Sources of Self-Efficacy in Engineering Students

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Introduction

- Bandura (1997) contended that efficacy beliefs are based on four sources: mastery experiences, vicarious experiences, social persuasions, and physiological states.
- So far, no measure has been developed to measure the four sources of self-efficacy quantitatively in the domain of engineering (Loo & Choy, 2013).
- Women earn only 18% of bachelor's degrees in engineering (NSB, 2012).
- Gender differences in the sources of self-efficacy have been found in scientific areas via case studies (Zeldin, Britner, & Pajares, 2008) but not via quantitative methods.

Purpose of Study

- To develop and validate a scale to assess the sources of engineering self- efficacy
- To determine which sources are most predictive of undergraduate students' engineering self-efficacy in general
- To explore gender differences in the sources of engineering self-efficacy

Method

- An online survey was administered to 1,196 undergraduate engineering students (919 men, 277 women) attending a research intensive university within the United States.
- Measures included items adapted from the Sources of Self-Efficacy in Middle School Mathematics scale (Usher & Pajares, 2009) using a 6-point Likert scale ranging from 1 (Strongly disagree) to 6 (Strongly agree) and four measures of engineering self-efficacy (Mamaril et al., 2016).

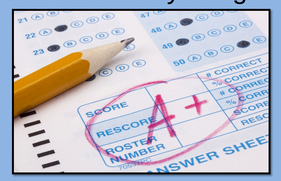
Analyses

- Confirmatory factor analyses were used to confirm the four-factor structure of the sources of self-efficacy scale.
- Mean differences by gender were examined using independent *t* tests.
- Multiple linear regression analyses were conducted to investigate the influence of the four sources on engineering self-efficacy.

Results

- A four-factor structure fit the data well for the sources of engineering self-efficacy scale, S-B $\chi 2$ (98) = 417.68, CFI = .95, RMSEA = .05.
- Four items assessed mastery experience (α = .88), four items assessed vicarious experience (α = .85), four items assessed social persuasion (α = .85), and four items assessed physiological state (α = .86).

Sample Items:
How much do you agree with the following statements?



Mastery Experience
I make excellent grades on engineering tests.

Social Persuasion
My professors tell me I am good at engineering.

Vicarious Experience
Shadowing an engineer makes me think I can be an engineer.

Physiological State
I feel stressed out as soon as I begin my engineering work.

Table 1 *Mean, Standard Deviation, Correlation Among General Engineering Self-Efficacy, Engineering Skills Self-Efficacy, Sources of Engineering Self-Efficacy, and Gender for the Full Sample (N* = 1, 196*)*

Variables	M	SD	1	2	3	4	5	6	7	8
1. General Engineering SE	4.93	0.85								
2. Experimental SE	4.95	0.77	.62**							
3. Tinkering SE	4.81	0.92	.43**	.58**						
4. Engineering Design SE	4.78	0.91	.55**	.67**	.70**					
5. Mastery Experiences of ESE	4.65	0.92	.75**	.43**	.24**	.37**				
6. Vicarious Experiences of ESE	4.73	1.06	.43**	.40**	.31**	.38**	.40**			
7. Social Persuasions of ESE	4.15	1.01	.52**	.40**	.30**	.41**	.62**	.47**		
8. Physiological States of ESE	2.86	1.08	-.41**	-.29**	-.23**	-.22**	-.37**	-.17**	-.23**	
9. Gender	-	-	-.036	-.007	-.20**	-.08**	-.02	.04	-.04	.02

** $p < .01$

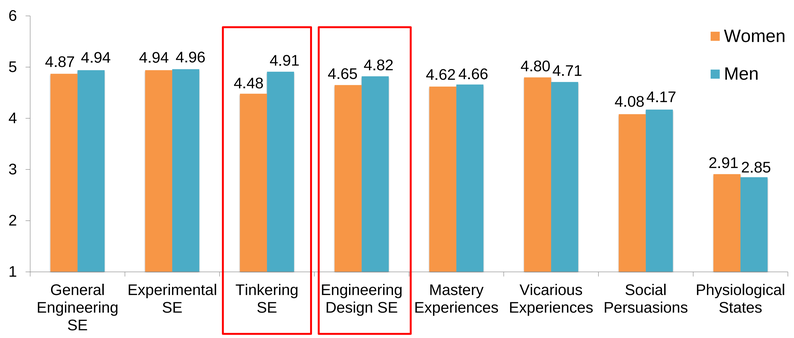


Figure 1. Mean levels of all study variables by gender. Red boxes indicate statistically significant results.

Table 2 *Standardized Regression Coefficients* (β) *for the Prediction of General Engineering Self-Efficacy, Experimental Skills Self-Efficacy, Tinkering Skills Self-Efficacy, and Design Skills Self-Efficacy*

Variables	GESE	Experimental SSE	Tinkering SSE	Design SSE
Full Sample (*N* = 1,196)				
Mastery Experience	.61***	.20***	-.01	.12***
Vicarious Experience	.15***	.23***	.20***	.22***
Social Persuasions	0.05†	.14***	.18***	.21***
Physiological State	-.15***	-.14***	-.16***	-.09***
F	460.27***	110.10***	51.37***	90.33***
Model R^2	.61	.27	.15	.24
Men (*n* = 919)				
Mastery Experience	.62***	.19***	-.02	.10*
Vicarious Experience	.15***	.26***	.23***	.25***
Social Persuasions	.04	.16***	.20***	.22***
Physiological State	-.14***	-.14***	-.16***	-.10***
F	367.38***	97.06***	45.21***	76.12***
Model R^2	.62	.30	.17	.25
Women (*n* = 277)				
Mastery Experience	.58***	.21**	.01	.17*
Vicarious Experience	.13**	.15*	.20**	.18**
Social Persuasions	.07	.05	.08	.18*
Physiological State	-.18***	-.18**	-.18**	-.07
F	90.69***	14.83***	8.99***	15.28***
Model R^2	.58	.18	.12	.19

Note. †$p = .059$. *$p < .05$. **$p < .01$. ***$p < .001$.

Implications and Future Directions

- Contrary to previous findings on the sources of women's self-efficacy (Usher & Pajares, 2008), women's general engineering, experimental, and tinkering self-efficacy were not influenced by social persuasion.
- Findings suggest that successful experience and exposure to social models are powerful influences on engineering students' self-efficacy.
- Findings suggest that mastery experience is not a significant predictor for students' tinkering skills self-efficacy.
- Interventions targeting these two sources (e.g., participation in cooperative learning) may be particularly important to a strong sense of engineering self-efficacy.

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