectively Example tests Accommodation for test anxiety Remove the trigger – level the playing field Practical context for fundamentals studied - problem based learning Overview of the field include wo/men in engineering, creativity

Training TA's

- Awareness of Self-efficacy Issues
- Include Self-efficacy in training session for TA's
- List of strategies
- Observation and coaching





Some Universities Crack Code in Drawing Women to Computer Science



- Emphasize the creative and real world applications of the subject matter
- "Frame engineering and computer science as creative problem-solving, not hard core mathematics or programming"

"Some Universities Crack Code in Drawing Women to Computer Science," Women in Tech, The Upshot, 17 July 2014



Computer Science Example

Crafting the Syllabus & Course Outline

How Prerequisite Levels Relate to the Advance Level



Formal Assessment Scenario

Consider this programming class scenario:

Throughout the semester students learned to program using the [insert programming language here.] Several of their class projects required them to design programs for [Insert situation here] on their computers. For the final assessment they were asked to create a program for [insert task here] by writing the codes on paper. The TA's would then enter the coding information in the computer to see if the program worked.



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What self efficacy experience might this scenario



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Informal Assessment

- Demonstrate tasks to students
- Give in-class practice
- Give feedback before moving on with anonymous problem submission
- Consider virtual office hours
- Bring in role models they can relate to
- Let students know you care about their success; solicit concerns
- Minute Paper formative assessment





Vicarious Experiences

Mastery Experiences

Social Persuasion



Have you used the "Minute Paper?"— Click your "hand" icon if you have!

	Click the icon to
Access	raise your hand.
Talking: Nathalie De	escusse
Questions	3
	-
	Con

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The Minute Paper

Minute Paper Date:

What are the two most important points from today's session?

What point are you most confused about from today's session?

What would be helpful to make the material clearer for you?"

Comments:

- Anonymous
- Instructor addresses
 comments
 - In the next session
 - On-line
- Encourages students to reflect and question their learning

Vicarious Experiences

Mastery Experienc

Social Persuasion

Active Learning



Active Learning Techniques

- Think-Pair-Share
- Concept tests
- Thinking-aloud/Pair Problem
 Solving

Many more very good techniques and examples can be found in the literature from Richard Felder

http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/ALpaper(ASQ).pdf

Vicarious Experiences

Mastery Experiences

Social Persuasion

Outside the Classroom – Get Involved



http://www.eng.vt.edu/residentialprograms/invents

Vicarious Experiences

Mastery Experiences

Social Persuasion

Summary of Key Points

- Foundations
 - Best-practice research affirms the importance of self-efficacy within the learning context
 - Educators can positively influence the self-efficacy of their students
- Applications
 - Provide Active Learning experiences
 - Create safe learning environments
 - Start with small changes
 - Helps everyone!







Asking Questions and Discussion

Type questions in to "Questions Pane"





Dr. Margaret Beier Social Scientist



Dr Jack Lesko Engineer



Dr. Catherine Amelink **Engineering Educator**





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Personalized "To Do"

Now that you have heard this information, what are some things that you might want to do?





Next Steps

- Provide us Feedback
- Go to our website: <u>www.WSKC.org/EIT</u>
 - Participate in other live or recorded webinars
 - Use the Action Checklists & recommended reading

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• Share this information with colleagues!





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Together we can engage all minds in engineering the future!

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