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Understanding of the Relationship Between Interest and Expectancy for Success in Engineering Design Activity in Grades 9–12

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ABSTRACT

In this study, the relationship between students' interest in engineering design activities and their expectancy for success in grades 9–12 was evaluated. The theoretical frameworks developed by Eccles and colleagues (i.e., expectancy value) and Butler and Cartier (i.e., what the students bring to contexts under a self-regulated learning framework) were used to frame the relationship between students' interest and expectancy for success. Specifically, this study extends the value part with interest by using psychological constructs of the Motivated Strategies for Learning Questionnaire (MSLQ). Three psychological constructs were used to evaluate students' interest: intrinsic goal orientation (IGO), extrinsic goal orientation (EGO), and task value (TV). Two other psychological constructs were used to evaluate students' expectancy for success in completing the design tasks: control of learning beliefs (CLB) and self-efficacy for learning and performance (SELP). A total of 113 students participated in the study. These students participated in five schools (in three states) that implement the Project Lead the Way curriculum. After finishing their design project, each student was asked to complete a modified version of the MSLQ survey instrument that evaluated the five aforementioned constructs. From a statistical test, it was found that there was a significant relationship between students' interest in the engineering design tasks and their expectancy for success. Further statistical tests also indicated significant relationships between each construct of the interest and expectancy components. From a regression test, it was found that students' intrinsic goal orientation and task value were significant predictors, each contributing about 55 and 34 percent, respectively, to students' expectancy for success.

Keywords

Interest, Expectancy for success, Motivation, Engineering design

Introduction

It has been suggested by the Committee on K–12 Engineering Education (Katehi, Pearson, & Feder, 2009) that K–12 engineering education should emphasize engineering design. Everett, Imbrie, and Morgan (2000) noted that through the engineering design process "students not only know the mathematics and science but also actually understand why they need to know it" (p. 171). Thus, engineering design allows students to apply and integrate concepts and principles learned in other subjects in a more meaningful learning experience. Inasmuch as engineering design activities are promoted and predominant in most K–12 curricular and professional development programs, understanding the dynamics of students' motivation in engineering design activities is critical. One common challenge facing engineering and technology educators is how to introduce and teach engineering design in a manner that would interest their students. This challenge involves cognitive and motivational aspects that impact students' learning.

The human brain engages a wide range of cognitive processes to solve an ill-structured problem such as an engineering design task. It is well known that cognitive and motivational issues such as skill and will are interwoven (Corno & Mandinach, 1983). Studies have also suggested that motivation plays an essential factor in students' learning accomplishments (Bong, 2001; Chemers, Hu, & Garcia, 2001; Chowdhury & Shahabuddin, 2007; Gore, 2006; Multon, Brown, & Lent, 1991; Zajacova, Lynch, & Espenshade, 2005). The objective of this study is to focus on the motivational aspects used by students in working on an engineering design task.

Numerous researchers have posited a variety of motivational constructs to explain how they affect achievement performance and choice. One is the expectancy-value model of achievement motivation (Eccles, Adler, & Meece, 1984; Eccles et al., 1983; Wigfield, 1994; Wigfield & Eccles, 1992, 2000). In it, the expectancies for success and ability beliefs, and task value are the major constructs studied by the researchers. Despite a number of studies that suggested the relationship between students' motivation and learning performance, few studies have evaluated how the interest components of students' motivation relate to their expectancy for learning success. Frick (1992) argued that interest influences “what people attend to, think about, discuss and learn more about” (p. 113). Understanding the connection between how students’ interest in engaging in an engineering design task and their expectancy to successfully complete the task should not only positively contribute to the knowledge building, but may also help inform engineering- and technology-related educators in grades 9–12.

The term *expectancy for success* in this study is defined as one of the motivational components that leads an individual to believe that he or she has the potential to successfully accomplish a task. This definition includes one’s ability (i.e., self-efficacy), confidence (i.e., self-confidence), and control of his or her effort (i.e., control of learning beliefs) to accomplish a task (Schunk, 1991; Shields, 1991; Wigfield & Eccles; 1992, Wigfield, 1994; Yong, 2010). The *interest* in engaging in a task, on the other hand, is the motivational component that includes intrinsic and extrinsic goal orientations that lead an individual to participate in a task and also his or her evaluation of how interesting, important, and useful the task is (i.e., task value) (Geiger & Cooper, 1995).

This study was conducted to answer two research questions:

1) While students were engaged in an engineering design task, was there any significant correlation between the following?
   a) interest in the engineering design task and their expectancy for success
   b) intrinsic goal orientation and control of learning beliefs
   c) intrinsic goal orientation and self-efficacy for learning and performance
   d) extrinsic goal orientation and control of learning beliefs
   e) extrinsic goal orientation and self-efficacy for learning and performance
   f) task value and control of learning beliefs
   g) task value and self-efficacy for learning and performance
2) What is the relative importance of contribution of those interest components toward students’ expectancy for success?

Relevant literature

Numerous studies have revealed the relationship between expectancy value and academic achievement (Atkinson, 1957; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Eccles et al., 1983; Liew, McTigue, Barrois, & Hughes, 2008; Wigfield & Eccles, 1992; Wigfield, 1994). The relationship between students’ expectancy for success and learning performance or achievement was also reported in a study conducted by Geiger & Cooper (1995). Similar findings also confirmed that the students who had a high expectancy for success would achieve success, while those who did not often failed in their tasks (Stephan, Bernstein, Stephan, & Davis, 1979). In these studies, students’ expectancy for success was assessed by the students, and their academic achievement was evaluated by their teachers. The way the students and teachers evaluated success may be different.

In one study, Cartier (2002) argued that what occurs in an individual’s learning is also influenced by what he or she brings to each particular context. Strength, challenge, preference, and interest are important components of learning (Butler & Cartier, 2005). It is important to investigate if students’ interest to engage in a task leads to their expectancy for success. In this study, Pintrich, Smith, Garcia, and McKeachie’s (1991) motivational model was used. Students’ interest was viewed from motivational constructs that include intrinsic goal orientation (IGO), extrinsic goal orientation (EGO), and task value. Expectancy for success components includes self-efficacy for learning and performance (SELP) and control of learning beliefs (CLB). Because interest and expectancy for success are both viewed from the students’ perspectives, the results of this study offer potential for the improvement of engineering and technology education in grades 9–12.

Goal orientation

Goal orientation in this case refers to the beliefs that induce one to approach, engage in, and respond to tasks in different ways (Ames, 1992). There are two general categories of goal orientation: mastery, where students focus on learning and mastering the material, and performance, where students demonstrate their abilities and performance compared to others (Wolters, Yu, & Pintrich, 1996). In general, mastery goal orientation is associated with an inclination for challenging tasks, an intrinsic interest in learning itself, and positive motivational beliefs such as high self-efficacy. On the other hand, performance goal orientation is usually associated with seeking extrinsic rewards, such as grades and evaluation by others, rather than an intrinsic interest in learning (Ames, 1992; Dweck & Leggett, 1988).

Performance goal orientation can be further divided into performance-approach, where students strive to achieve a goal and demonstrate their abilities, and performance-avoidance, where students' major concern is avoiding failure and hiding their lack of abilities (Elliot, 1999). According to Yang, Tsai, Kim, Cho, and Laffey (2006), goal orientation can be subcategorized as intrinsic and extrinsic. Intrinsic goal orientation (IGO) involves the extent to which students perceive themselves as engaging in a task for reasons such as challenge, curiosity, and mastery. Extrinsic goal orientation (EGO) deals with the degree to which students perceive themselves as engaging in a task for reasons such as grades, rewards, performance, evaluation by others, and competition (Pintrich et al., 1991). Students with intrinsic goals are inclined to exert more effort and are more likely to persistent with difficult tasks than those with extrinsic goals (Ames & Archer, 1988; Merritte, 1999; Nicholls, 1984; Pintrich & Schunk, 2002). Although there are some differences in the literature about the categories of goal orientation, on the basis of the literature review and definitions above, we consider that mastery goal orientation is analogous to intrinsic goal orientation in that the two share some common constructs. To some degree, performance goal orientation is similar to extrinsic goal orientation.

Task value

Task value refers to a student's perception of the extent to which the task is interesting, important, and useful. That is, what do students think of a certain task in terms of interest, importance, and utility? According to Wolters et al. (1996), mastery goal orientation is a positive predictor of task value and promotes adaptive motivational beliefs such as higher task value and self-efficacy. Also, task value is often positively related to self-efficacy. Both have been well documented as effective predictors of academic outcomes (Bong, 2004; Multon, Brown, & Lent, 1991). Students' understanding about task is a key determinant of goal settings, strategy selection, and criteria used to self-assess outcomes (Butler & Cartier, 2005). The findings of Yang et al. (2006) suggested that students with high task value were more likely to improve their learning and performance by social interaction with peers.

Self-efficacy for learning and performance

Self-efficacy refers to judgments about one's abilities to succeed in a given task (Bandura, 1997). It applies to a variety of contexts and is a good predictor of performance and behavior (Bandura, 1978, Gist & Mitchell, 1992). Numerous studies (e.g., Bandura & Schunk, 1981; Brown & Inouyne, 1978; Schunk, 1981; Weinberg, Gould, & Jackson, 1979) have suggested that strong self-efficacy is more likely to stimulate the exertion of greater effort to overcome a challenge, while weak self-efficacy tends to reduce one's efforts or even cause a person to quit (Chowdhury & Shahabuddin, 2007). Self-efficacy influences how much effort is exerted, persistence when confronted with difficulties, and resilience to failures (Chowdhury & Shahabuddin, 2007).

Control of learning beliefs

Control of learning involves students' beliefs that learning depends on their endeavors rather than external causes, such as the teacher. In this sense, if students believe that their efforts have a positive influence on their learning, they will be more likely to engage in learning activities strategically and effectively. According to Sungur (2007), a significantly positive correlation was found among control of learning beliefs, self-efficacy for learning and performance, task value, and intrinsic goal orientation.

Method

Participants

One hundred twenty-three students from five high schools in three different states in the U.S. participated in the study, and 113 students completed valid questionnaires. These schools implement a Project Lead the Way (PLTW) curriculum, which supplies middle- and high-school students with hands-on, rigorous, and preliminary courses involved in engineering or biomedical sciences. The reason we chose schools that implement a PLTW curriculum is twofold. First, student participants from those five schools would work on the same projects that have identical requirements and level of difficulty. Second, the teachers who deliver the classes across those five schools have received the same training on engineering design activities of PLTW. As a consequence, we assumed that the variation of student motivation due to instruction could be minimized because of similar instruction for selected engineering design activities and because results of the study on students' motivation when engaging in different engineering design activities are comparable.

These students participated in a Principles of Engineering class that required them to explore technology systems and manufacturing processes, and address the social and political consequences of technological change through a combination of activity-, project-, and problem-based learning. These students were required to engage in several engineering design activities (e.g., marble-sorter design or bridge design).

Measures

This study utilized a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ) survey instrument. The MSLQ is a self-reporting instrument developed by Pintrich et al. (1991) to assess college students' motivational orientations and their use of different learning strategies for a college course. Although the MSLQ was designed for a college course, the researchers chose this instrument for three reasons: (1) This is the only instrument available that measures motivation with the interest and expectancy components; (2) This instrument has been widely used in educational research in college and lower-level education courses; (3) Because the course in which the study participants enrolled (i.e., Principles of Engineering) is college credit equivalent, it was expected that statements in this survey would be understood by sophomore and junior high-school students.

The modification of the instrument was made by rewording words associated with learning in an engineering design activity. The intention was to help students focus on their design project as the context of each statement in the survey. The wording became an essential factor in modifying the instruments because students typically distinguish between their capabilities for dealing with two or more characteristically different topics or problems within the same measurement specificity (Bong, 1999). Two open-ended questions were added in the instrument to provide additional information about the most and least motivating factors.

Validation of the MSLQ and the subscale correlations with final grades were significant, demonstrating predictive validity. Confirmatory factor analysis tested how closely the input correlations could be reproduced, given the constraints that specific items fall on. For example, we had six items that were assumed to be indicators of the task value construct. The confirmatory factor analysis tested how closely the input correlations could be reproduced, given that those items fall onto one specific factor (i.e., task value). All of the 26 motivation items were tested to see how well they fit the latent factors. The Cronbach's alpha coefficients were robust, ranging from .68 to .93 (Pintrich, Smith, Garcia, & McKeachie, 1993).

Only the motivational scales of the MSLQ (i.e., 26 items) were used in this study. The examples of motivational scale items are shown in Table 1. The motivational scales included five components. First, the instrument comprises statements that measure students' perceptions of why they are engaging in the learning task (i.e., items 1, 16, 22, and 24), an IGO (α = 0.74). Second, statements measure the degree to which students perceive themselves to be participating in the task for extrinsic reasons (i.e., items 7, 11, 13, and 30), an EGO (α = 0.62). Third, statements measure students' perception of how important, useful, and interesting the task is (i.e., items 4, 10, 17, 23, 26, and 27), a TV (α = 0.90). Fourth, statements are present that measure the students' beliefs that their efforts to learn will result in positive outcomes (i.e., items 2, 9, 18, and 25), a CLB (α = 0.68). Fifth, statements are present that measure each student's expectation to perform the task well and to be self-efficient (i.e., items 5, 6, 12, 15, 20, 21, 29, and 31), a SELP (α = 0.93). Students rated themselves on a seven-point Likert scale, from "not at all true of me" (a score of 1) to "very true of me," (a score of 7).

Data collection and analysis

Immediately after completing the design project, students were asked to complete the survey instrument. This was done to ensure that students had a good recollection of their design experiences. The mean and standard deviation of students' interest, expectancy for success, IGO, EGO, TV, CLB, and SELP were calculated. Pearson correlation tests were conducted to find any correlation between the interest and the expectancy for success components. Similar correlation tests were also conducted to evaluate any correlation between each component of the interest and expectancy for success. These correlation tests were conducted to answer research question 1. A simple regression test was used to evaluate the relative importance of contribution of those interest components toward students' expectancy for success (to answer research question 2). Because some questions in the survey instrument were provided in open-ended format, common themes were categorized into the five motivational constructs to help us further understand students' motivation qualitatively. Two research assistants helped the researcher categorize students' responses. Any disagreement in categorization was reviewed and discussed to achieve consensus.

Table 1. Examples of motivational scale items

Motivational scale	Statement
Intrinsic goal orientation	In a class like this, I prefer course material that really challenges me so I can learn new things.
	In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.
Extrinsic goal orientation	Getting a good grade in this class is the most satisfying thing for me right now.
	The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.
Task value	I think I will be able to use what I learn in this course in other courses.
	It is important for me to learn the course material in this class.
Control of learning beliefs	If I study in appropriate ways, then I will be able to learn the material in this course.
	It is my own fault if I don't learn the material in this course.
Self-efficacy for learning and performance	I believe I will receive an excellent grade in this class.
	I'm certain I can understand the most difficult material presented in the readings for this course.

Results

A. Descriptive statistics of students' motivation

The descriptive statistics show the mean of students' interest, expectancy for success, and other motivational aspects (Table 2). A negatively skewed distribution was indicated for all the constructs. Among other motivational constructs, SELP had the highest mean.

Table 2. Descriptive statistics of students' motivation (N = 113)

	Mean	*SD*
Interest	5.34	1.04
Expectancy for success	5.46	1.15
IGO	5.15	1.29
TV	5.37	1.34
SELP	5.54	1.29
EGO	5.50	1.12
CLB	5.39	1.19

Note. *SD* = standard deviation.

B. Correlations between interest and expectancy components

Correlation tests need to be conducted to answer research question 1. As mentioned before, three psychological constructs, IGO, EGO, and TV, will be correlated with the other two psychological constructs, CLB and SELP. Pearson correlation tests indicated a significant correlation between students' (see Figure 1 and Tables 3 and 4):

1) interest in the design task (Interest) and expectancy for success (Expectancy for Success)
2) self-efficacy for learning performance (SELP) and intrinsic goal orientation (IGO)
3) self-efficacy for learning performance (SELP) and task value (TV)

4) self-efficacy for learning performance (SELP) and extrinsic goal orientation (EGO)
5) control of learning beliefs (CLB) and intrinsic goal orientation (IGO)
6) control of learning beliefs (CLB) and task value (TV)
7) control of learning beliefs (CLB) and extrinsic goal orientation (EGO)

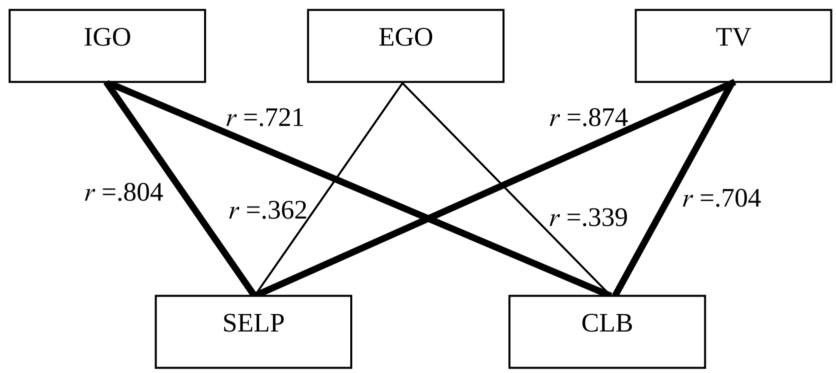

Figure 1. Correlation among interest and expectancy for success components.

Because the data were collected from two pools of students working on two different design tasks (i.e., bridge and marble-sorter designs), further correlation tests were conducted. The objective was to evaluate if similar significant correlations also existed in students working on the same design task. From the statistical tests, significant correlations also existed between students' interest in the design task and their expectancy for success. From the correlation tests, it was found that the correlation coefficient (*r*) between IGO and SELP, IGO and CLB, TV and SELP, and TV and CLB were much higher than between EGO and SELP and between EGO and CLB.

Table 3. Correlation between interest and expectancy for success

		Expectancy for success
Interest	Pearson Correlation	.838**
	Sig. (two-tailed)	.000
	N	113

Note: ** Correlation is significant at the 0.01 level (two-tailed).

Table 4. Correlations among motivational constructs

		IGO	TV	EGO
SELP	Pearson Correlation	.804**	.874**	.362**
	Sig. (two-tailed)	.000	.000	.000
	N	113	113	113
CLB	Pearson Correlation	.721**	.704**	.339**
	Sig. (two-tailed)	.000	.000	.000
	N	113	113	113

Note: ** Correlation is significant at the 0.01 level (two-tailed).

C. The importance of the interest components in students' expectancy for success

A simple regression test was conducted to determine the relative importance of the contribution of IGO, EGO, and TV towards students' expectancy for success. The results revealed that TV (β = .547, p = .000) and IGO (β = .339, p = .000) were highly significant predictors of students' expectancy for success; EGO was not a significant predictor of SELP (β = .050, p = .327). The three interest-related constructs constituted about 76 percent of students' expectancy for success (indicated by the adjusted R^2 value of .758). From the results, it may be inferred that the motivational constructs that measure students' interest (i.e., IGO, EGO, and TV) account for 75.8 percent of the variation in students' expectancy for success. In fact, there are other factors that might contribute to expectancy for success, such as student's anxiety and maladaptive behavior, which may include tardiness and unrealistic aspirations.

D. Common themes of students' motivation

Of the 113 students, a total of 104 responded to the two open-ended questions in the survey instrument. Students were asked to share their thoughts about the most and least motivating factors they experienced during their design activities. Common themes were categorized according to the five motivational constructs used in this study (i.e., EGO, IGO, TV, SELP, and CLB; see Tables 5 and 6). No relevant theme was found for control of learning beliefs.

From the collected themes, it is clear that some themes were perceived as both most and least motivating factors. For instance, a task that was challenging was perceived as the most motivating factor for some students, while it was perceived as the least motivating for others. Similarly, for the time allotted to complete the design task, limited supporting materials available for students to use during design process was perceived differently.

The most motivating themes illustrated how the students responded positively to hands-on experience, task challenge, time challenge, and mastery. Students were also motivated because of their successful performance in solving the design task and interest in the design task itself. The least motivating themes showed that some students were concerned with failure or poor performance, task challenge, and lack of interest. It is clear the students were aware of how the design task was presented to them and how they related the task to their abilities. Difficult or complex design tasks tended to decrease their overall motivation. In other words, unmanageable design tasks may lead students to failure or poor performance.

Table 5. Most motivating common themes

Interest	IGO	Hands-on experience, mastery, task challenge, time challenge, plenty of time available
	EGO	Successful performance, getting a good grade, comparison and competition, good teamwork, evaluation by others, teacher assistance, supporting materials
	TV	Interest in the content or project
Expectancy for success	CLB	(no relevant theme was found)
	SELP	Ability to master, self-confidence to perform

Table 6. Least motivating common themes

Interest	IGO	Task challenge, time challenge, administrative challenge, lack of challenge
	EGO	Supporting materials, failure or poor performance, bad teamwork, lack of instruction and teacher assistance, getting an unsatisfactory grade, competition
	TV	Lack of interest, lack of opportunity to engage in similar project
Expectancy for success	CLB	(no relevant theme was found)
	SELP	Lack of ability to master, lack of self-confidence to perform

Conclusion

The significant correlations between all the three interest constructs (IGO, EGO, and TV) and the two expectancy constructs (CLB and SELP) clearly indicated a strong relationship between students' interest in design activities and their expectancy for success in completing the design task. These findings conform to modern expectancy-value theories, which suggest that expectancies and values are positively and not inversely related (Eccles & Wigfield, 2002). Strong correlation coefficients between IGO and SELP (r = .804, p = .000), IGO and CLB (r = .721, p = .000), TV and CLB (r = .704, p = .000), and between TV and SELP (r = .874, p = .000) imply a more dominant role of intrinsic and task value in the increase of students' expectancy for success. The results conform to high beta values for IGO (β = .339, p = .000) and TV (β = .547, p = .000) in the regression test results. This suggests that students with high self-belief in their effectiveness or confidence are more likely to believe they will perform better in design tasks.

From the expectancy-value model (Eccles & Wigfield, 2002), it is suggested that both expectancies and values lead to performance, persistence, and choice. Students who have low self-perceptions of ability to succeed and control, do not perceive a task to be important, useful, or interesting (low perceptions of task value), may seek to avoid a task rather than to invest effort in completing it. According to Schunk (1991), when students see themselves as effective learners, they are more highly motivated, work harder on learning tasks, expend more effort, and display more self-regulatory behaviors. The level of self-efficacy, therefore, may be related to students' intrinsic motivation to persist in carrying out a learning task and thereby affects their ability to develop problem-solving skills. One's expectancy for success may also influence the development of task values.

Discussions

The results of this study may have implications in engineering and technology education in grades 9–12. First, in relation to the significant correlation between students' interest in the design task and expectancy for success, students' interest in engaging in the design tasks should be positive. A study conducted by Durik and Harackiewicz (2007) suggested that TV plays an important role in students' interest development. Efforts that promote students' understanding about the usefulness, interest, and importance of solving the design task are necessary. A teaching approach that emphasizes how a design solution can be used in real-life applications may positively contribute to the increase of students' task value and interest development. For example, control systems designed by the students in the marble-sorter design project may be used in the detecting system in industry. The level of difficulty and complexity of the task also must be carefully considered before the task is given to the students. Teachers may want to present their students with a design task that is challenging but within their reach. When students perceive the design task to be beyond their abilities, they may become discouraged, which may, in turn, lower their intrinsic motivation.

Second, the 76 percent contribution of IGO and TV toward students' expectancy for success also indicated other factors that played roles in developing students' expectation to successfully complete their design tasks. EGO does not seem to be a good predictor for students' expectancy for success. Smaller correlation coefficients between EGO and SELP (r = .362, p = .000) and between EGO and CLB (r = .339, p = .000) conforms to insignificant standardized beta coefficient in the regression test (β = .050, p = .327). Those other factors may be associated with the way the instruction of the design courses was presented. Moreover, in addition to students' appraisal of challenge and task absorption, issues that relate to students' self-determination and a feeling of autonomy are also essential elements in intrinsic motivation (Butler, 1987). When students are allowed to make decisions, their interest in learning is likely to increase. When student evaluation is based upon self-referenced information, students develop learning goals. However, when evaluation information is based on normative standards and social comparison (i.e., EGO), students will be more likely to focus on performance goals (Song, 2004), which may increase evaluative pressure and, in turn, may work against intrinsic motivation (Deci & Ryan, 1980). Whenever necessary, teachers may want to carefully exercise extrinsic motivational strategies to increase students' expectancy for success in a design challenge. Contrary to many studies that found intrinsic and extrinsic motivations to be positively correlated, some studies found otherwise (Wolters, Yu, & Pintrich, 1996).

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References

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261–271.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*(3), 260–267.

Atkinson, J. W. (1957). Motivational determinants of risk taking behavior. *Psychological Review*, *64*, 359–372.

Bandura, A. (1978). Reflections on self-efficacy. *Advances in Behavioural Research and Therapy*, *1*(4), 237–269.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W. H. Freeman & Company.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (1996). Multifaceted impact of self-efficacy beliefs on academic functioning. *Child Development, 67*(3), 1206–1222.

Bandura, A., & Schunk, D. H. (1981). Cultivating confidence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality & Social Psychology*, *41*(3), 586–598.

Bong, M. (1999, August). *Comparison between domain-, task-, and problem-specific academic self-efficacy judgments: Their generality and predictive utility for immediate and delayed academic performances*. Paper presented at the annual convention of the American Psychological Association, Boston, MA.

Bong, M. (2001). Role of self-efficacy and task-value in predicting college students' course performance and future enrollment intentions. *Contemporary Educational Psychology, 26,* 553–570.

Bong, M. (2004). Academic motivation in self-efficacy, task value, achievement goal orientations, and attributional beliefs. *The Journal of Educational Research*, *97*(6), 287-297.

Brown Jr., I. & Inouyne, D. K. (1978). Learned helplessness through modeling: The role of perceived similarity in competence. *Journal of Personality and Social Psychology*, *36*(8), 900-908.

Butler, D. L., & Cartier, S. C. (2005, April). *Multiple complementary methods for understanding self-regulated learning as situated in context*. Paper presented at the annual meetings of the American Educational Research Association, Montreal, QUC, Canada.

Cartier, S. (2002). Étude de l'apprentissage par la lecture d'étudiants en contexte d'apprentissage par problems (APP) (A study of student text-learning strategy). *Canadian Journal of Higher Education*, *32*(1), 1–29.

Chemers, M. M., Hu, L., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational Psychology, 93,* 55–64.

Chowdhury, M., & Shahabuddin, A. (2007). Self-efficacy, motivation and their relationship to academic performance of Bangladesh college students. *College Quarterly*, *10*(1), 1–9.

Corno, L., & Mandinach, E. (1983). The role of cognitive engagement in classroom learning and motivation. *Educational Psychologist*, *18*, 88–100.

Deci, E. L., & Ryan, R. M. (1980). The empirical exploration of intrinsic motivation processes. In L. Berkowitz (Ed.) *Advances in Experimental Social Psychology* (Vol. 13, pp. 39–80). New York: Academic Press.

Durik, A. M., & Harackiewicz, J. M. (2007). Different strokes for different folks: How personal interest moderates the effects of situational factors on task interest. *Journal of Educational Psychology*, *99*, 597–610.

Dweck, C., & Leggett, E. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95,* 256–273.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., & Midgley, C. (1983). Expectancies, values and academic behaviours. In J. T. Spence (ed.), *Achievement and Achievement Motives* (pp. 75–146). San Francisco: W. H. Freeman.

Eccles, J. S., Adler, T. F., & Meece, J. L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology*, *46*(1), 26–43.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109–32.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34,* 169–189.

Everett, L. J., Imbrie, P. K., & Morgan, J. (2000). Integrated curricula: Purpose and design. *Journal of Engineering Education*, *89*(2), 167–175.

Frick, R. W. (1992). Interestingness. *British Journal of Psychology*, *83*, 113–128.

Geiger, M. A., & Cooper, E. A. (1995). Predicting academic performance: The impact of expectancy and needs theory. *The Journal of Experimental Education*, *63*(3), 251–262.

Gist, M. E., & Mitchell, T (1992). Self-efficacy: A theoretical analysis of its determinants and malleability. *Academy of Management Review*, *17*(2), 183–211.

Gore, P. A. (2006). Academic self-efficacy as a predictor of college outcomes: Two incremental validity studies. *Journal of Career Assessment, 14,* 92–115.

Katehi, L., Pearson, G., & Feder, M. (2009). *Engineering in K–12 education: Understanding the status and improving the prospects.* Washington, DC: National Academy of Engineering and National Research Council of the National Academies.

Liew, J., McTigue, E. M., Barrois, L., & Hughes, J. N. (2008). Adaptive and effortful control and academic self-efficacy beliefs on literacy and math achievement: A longitudinal study on 1st through 3rd graders. *Early Childhood Research Quarterly, 23*(4), 515–526.

Merritte, K. K. (1999). A domain-specific investigation of goal orientation, related cognitive and behavioral variables, and prediction model for academic achievement. *Dissertation Abstracts International, 60*(10), 5243B.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of selfefficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*, 30–38.

Nicholls, J. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*, 328–346.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ).* (ERIC Document Reproduction Service No. ED338122).

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*, 801–813.

Schunk, D.H. (1981). Modeling and attribution effects on children's achievement: A self-efficacy analysis. *Journal of Educational Psychology*, *73*(1), 93–105.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Education Psychologist, 26*(3 & 4), 207–231.

Shields, C. (1991). Girls, math, and the glass ceiling. *Curriculum Review, 30*(6), 8–12.

Song, H. (2004). Motivating online collaborative learning: Design implications from a learning-goal orientation perspective. *Educational Technology*, *44*(2), 43–47.

Stephan, W. G., Bernstein, W. M., Stephan, C., & Davis, M. H. (1979). Attributions for Achievement: Egotism vs. Expectancy Confirmation. *Social Psychology Quarterly*, *42*(1), 5–17.

Sungur, S. (2007). Modeling the relationships among students' motivational beliefs, metacognitive strategy use, and effort regulation. *Scandinavian Journal of Educational Research, 51*(3), 315–326.

Weinberg, R. S., Gould, D., & Jackson, A. (1979). Expectations and performance: An empirical test of Bandura's self-efficacy theory. *Journal of Sport Psychology*, *1*(4), 320–331.

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review*, *6*(1), 49–78.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review*, *12*, 265–310.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68–81.

Wolters, C. A., Yu, S., & Pintrich. P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences, 8*(3), 211–238.

Yang, C., Tsai, I., Kim, B., Cho, M., & Laffey, J. (2006). Exploring the relationships between students' academic motivation and social ability in online learning environments. *Internet and Higher Education, 9*(4), 277–286.

Yong, F. L. (2010). A study on the self-efficacy and expectancy for success of pre-university students. *European Journal of Social Sciences, 13*(4), 514–524.

Zajacova, A., Lynch, S. M., & Espenshade, T. J. (2005). Self-efficacy, stress, and academic success in college. *Research in Higher Education, 46,* 677–706.