



Prior Self-Efficacy Interacts with Experiential Valence to Influence Self-Efficacy among Engineering Students: An Experimental Study

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ABSTRACT

Self-efficacy toward science learning has been shown to play a crucial role in determining students' motivation and achievements. Social cognitive theory proposes that positive and negative task outcomes affect mastery experiences from which self-efficacy develops. The current research examined whether prior level of self-efficacy would serve as a moderator of the effect of experiential valence on self-efficacy in science learning. One hundred and thirty engineering undergraduates with varying levels of prior self-efficacy (high, medium, and low) were randomly assigned to receive either a positive or a negative task experience regarding circuit design. The findings of our experiment showed that students with lower levels of self-efficacy appeared to be more affected by positive versus negative task experiences, and those with higher levels of self-efficacy tended to be more affected by negative versus positive task experiences. The present findings indicate that both valence of task experience and students' prior self-efficacy affect their changes in self-efficacy with regard to STEM learning. The present findings have far-reaching implications for enhancing self-efficacy on learning of science.

Keywords: Engineering students, self-efficacy, task experience, valence of experience

INTRODUCTION

Social cognitive theory (Bandura, 1989) proposes that self-efficacy is closely related to academic performance, and this proposition is supported by presented research. Because self-efficacy refers to believing in one's own capability to perform chosen tasks, this belief influences choice of activities, degree of effort expended, and persistence of effort (Bandura, 1986). Theoretical and empirical evidence suggest that self-efficacy might serve as a very powerful construct for predicting behavior and task performance (e.g., Barbeite & Weiss, 2004; Bilgin, Karakuyu, & Ay, 2015; Diseth, 2011; Jackson, 2002; Luszczynska, Scholz, & Schwarzer, 2005; Ogan-Bekiroglu & Aydeniz, 2013; Saçkes, Trundle, Tuckman, & Krissek, 2012). Bandura

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State of the literature

- Social cognitive theory indicates that receiving positive task experiences increases students' self-efficacy, whereas receiving negative task experiences decreases self-efficacy.
- The notion of gain–loss theory suggests that positive task experiences should produce a greater effect for students with lower self-efficacy, whereas negative task experiences should generate a more prominent impact for students with higher self-efficacy.
- An experimental investigation on how students' prior self-efficacy moderates the effect of valence of task experience on the change of self-efficacy will provide far-reaching implications for promoting self-efficacy on learning of science.

Contribution of this paper to the literature

- Through an experimental study, the current research tested whether engineering students' prior level of self-efficacy would interact with experiential valence (i.e., positive or negative) to influence self-efficacy change in science learning.
- The present findings showed that engineering students with low self-efficacy are more influenced by positive task experiences, whereas those student with high self-efficacy are more influenced by negative task experiences.
- This research provides the first demonstration that prior self-efficacy moderates the link between experiential valence and self-efficacy change in science learning.

(1997) further points out that a mastery experience constitutes a major source of self-efficacy in that it generates confidence in having the raw knowledge, skills, and experience to successfully reach a goal or complete a task. In the context of engineering education, a positive experience with completing a particular major or a specific course—including having completed the requirements for a previous degree or course of study in a science, technology, engineering, and mathematics (STEM) discipline—might serve as an mastery experience.

Engineering students are expected to master a variety of skills in the fields of mathematics, physics, and other STEM areas. Self-efficacy affects motivation toward science learning (Bryan, Glynn, & Kittleson, 2011; Tuan, Chin, & Shieh, 2005; Velayutham, Aldridge, & Fraser, 2011, 2013) and is important for improving science education (Thomas, Anderson, & Nashon, 2008; van Dinther, Dochy, & Segers, 2011). Engineering educators should understand how to develop this belief and incorporate these principles into their lessons (Ponton, 2002; van Dinther et al., 2011). However, past research regarding self-efficacy toward STEM teaching and learning focused primarily on antecedents (e.g., Betz & Schifano, 2000; Bilgin et al., 2015; Çalık, 2013; Hutchison, Follman, Sumpter, & Bonder, 2006), correlates (e.g., Adedokun, Bessenbacher, Parker, Kirkham, & Burgess, 2013; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Tsai, Ho, Liang, & Lin, 2011; van Dinther et al., 2011), and its consequences (e.g., DiBenedetto & Bembenuddy, 2013; Sancar-Tokmak, 2013; Wang, Wu, & Huang, 2007). Many case-based studies on self-efficacy simply arranged different tasks for participants in order to understand the relationships between self-efficacy and performance (e.g., Komarraju &

Nadler, 2013; Louis & Mistele, 2012; Peters, 2013) and between self-efficacy and task difficulty (e.g., Hasan, 2003; Hepler & Feltz, 2012; Phan, 2012). Very few studies further examined how changes in self-efficacy were influenced by the interaction of prior experience and experiential valence. Thus, the self-efficacy of engineering students as well as the dynamics characterizing the development of this phenomenon should be examined. Understanding the development of this specific kind of self-efficacy might illuminate approaches to enhancing self-efficacy in STEM learning.

The Role of Experiential Valence in the Change of Self-Efficacy

In principle, experience with a task might provide crucial information with which individuals can judge their self-efficacy in relation to a specific task. Many researchers in several fields have investigated how people deal with evaluative information and how framing affects the influence of messages on decisions and judgments. Studies in this domain have been performed by researchers focused on behavior modification (Williams, Clarke, & Borland, 2001; Wilson, Wallston, & King, 1990), attitude formation (Eiser, Fazio, Stafford, & Prescott, 2003), attitude change (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001), and auditing (Jones & Chen, 2005).

Self-efficacy has been demonstrated to be a strong predictor of subsequent task-specific performance (e.g., Compeau & Higgins, 1995; Hsieh, Sullivan, Sass, & Guerra, 2012; Peters, 2013), and task experience appears to be highly related to self-efficacy (e.g., Chen & Usher, 2013; Jackson, 2002; Loo & Choy, 2013; van Dinther et al., 2011). This relationship can be evaluated by examining individuals to determine if their confidence in a specific task increases after successfully performing that task. Thus, self-efficacy is acquired from mastery experiences via interpretation of individual performances on particular tasks (Bandura, 1997). In general, task experiences that are perceived as positive tend to raise students' confidence in task-relevant abilities and thereby enhance self-efficacy, whereas those that are perceived as negative tend to decrease confidence and thereby diminish self-efficacy (Wood & Bandura, 1989). Therefore, it would be reasonable to argue that engineering students' self-efficacy should be closely related to the experiential valence of STEM learning. More specifically, positive task experiences would be expected to enhance a student's self-efficacy, whereas negative task experiences would be expected to diminish it (Bandura & Locke, 2003).

The Moderating Role of Prior Self-efficacy in the Link between Experiential Valence and Change in Self-Efficacy

Prior level of self-efficacy should be considered when examining the effect of experiential valence on changes in self-efficacy because human development is based on continuity with prior states (Crandell, Crandell, & Zanden, 2011). In addition to its direct effect, experiential valence might also interact with prior levels of self-efficacy to influence the extent to which self-efficacy changes.

Gain-loss theory (Aronson, 1969; see also Aronson & Linder, 1965), discussed in social psychology, can justify this logic. This theory notes that varied outcomes are more effective than is stable information. A varying pattern of negative-to-positive represents "gain," whereas a pattern of positive-to-negative represents "loss," indicating that the impact of positive or negative information is contingent upon the prior state. According to this logic, the detrimental effect of negative information would be greater when the prior state was positive than when it was negative. In contrast, the incremental effect of positive information would be more pronounced when the prior state was negative than when it was positive.

Drawing upon the notion of the gain-loss theory, individuals with higher self-efficacy begin with a prior positive condition; hence, a subsequent negative experience should have a greater effect. In contrast, a positive experience should have a more pronounced impact for individuals whose prior self-efficacy was lower. Indeed, prior level of self-efficacy might moderate the differential impact of experiential valence on the development of self-efficacy (Chiou & Wan, 2007). Via an information search task, Chiou and Wan (2007) demonstrated that positive searching experience enhanced self-efficacy to a great degree for searchers with lower self-efficacy than for those with higher self-efficacy, whereas negative searching experience undermine self-efficacy to a great degree for searchers with higher self-efficacy than for those with lower self-efficacy. Building on this research, the current study investigated whether prior self-efficacy would interact with valence of task experience to affect changes in self-efficacy regarding STEM learning. It was predicted that the enhancing effect of a positive task experience on self-efficacy would be more prominent for engineering students with lower versus higher levels of self-efficacy, whereas the diminishing effect of a negative task experience on self-efficacy would be more prominent for those students with higher versus lower levels of self-efficacy.

METHOD

Participants and Design

An experimental study was conducted to examine whether or not the prior level of self-efficacy would moderate the valence of experience effect. Participants were 130 undergraduates (36 females, 94 males; mean age = 21.12 years) from the department of electronic engineering at a national university in southern Taiwan. Self-efficacy in circuit design was the specific area of self-efficacy examined in this research because of its importance in the class on electrical circuits and because the electrical circuit is a fundamental subject for engineering students majoring in electrical engineering.

All respondents participated in this research for course credit. The initial circuit design task was of intermediate difficulty in order to elicit greater individual differences in self-efficacy. The initial task was used to classify the participants according to initial self-efficacy with regard to circuit design. A 0.5 standard deviation above or below the group mean for self-efficacy was used as the threshold for classification into three levels of self-efficacy (high vs.

medium vs. low). Forty-two respondents with medium levels of self-efficacy in the initial task were selected as the contrast group for this research, and the remaining 88 respondents with high (44 participants) or low (44 participants) levels of self-efficacy served as the experimental groups. Participants were assigned according to a 2 (valence of task experience: positive vs. negative) \times 3 (prior self-efficacy: high vs. medium vs. low) between-subjects design.

Procedure

The present study was disguised as a portion of the mid-term quiz in the electrical circuit course. The initial task with medium difficulty was administered under a 20-minute time constraint. After 20 minutes had elapsed, participants used a non-graded scale to rate their self-efficacy with regard to circuit design and then rested for 10 minutes. During this rest period, a tutor monitored the participants to ensure that they did not review any material relevant to the circuit design. During this break, we were able to use the self-efficacy evaluations for the initial task to divide participants into three subgroups with varying levels of self-efficacy with regard to circuit design.

After the rest period, the experiential valence of the task was manipulated between subjects. Members of low-, medium-, and high-self-efficacy groups were randomly assigned to two subgroups to manipulate the valence of experience. Each subgroup received one positive (i.e., another low difficulty task) or negative experience (i.e., another high difficulty task). After the second task, respondents used a non-graded scale to rate their confidence with regard to circuit design; these scores reflected evaluations of self-efficacy. The dependent measure of this experiment was the magnitude of the change in self-efficacy between the pretest and the posttest.

Task

Because it was hypothesized that the effect of experiential valence on change in self-efficacy would be dependent on prior self-efficacy, we manipulated the experiential valence of a circuit design task by controlling the difficulty of the task. This design was based on the assumption that easy tasks result in positive task experiences, whereas difficult tasks result in negative task experiences. Two full professors in the department of electrical engineering provided circuit design tasks with three levels of difficulty; these were independently examined by two other professors who were blind to the study to determine inter-rater reliability.

Data obtained in a pretrial supported the validity of using our method to manipulate experiential valence. For the pretrial sample, we used 84 engineering students at another university to avoid disseminating information about the experimental manipulation to potential participants in the subsequent experiment. The participants in the pretrial were randomly assigned to one of the three levels of task difficulty. Participants engaged in a circuit design task under a time constraint 20 minutes. The proportions of correct designs under the three levels of task difficulty were 85% for the low difficulty task ($n = 28$), 61% for the medium

difficulty task ($n = 20$), and 34% for the high difficulty task ($n = 11$). A Chi-square test demonstrated the differentiation among the three task difficulty, $\chi^2(2) = 16.58$, Somer's $d = .39$ (correct design as a dependent measure), and $p < .001$. In summary, the pretrial demonstrated that the three levels of task difficulty in the circuit-design tasks were suitable to manipulate valence of task experience.

Dependent Measure

After each trial, respondents were asked to rate their self-efficacy with regard to circuit design using a non-graded scale with two end points ("without any confidence at all" and "with complete confidence") by marking the appropriate place on the continuum with an arrow. Because ratings of self-efficacy were based on a single item, a non-graded scale might have been not only more appropriate for reflecting confidence levels with regard to performing a specific task, but might also have been less vulnerable to the impact of social desirability than would a point scale. Participants' responses were later quantified by measuring the distance from the lower end of the scale to the mark reflecting their evaluations of self-efficacy. Responses were then standardized on a 100-point scale so that 0 signified "no confidence" and 100 signified "strong confidence" in completing the task.

A contrast-group method was also employed to test the validity of the self-efficacy measure. Responses of the participants ($N = 56$) who were assigned to the high and low task difficulty conditions in the pretrial were used. In principle, participants who performed the less difficult task should have expressed higher levels of self-efficacy with regard to circuit design, whereas those who performed the more difficult task should have expressed lower levels of self-efficacy in this regard. Results of the t -test supported this prediction and showed that participants under the low difficulty condition ($M = 68.18$, $SD = 8.01$) exhibited higher self-efficacy than did those under the high difficulty condition ($M = 26.54$, $SD = 6.52$), $t(54) = 21.32$, $p < .001$, Cohen's $d = 5.69$. In sum, this finding indicated that the manipulation of task difficulty was associated with either a positive or negative task experience in addition to affecting self-efficacy.

RESULTS

A summary of the changes in self-efficacy is presented in **Table 1**. A 2 (valence of task experience: positive vs. negative) \times 3 (prior self-efficacy: high vs. medium vs. low) between-subjects ANOVA model was conducted to examine the interaction of the experiential valence of the task and the prior level of self-efficacy on change in self-efficacy.

Table 1. Self-Efficacy Change as a Function of Prior Level by the Valence of Task Experience

Prior Level	<i>n</i>	Valence of Task Experience			
		Positive		Negative	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Low self-efficacy group	<i>n</i>		22		22
Pretest		21.05	11.16	22.77	9.45
Posttest		48.00	12.86	15.55	6.47
Self-efficacy change		26.95	8.63	-7.22	4.55
Medium self-efficacy group	<i>n</i>		21		21
Pretest		45.29	6.25	45.29	6.25
Posttest		59.38	6.00	31.52	6.34
Self-efficacy change		14.09	3.19	-13.77	3.71
High self-efficacy group	<i>n</i>		22		22
Pretest		67.77	11.42	66.64	11.71
Posttest		76.45	9.48	36.50	13.81
Self-efficacy change		8.68	4.25	-30.14	8.28

Note. Cell means in the pretest row indicated participants' initial self-efficacy level and those in the posttest row represented their subsequent evaluations of self-efficacy after receiving a positive or negative task experience. Thus, "positive" values of self-efficacy change signified an increase in self-efficacy, whereas "negative" values signified a decrease in self-efficacy.

In general, positive experiences were associated with increased self-efficacy ($M = 16.62$, $SD = 9.70$) when μ_{change} was set to zero, $t(64) = 13.82$, $p < .001$, Cohen's $d = 1.71$. In contrast, negative experiences were associated with decreased self-efficacy ($M = -17.09$, $SD = 11.37$), $t(64) = -12.12$, $p < .001$, Cohen's $d = 1.50$. More importantly, a significant interaction was observed, indicating that the impact of experiential valence on self-efficacy change was a function of prior level of self-efficacy, $F(2, 124) = 9.37$, $p < .001$, $\eta_p^2 = .13$.

Follow-up contrasts were conducted in order to examine the simple main effect of prior self-efficacy with regard to both positive and negative task experiences (Table 1). The enhancement effect of a positive experience on self-efficacy was significantly greater in the low self-efficacy group ($M_{\text{change}} = 26.95$) than in the medium self-efficacy group ($M_{\text{change}} = 14.09$) or in the high self-efficacy group ($M_{\text{change}} = 8.68$) at $p < .001$, for both the former contrast, $t = 3.02$, Cohen's $d = 0.38$, and the latter contrast, $t = 10.30$, Cohen's $d = 1.31$, analyzed separately. Furthermore, the enhancement effect of a positive experience on self-efficacy was significantly smaller in the high self-efficacy group than in the medium self-efficacy group, $t = -7.16$, $p < .001$, Cohen's $d = 0.92$. Hence, these findings indicated that the enhancement effect of a positive experience on self-efficacy was greatest for the low self-efficacy group, smallest for the high self-efficacy group, and moderate for the medium self-efficacy group.

On the other hand, Table 1 shows that the diminishing effect of negative task experiences was significantly greater in the high self-efficacy group ($M_{\text{change}} = -30.14$) than in the medium self-efficacy group ($M_{\text{change}} = -13.77$) or in the low self-efficacy group ($M_{\text{change}} = -7.22$) at $p < .001$ for both the former contrast, $t = 8.30$, Cohen's $d = 1.16$, and the latter contrast, $t = 12.90$,

Cohen's $d = 1.64$, analyzed separately. In addition, the diminishing effect of negative experiences on self-efficacy was significantly smaller in the low self-efficacy group than in the medium self-efficacy group, $t(41) = -3.64, p < .001$, Cohen's $d = 0.46$. Hence, these findings indicated that the diminishing effect of negative experiences was greatest for the high self-efficacy group, smallest for the low self-efficacy group, and moderate for the medium self-efficacy group.

Supplementary analyses were conducted to examine the within-group differences with regard to the effect of experiential valence. For those participants with medium levels of prior self-efficacy, the enhancement effect of a positive experience ($M = 14.09$) and the diminishing effect of a negative experience ($M = 13.77$) were equivalent in terms of the magnitude of self-efficacy change (i.e., the absolute value of self-efficacy change), $t(40) = 0.31, p > .75$. This finding indicated that experiential valence had an equivalent impact for participants with medium levels of prior self-efficacy. For the low self-efficacy group, the enhancement effect of a positive experience ($M = 26.95$) was significantly greater than was the diminishing effect of a negative experience ($M = 7.22$), indicating that participants with lower levels of prior self-efficacy were more affected by a positive than by a negative experience, $t(42) = 9.48, p < .001$, Cohen's $d = 1.42$. For the high self-efficacy group, the diminishing effect of a negative experience ($M = 30.14$) was significantly greater than was the enhancement effect of a positive experience ($M = 8.68$), indicating that participants with higher levels of prior self-efficacy were more affected by a negative than by a positive experience, $t(42) = 10.81, p < .001$, Cohen's $d = 1.63$.

In addition, previous studies have suggested the existence of sex differences among engineering students with regard to self-efficacy (e.g., Marra, Rodgers, Shen, & Bogue, 2009). However, the result of analysis of sex by prior level by experiential valence was not significant, $F(2, 118) = 1.12, p > .32$, indicating that the moderating role of prior level of self-efficacy with regard to the effect of experiential valence on change in self-efficacy was not dependent upon sex.

DISCUSSION

The findings of present study indicated that the enhancement effect of positive task experience was contingent upon prior level of self-efficacy. A positive task experience appeared to have more impact on individuals with lower self-efficacy than on those with higher self-efficacy. Moreover, the diminishing effect of a negative task experience on self-efficacy was also moderated by prior self-efficacy. The diminishing effect was more significant among those with higher self-efficacy than among those with lower self-efficacy. These results are consistent with our predictions and are congruent with findings from Chiou and Wan's study (2007), suggesting that the effect of experiential valence on self-efficacy may interact with prior self-efficacy level.

The literature suggests that unfavorable information is likely to be more influential than favorable information on judgments and decisions (Mizerski, 1982). However, the data

presented in this research show that positive information (i.e., a positive task experience) had a greater impact than did negative information (i.e., a negative task experience) in some cases. The results revealed that the prior level of self-efficacy moderated the effect of experiential valence on self-efficacy change. Specifically, the impact of a positive experience on self-efficacy was bolstered for individuals with lower self-efficacy, whereas this effect was diminished for those with higher self-efficacy. On the other hand, the effect of a negative experience on self-efficacy was more prominent for people with higher self-efficacy, whereas this effect was not as apparent for those with lower self-efficacy. The present findings suggest that both experiential valence and prior level of self-efficacy appear to be important contributors to the development of engineering students' self-efficacy with regard to STEM learning.

In terms of limitations and directions for future research, the specific domain of self-efficacy studied in this research concerned circuit design. Further evidence for the generalizability of these findings to other engineering contexts or tasks is needed. Cross-skill studies might contribute to expanding the external validity of the arguments presented in this article. In addition, the impact of experiential valence on self-efficacy might depend on whether individuals are personally affected by the outcome of a task. In other words, the effect of experiential valence should be more pronounced when the consequence of a task is very important or personally relevant. The ability of personal relevance and the importance of consequences to moderate the impact of experiential valence on self-efficacy is worthy of further investigation.

In general, this research provides a new perspective on the ontogenesis of self-efficacy in the mastery experience; this perspective can enrich Bandura's self-efficacy framework. Most of the previous studies of self-efficacy focused on antecedents (e.g., Bilgin et al., 2015; Çalık, 2013; Chen & Usher, 2013; Loo & Choy, 2013) or on related outcome variables (e.g., Adedokun et al., 2013; DiBenedetto & Bembenuddy, 2013; Komarraju & Nadler, 2013; Peters, 2013; Tsai et al., 2011). The present findings clearly showed that engineering students with higher levels of self-efficacy react more sensitively to negative task experiences, whereas those students with lower levels of self-efficacy react more sensitively to positive task experiences. The dynamic nature of changes in self-efficacy should be neither overlooked nor misconstrued as static. Researchers studying the impact of experiential valence on changes in self-efficacy among students need to consider the moderating role of prior self-efficacy.

Educators may benefit from the present findings via considering that the effect of experiential valence on changes in self-efficacy is contingent on students' prior levels of self-efficacy. This research demonstrated that positive task experiences were more powerful than were negative experiences in their impact on students with lower self-efficacy. Thus, positive task experiences might result in impressive improvements in students with lower levels of self-efficacy. Educators should provide positive experiences by tailoring the difficulty of tasks to these particular students. On the other hand, negative task experiences were found to considerably damage those students with higher levels of self-efficacy. Since there is much more negative than positive experience in the real world, it is crucial for students with higher

self-efficacy to learn how to cope with negative task experiences. Given that students' acquisition of mastery experiences is a process, the present findings indicate that educators should continually monitor and evaluate the possible interaction of students' prior self-efficacy and the experiential valence of the task at hand.

REFERENCES

- Adedokun, O. A., Bessenbacher, A. B., Parker, L. C., Kirkham, L. L., & Burgess, W. D. (2013). Research skills and stem undergraduate research students' aspirations for research careers: Mediating effects of research self-efficacy. *Journal of Research in Science Teaching, 50*, 940-951.
- Aronson, E. (1969). Some antecedents of interpersonal attraction. In W. J. Arnold & D. Levine (Ed.), *Nebraska Symposium on Motivation* (pp. 143-173). Lincoln, NE: University of Nebraska Press.
- Aronson, E., & Linder, D. (1965). Gain and loss of esteem as determinants of interpersonal attractiveness. *Journal of Experimental Social Psychology, 1*, 151-171.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.
- Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist, 44*, 1175-1184.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology, 88*, 87-99.
- Barbeite, F. G., & Weiss, E. M. (2004). Computer self-efficacy and anxiety scales for an Internet sample: Testing measurement equivalence of existing measures and development of new scales. *Computers in Human Behavior, 20*, 1-15.
- Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*, 323-370.
- Betz, N. E., & Schifano, R. S. (2000). Evaluation of an intervention to increase realistic self-efficacy and interests in college women. *Journal of Vocational Behavior, 56*, 35-52.
- Bilgin, I., Karakuyu, Y., & Ay, Y. (2015). The effects of project based learning on undergraduate students' achievement and self-efficacy beliefs towards science teaching. *Eurasia Journal of Mathematics, Science & Technology Education, 2015, 11*, 469-477.
- Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, achievement, and advanced placement intent of high school students learning science. *Science Education, 95*, 1049-1065.
- Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: A multiple-groups analysis. *Journal of Counseling Psychology, 57*, 205-218.
- Çalık, M. (2013). Effect of technology-embedded scientific inquiry on senior science student teachers' self-efficacy. *Eurasia Journal of Mathematics, Science & Technology Education, 9*, 223-232.
- Chen, J. A., & Usher, E. L. (2013). Profiles of the sources of science self-efficacy. *Learning and Individual Differences, 23*, 218-224.
- Chiou, W.-B., & Wan, C.-S. (2007). The dynamic change of self-efficacy in information searching on the Internet: Influence of experience valence and prior self-efficacy. *Journal of Psychology, 141*, 589-603.
- Compeau, R. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly, 19*, 189-211.

- Crandell, T., Crandell, C., & Zanden, J. V. (2011). *Human development* (10th Ed.). New York: McGraw-Hill.
- DiBenedetto, M. K., & Bembenutty, H. (2013). Within the pipeline: Self-regulated learning, self-efficacy, and socialization among college students in science courses. *Learning and Individual Differences, 23*, 218–224.
- Diseth, A. (2011). Self-efficacy, goal orientations and learning strategies as mediators between preceding and subsequent academic achievement. *Learning and Individual Differences, 21*, 191–195.
- Eiser, A. H., Fazio, R. H., Stafford, T., & Prescott, T. J. (2003). Connectionist stimulation of attitude learning: Asymmetries in the acquisition of positive and negative evaluations. *Personality and Social Psychology Bulletin, 29*, 1221–1235.
- Hasan, B. (2003). The influence of specific computer experiences on computer self-efficacy beliefs. *Computers in Human Behavior, 19*, 443–450.
- Hepler, T. J., & Feltz, D. L. (2012). Take the first heuristic, self-efficacy, and decision-making in sport. *Journal of Experimental Psychology: Applied, 18*, 154–161.
- Hsieh, P. P., Sullivan, J. R., Sass, D. A., & Guerra, N. S. (2012). Undergraduate engineering students' beliefs, coping strategies, and academic performance: An evaluation of theoretical models. *Journal of Experimental Education, 80*, 196–218.
- Hutchison, M. A., Follman, D. K., Sumpter, M., & Bonder, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education, 95*, 39–47.
- Jackson, J. W. (2002). Enhancing self-efficacy and learning performance. *Journal of Experimental Education, 70*, 243–254.
- Jones, K. T., & Chen, C. C. (2005). The effect of audit outcomes on evaluators' perceptions. *Managerial Auditing Journal, 20*, 5–18.
- Komarraju, M., & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter? *Learning and Individual Differences, 25*, 67–72.
- Loo, C. W., & Choy, J. L. F. (2013). Sources of self-efficacy influencing academic performance of engineering students. *American Journal of Educational Research, 1*(3), 86–92.
- Louis, R. A., & Mistele, J. M. (2012). The differences in scores and self-efficacy by student gender in mathematics and science. *International Journal of Science and Mathematics Education, 10*, 1163–1190.
- Luszczynska, A., Scholz, U., & Schwarzer, R. (2005). The general self-efficacy scale: Multicultural validation studies. *The Journal of Psychology, 139*, 439–457.
- Mizerski, R. W. (1982). An attribution explanation of the disproportionate influence of unfavorable information. *Journal of Consumer Research, 9*, 301–310.
- Ogan-Bekiroglu, F. & Aydeniz, M. (2013). Enhancing pre-service physics teachers' perceived self-efficacy of argumentation-based pedagogy through modelling and mastery experiences. *Eurasia Journal of Mathematics, Science & Technology Education, 9*, 233–245.
- Peters, M. L. (2013). Examining the relationships among classroom climate, self-efficacy, and achievement in undergraduate mathematics: A multi-level analysis. *International Journal of Science and Mathematics Education, 11*, 459–480.
- Phan, H. P. (2012). Relations between informational sources, self-efficacy and academic achievement: A developmental approach. *Educational Psychology, 32*, 81–105.
- Ponton, M. K. (2002). Motivating students by building self-efficacy. *Journal of Professional Issues in Engineering Education & Practice, 128*, 54–57.

- Saçkes, M., Trundle, K. C., Tuckman, B. W., & Krissek, L. A. (2012). Development of the efficacy beliefs for conceptual change learning questionnaire. *Journal of Experimental Education*, 80, 338–351.
- Sancar-Tokmak, H. (2013). Effects of video-supported expertise-based training (XBT) on preservice science teachers' self-efficacy beliefs. *Eurasia Journal of Mathematics, Science & Technology Education*, 9, 131–141.
- Thomas, G., Anderson, D., & Nashon, S. (2008). Development of an instrument designed to investigate elements of science students' metacognition, self-efficacy and learning processes: The SEMLI-S. *International Journal of Science Education*, 30, 1701–1724.
- Tsai, C.-C., Ho, H. J., Liang, J.-C., & Lin, H.-M. (2011). Scientific epistemic beliefs, conceptions of learning science and self-efficacy of learning science among high school students. *Learning and Instruction*, 21, 757–769.
- Tuan, H. L., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education*, 27, 639–654.
- van Dinther, M., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. *Educational Research Review*, 6, 95–108.
- Velayutham, S., Aldridge, J., & Fraser, B. (2011). Development and validation of an instrument to measure students' motivation and self-regulation in science learning. *International Journal of Science Education*, 33, 2159–2179.
- Velayutham, S., Aldridge, J., & Fraser, B. (2013). Gender differences in student motivation and self-regulation in science learning: A multi-group structural equation modeling analysis. *International Journal of Science and Mathematics Education*, 10, 1347–1368.
- Wang, M. N. M., Wu, K. C., & Huang, T. C. I. (2007). A study on the factors affecting biological concept learning of junior high school students. *International Journal of Science Education*, 29, 453–464.
- Williams, T., Clarke, V., & Borland, R. (2001). Effects of message framing on breast-cancer-related beliefs and behaviors: The role of mediating factors. *Journal of Applied Social Psychology*, 31, 925–950.
- Wilson, D. K., Wallston, K. A., & King, J. E. (1990). Effects of contract framing, motivation to quit, and self-efficacy on smoking reduction. *Journal of Applied Social Psychology*, 20, 531–547.
- Wood, R., & Bandura, A. (1989). Impact of conceptions of ability on self-regulatory mechanisms and complex decision making. *Journal of Personality and Social Psychology*, 56, 407–415.

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