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Gypsy Denzine, Northern Arizona University

Five Misconceptions about Engineering Students' Motivation that Affect the Teaching and Learning Process

Gypsy M. Denzine, Ph.D.
College of Education
Northern Arizona University

INTRODUCTION

The engineering education literature cites findings revealing that approximately fifty percent of students who enter engineering programs as traditional freshman do not earn an undergraduate engineering degree[1]. In response to this retention problem, engineering educational researchers have applied a wide variety of theoretical perspectives to the study of college student learning and college teaching. Some researchers look for more external factors such as lack of financial aid[2,3], while other researcher focus on lack of academic preparation or ability[3,4] such as failure or withdraw from Calculus I and other "gatekeeper" courses in the freshman year[5]. Over the last two decades, an increasingly number of engineering education researchers have begun to explore internal cognitive factors that may affect college student learning, achievement, and degree completion. Perhaps sparked by Felder and Silverman's[6,7] 1988 seminal paper on the definitions of learning styles, engineering education researchers are attending to the understanding of individual differences in college student learning and achievement. In doing so, this group of researchers appear to be eager to apply theories of learning and development to the study of college student retention, academic success, and career choice. For example, in their 2004 paper, Hartman and Branoff[8] applied Vygotsky's socio-cultural-historical, Bandura's social-cognitive theory, and Human Information-Processing theory to the instruction of constraint-based solid modeling and other engineering graphics topics. In contrast to Hartman and Branoff's application of "grand" theories of learning, a substantial number of engineering education researchers are focusing on the topic of achievement motivation[2,9-13.]

A quick scan of the topics of papers presented over the past five years at ASEE reveals there is indeed a strong interest in achievement motivation[9-13]. A review of these papers from the viewpoint of an educational psychologist, however, suggests there is a need to clarify and expand the current engineering education theoretical knowledge base in regards to learning theory and more specifically, college student achievement motivation. In response to this need, this paper is organized around five common misconceptions about college student motivation held by many educators and researchers in higher education. The misconceptions discussed in this paper are not unique to faculty members in Colleges of Engineering. In fact, some of the misconceptions and controversies about college student learning and motivation are present among faculty members in Colleges of Education. The primary goal of this paper is to challenge some of the misconceptions about college student learning, recommend some teaching strategies and interventions, and provide engineering education researchers with some key references from the field of educational psychology.

FIVE MISCONCEPTIONS ABOUT ENGINEERING STUDENTS' MOTIVATION

Misconception #1. Learning and motivation are influenced by students' learning styles.

The higher education literature has an abundance of learning style models and frameworks, which have overlapping theoretical assumptions. One of the theoretical assumptions is that students will bring their unique style to a wide variety of tasks regardless of their prior knowledge or value for the task. Another assumption is that students' learning styles are relatively permanent across time. Two of the more well known learning style perspectives are *the visual/verbal/tactile* theories[14-16] and the controversial *hemispheric specialization perspectives* (i.e., "right-brained" or "left-brained").

Within the engineering education literature, Felder and Silverman's model seems to be the prevailing learning styles perspective. Based on the work of Jung, Kolb, and Myers-Briggs, they posit several binary factors corresponding to how students learn and process information. More specifically, they claim students can be identified by the following dimensions: sensory vs. intuitive, visual vs. verbal, active vs. reflective, and sequential vs. global. Felder and Silverman purport knowing a student's learning style can help understand why the student may be inattentive in class, perform poorly on tests, and become discouraged when faced with a challenge or failure, and other various problems that serve as a barrier to academic success. Since its inception, Felder and Silverman's model has been adopted by many engineering education faculty members and researchers (see the University of Michigan College of Education website for a review). A recent criticism of Felder and Silverman's learning style model was articulated by Roberta Harvey[17] in her 2004 ASEE paper. Harvey criticizes Felder and Silverman's model on theoretical grounds (e.g., the role of affect is not developed or explained) and also raised concerns about the use of Felder's instrument (Index of Learning Style), which she claimed is limited because the results can only be used to identify tendencies. Instead, Harvey recommends the use of the Interactive Learning Model (ILM), which she claims is more comprehensive, flexible, and has greater explanatory power than Felder's model. The ILM is a descriptive model based on three domains: affective, conative, and cognitive. The affective domain refers to how student feel, including their values and self-efficacy beliefs. The conative domain describes students' actions, the pace of their learning, and their desired degree of autonomy. The cognitive domain refers to what students think and understand, including their multiple intelligences and prior experiences. These dimensions are used to describe students' experiences through four patterns of mental processes, as assessed by the Learning Connections Inventory (previously titled the Learning Combination Inventory), which was developed by Christine Johnson and Gary Dainton[18] of Let Me Learn™ and the Rowan University Center for the Advancement of Learning. The four learning patterns (sequence, precision, technical, and confluence) are assumed to be present in all learners, however, individual learners have preferred learning patterns and they may actively avoid other patterns. Although Harvey raises several concerns about the theoretical and empirical validity of Felder's learning style model, the patterns representing the ILM model are equivalent in terms of the theoretical assumptions. Similar to learning styles models, ILM learning patterns assume we can adequately and reliably measure various typologies of learning which are considered to be relatively stable across time and task.

While the learning styles research may be popular in engineering education research[19-23], numerous educational researchers (mostly from the field of educational psychology) are quick to criticize the learning styles movement and have challenged the very existence of learning styles or learning patterns for both theoretical and empirical reasons[24-37]. First, the validity of some of the learning styles research has been strongly questioned. Second, O'Neil[24] notes there is a heated debate today about whether identifying ethnic-group differences in learning styles and preferences is a dangerous, racist, sexist exercise. In our society we are quick to move from the notion of "difference" to the idea of "deficit."

According to Stahl[28], “The reason researchers roll their eyes at learning styles research is the utter failure to find that assessing children’s learning styles and matching to instructional methods has any effect on their learning” (Stahl, 2002, p. 99). Criticisms of leaning styles research are not limited to understanding the cognitive processes of children. Patricia King[37], a well known theorist (co-creator of the Reflective Judgment Model) and researcher on college student development has written the following about learning styles models and research:

> “this stance has the advantage of affirming individuals “where they are” and showing respect for individual differences. This focus on appreciating differences and making nonevaluative judgments is appealing to faculty and staff alike, in part because giving feedback to students about their approach is correspondingly descriptive rather than judgmental, which helps create a more inviting and affirming type of contact with students. The nonjudgemental approach creates difficulties, however, when the student faces problems for which his or her preferred approach is not effective. ..... While this group of learning models uses contrasting styles to point out differences, it is important for educators to note that these styles are frequently the extreme endpoint of a continuum with many variations- that is, many students- falling between them. In other words, most people do not rely exclusively on the skills associated with one approach to learning or one end of a given continuum of learning styles. This is an encouraging observation, as the most advanced or adaptive styles and the most effective learning strategies often require integration of elements from both extremes. Educators should be cautioned against the temptation to label a student as though he or she possess only one set of talents, skills, or sensitivities- as a “visual learner”, a “feeling type”, or a “right-brained thinker”, for example, instead of acknowledging the student’s attributes as points on a continuum.”

Further criticism comes from Anita Woolfolk[27], who is author of one of the most widely used undergraduate educational psychology textbooks for preparing future teachers. On the topic of using the “right-brain/left-brain” learning styles model, Woolkfolk warns future teachers:

> “You might want to discuss a very controversial source of differences in learning and cognitive styles, *hemispheric specialization*, or a person’s preference for right-brain versus left-brain processing. According to some educators, many students have problems learning because they tend to process information using the right hemisphere of their brain, whereas the tasks of school require mostly left-hemispheric processing. Is this true? Two basic assumptions underlying these ideas are that different abilities are completely controlled by one side of the brain or the other and that individuals favor one hemisphere over the other in processing information. In other words, they are “right-brained” or “left-brained”. There is little evidence for either assumptions. For people who have normal intact brains, both hemispheres are involved in all learning tasks, even if one side may be more or less involved at any given moment.”

Woolfolk notes there are some research findings indicating students learn more when they study in their preferred setting and manner[14]. For example, there is some evidence that very bright students prefer quiet, solitary learning environments and may need less structure. Woolfolk cautions against testing students' "learning style" and trying to accommodate to all students' learning styles because students may not be the best judges of how they should learn. She notes, a student's preference for a particular style may not always guarantee that using the style will be effective. As Woolfolk noted, some students, particularly poorer students, prefer what is easy and comfortable. They may not have experienced the fact that real learning can be hard, uncomfortable, and require great persistence. Sometimes students prefer to learn in a certain way because they do not have alternatives and their assessed learning style is the only way they know how to approach the task.

Given the harsh criticisms of learning styles from educational psychologists, what do they recommend as an alternative approach for understanding college student learning processes? In generally, most educational psychologists who refute learning style theoretical perspectives emphasize instead the study of *individual differences in approaches to learning* and models of *self-regulated learning*[38-54]. Rather than emphasizing a trait, style, or typological category, educational psychologists focus on individual differences in students' prior knowledge, knowledge misconceptions, achievement goal orientation, task interest, perceived task-value, self-efficacy beliefs for the given task, attributions for successes and failures, and limitations of the cognitive system such as limited working memory capacity.

Although they vary in specific dimensions, self-regulated learning (SRL) models share the common assumption that students' learning processing are best understood by exploring their "will" and "skill." Skill refers to the knowledge and skills they bring to the specific task, whereas, will refers to the students' motivation. While many theorists over the years have argued whether motivation can best be conceived of as involving inner forces, enduring traits, behavior responses to stimuli or set of beliefs and affects, most contemporary SRL models are based on a more cognitive view of social motivation[42]. Social cognitive approaches to motivation typically highlight the motivational importance of values, goals, affects, attributions for success and failure, perceptions of competency, and the importance of expectancies[39,41,44]. In the broadest sense, Pintrich and Schunk[42] define motivation as "the process whereby goal-directed activity is instigated and sustained" (p. 4). According to Brophy[47], motivation to learn is conceptualized as "an acquired competence developed through general experience but simulated most directly through modeling, communication of expectations, and direct instruction by significant others" (p. 40).

It has recently been suggested that developing motivated, self-directed learners should be explicitly stated as an important outcome in higher education[55-57]. Self-regulatory learning is defined as the self-generation and self-monitoring of thoughts, feelings, and behavior in order to reach a goal[48,49,52,58-60]. Self-regulated learners tend to set specific learning goals, use a wide variety of learning strategies in order to learn, frequently self-monitor their own learning, assess obstacles that may arise and potentially interfere with their learning, develop plans for sustaining their motivation, have a good sense of their emotional makeup and have strategies for managing their emotions, and systematically use strategies for evaluating their own progress towards a goal[61]. In contrast to learning styles models, which posit the learner as less flexible, research on SRL shows that teachers, tutors, mentors, and counselors can help students become competent self-regulated learners[58-60].

A review of some recent research in engineering education demonstrates a shift in moving away from the learning styles research and focusing more on SRL or self-directed learning. For example, Litzinger, Wise, Lee, and Bjorklund[61] advocated in their 2003 ASEE paper the importance of understanding "won't do", "will do", "can do", and "can't do" (see Flammer for original proposed motivation and ability model). On-going work at Penn State University's College of Engineering on students' self-directed learning capabilities shows a promising line of research for meeting the needs of individual learners (and fulfilling one of the ABET standards). Perhaps one area for improvement may be to consider more ways to provide students with feedback about their scores on the two self-directed learning scales utilized at Penn State University. My review of Litzinger et al.'s paper suggested the data is used for program evaluation and researchers have yet to explore the benefits of using the data to design intervention strategies for individual students. In addition to the work at Penn State University, the Freshman Year Experience course for engineering students at the University of Connecticut provides a nice model for how to design an orientation course to help students understand their learning processes. It is noted that according to Soulsby's[62] 2002 ASEE paper, the University of Connecticut course is based on the assessment and identification of Felder's learning styles. It is suggested here FYE courses for engineering students, as recommended by Landis[63], can be ideal for engaging students in self-assessing their goals, interests, self-efficacy beliefs, and skills for asking for help when needed.

Misconception #2. "Self-esteem beliefs are strong predictors of student behavior and motivation.

Beginning in the 1970's the humanist movement began to influence American schools. A concurrent trend at the time was to emphasize students' self-esteem as an outcome of the educational experience. For many years, and still today, many educators believed students must feel good about themselves on order to learn and be successful. This view was challenged by researchers who claimed generalized self-esteem is unrelated to achievement motivation[64]. Educational psychologists suggest there is insufficient empirical evidence to support the claim that students' motivation to learn in a given situation is correlated with their generalized perceptions of self-worth or self-esteem. Much of the controversy surrounds whether or not we can effectively measure "generalized" or global self-esteem. Similar to the learning styles criticisms, many educational psychologists argue self-esteem is not global trait or pattern that is consistent across time and task. Again, we ask, if the field of educational psychology does not endorse self-esteem perspectives what do they suggest as an alternative approach to understanding individual differences in students' beliefs related to the self? Even a quick scan of the educational psychology literature will illuminate the predominate construct in understanding self-systems is Albert Bandura's construct of self-efficacy[65-67].

Self-efficacy beliefs are personal judgments about one's generative capability for cognitive, behavioral, social, and emotional actions that vary in terms of their *level* (task demands), *generality* (range of activities) and *strength* (durability) [65-67]. Bandura has differentiated two types of expectancies, both of which both serve important mediating roles in understanding self-efficacy and behavior:

1. **Efficacy expectation** is the belief that one can perform behaviors at a certain level. *Efficacy* expectancy is a mediator between an individual and that individual's behavior.
2. **Outcome expectancy** is the belief that certain performed behaviors lead to particular outcomes. Outcome expectancy is a mediator between an individual's behavior and the *outcome* of that behavior.

Bandura (1997) and others (Maddux, 2002) have claimed self-efficacy is neither a generalized or fixed personality trait rather it develops over time and through experience. In defining self-efficacy, it is important to make the fine distinction between self-efficacy and confidence. According to Bandura (1997), "confidence" is a nondescript term that refers to strength of belief but does not necessarily specify what the certainty is about. Moreover, the following quote reveals Bandura's concern that our present understanding of the term "confidence" does not add to the understanding of the nomological network of human agency and the exercise of control:

> "I can be supremely confident that I will fail at an endeavor. Perceived self-efficacy refers to belief in one's agentive capabilities that one can produce given levels of attainment. A self -efficacy assessment, therefore, includes both an affirmation of a capability level and the strength of that belief. Confidence is a catchword rather than a construct embedded in a theoretical system. Advances in a field are best achieved by constructs that fully reflect the phenomena of interest and are rooted in a theory that specifies their determinants, mediating processes, and multiple effects. Theory-based constructs pay dividends in understanding and operational guidance. The terms used to characterize personal agency, therefore, represent more than merely lexical preferences." (Bandura, 1997, p. 382).

Maddux (2002) further distinguished self-efficacy and perceived skill by stating "self-efficacy is not perceived skill; it is what I believe I can do with my skills under certain conditions…my ability to coordinate and orchestrate skills and abilities in changing and challenging situations" (p. 278).

Bandura and others have written extensively about the differences between self-efficacy and self-esteem. In addition to differentiating the constructs conceptually, there is some debate regarding how self-efficacy and self-esteem are interrelated. Bandura[67]has argued self-efficacy is independent and unrelated to global measures of self-esteem. This view was captured by Bandura in his statement- "the fact that I acknowledge complete inefficacy in ballroom dancing does not drive me to recurrent bouts of self-devaluation" (Bandura[67], p.11). These researchers suggest there is insufficient empirical support to claim that student's motivation to learn or their self-efficacy for a given situation is correlated with their generalized perceptions of self-worth (e.g., "I am a good person").

Maddux[69] pointed out that efficacy beliefs in a given domain will contribute to an individual's self-esteem only in direct proportion to the importance the person places on that domain (p. 278). At this time, it appears researchers do not fully agree about the relations between self-efficacy and self-esteem. Part of the debate centers around criticisms surrounding the self-esteem literature itself. For example, Elliott, Kratochwill, Cook, and Travers[70] refer to as the "murky waters" of self-esteem research. Another unresolved debate in education is whether or not schools should try to increase students' self-esteem. Educational psychologists caution against educational interventions designed to boost students' self-esteem. They warn that too often adults indiscriminately use praise in classroom settings, which can encourage students to become passive learners and fear the loss of losing favorable opinions of others. At the other extreme of this controversial debate are the researchers who argue self-esteem is grounded in brain biology and praise and positive feedback can raise low self-esteem, which in turn prevents impulsive and violent behavior[71].

Bandura enters the self-esteem debate by arguing the focus should be in increasing a person's self-efficacy for a specific task, which will have a direct and indirect impact on achievement. It follows, once learners experience success, we can expect high levels of self-worth.

The construct of self-efficacy is not new to field of engineering education. Much of the literature is grounded in Lent, Brown, and Hackett's[72] social-cognitive theory of career and academic interest, choice, and performance. Career self-efficacy is important construct and research shows it is a strong predictor of who is likely to choose STEM college degrees and careers. Perhaps one area still in need of further research is the topic of academic self-efficacy. With the exception of Todd Johnson's[12] work at Washington State University, a review of some recent papers on academic self-efficacy reveals most of the research is conducted on measures of global self-efficacy beliefs rather than task-specific self-efficacy. Bandura and others are adamant in their call that academic self-efficacy must be assessed at the domain-specific or task level.

Misconception #3. "Students' performance goals harm their mastery or learning goals.

Since the 1980s research in the area of achievement goal theory has become one of the most active areas of research in the field of motivational science[73-85]. In particular, a significant amount of attention has been given to understanding how college students' achievement goals relate to such outcomes as academic self-regulation, affect, task value, interest, self-efficacy, learning, and achievement. In my preliminary review of the STEM literature I found little attention given to the topic of goal theory.

Although there are various models, in general, most educational psychologist distinguish two major types of achievement goals[39,42,45,82,83,85]; *performance goals* and *learning goals.* Students with performance goals strive for competence in order to demonstrate their abilities to others. A performance goal orientation frequently involves normatively based standards and students may appear competitive as they strive to outperform their peers. In contrast, students who adopt a learning goal orientation focus on the development of skills and mastery relative to the task. Students with a learning goal (sometimes also referred to as "mastery goal orientation" in the literature) orientation are less concerned about how their performance compares to others, rather they set self-referential goals and strive for improvement. They are motivated to learn as much as they can about a subject.

In general, students with learning goals are:

- tend to seek out challenges
- persist even when tasks become difficult
- consider failure to be a sign that they need to exert more effort
- use effective learning strategies
- view teachers as a guide and resource
- view errors as a normal part of the learning process
- tend to have a high sense of self-efficacy
- want to understanding the material
- evaluate their own performance in terms of the progress they made

Whereas, students with a performance goal orientation are:

- more likely to choose easy tasks that will allow them to look competent in the eyes of others

- may avoid challenging tasks and are motivated by extrinsic rewards
- interpret failure as a sign of low ability rather than lack of effort
- often use rote learning strategies such as repetition or copying
- perceive errors as a sign of failure
- view teachers as a rewarder or punisher
- believe people either have a high amount of intelligence or they don't
- may show high anxiety prior to and during exams
- may fear appearing "dumb or stupid" to others
- may have low self-efficacy
- are most likely to repeatedly ask professors "will this be on the test?"

In the past, these two types of achievement goals were separated; however, recent research indicates students can adopt both learning and performance goals[73,84]. An extensive amount research shows the many positive effects of a learning goal orientation for learning, motivation, and achievement. Therefore, the real concern is for college students who hold only performance goals with no demonstration of a learning goal orientation. Fortunately, researchers have found that the type of goal orientation adopted by a student is a malleable state rather than a fixed trait. Moreover, students' goals are frequently tied to a particular course and can even change during the course experience. The flexibility and domain-specific nature of achievement goals are appealing to educational psychologists, who openly criticize learning styles and global self-esteem models and research.

One of the practical implications of goal orientation research is that STEM faculty members are reminded of the importance of avoiding making normative comparisons among students. Most faculty members have experienced the student who continually asks "how did I do compared to everyone else in the class?" Even though the student is informed that he or she did well on the exam as a result of their hard work, the student still asks how his or her score compares to other students' scores. Based on researchers' recommendations[82,86-88], faculty members are urged to consider the potential negative effects of competition and normative comparisons relative to student performance. In practice, this means that faculty members are discouraged from reporting the average test scores after exams and should re-evaluate any type of curve grading. Also, faculty members may want to reconsider the common practice of posting students' grades in classes in public places.

Perhaps one of the most controversial educational practices in STEM disciplines is the common use of "grading on the curve." Although grading on the curve is still widely used on many college campuses, Blowers[89] argued in his 2002 ASEE paper:

> "Students on curved grading scales are generally motivated by grade based considerations to learn material instead of an innate desire to learn. They view their classmates as competitors that must be defeated instead of as resources to help them learn. Communication among the class members and the ability to create effective teams, both ABET criteria, are hurt by this competition among class members. For all of these reasons, curved grading scales should not be used in engineering courses."

Engineering faculty members are encouraged to communicate and model a learning goal orientation for their students. One of the most common ways faculty members communicate that learning is not the desired goal is when they announce to students "anyone who has an A going into the final, does not need to take the final." In this example, students are sent the message that the content in of itself is not important and performance goal orientations are likely to be perpetuated. The simple strategy of voicing to students the belief that learning is hard work and errors are a normal part of the learning process can go a long way in promoting students' adoption of a learning goal orientation.

Misconception #4. "Students who do not persist lack will-power or volition."

Some faculty members may believe students lack a work ethic or a motivation to learn trait. Engineering faculty members are encouraged to keep in mind the importance of understanding the situational aspects of motivation as investigated by several researchers in recent years. Paris and Turner[90] argue that, "analyses of motivation should consider the characteristics of individuals in specific situations because a person's motivational beliefs and behavior are derived from contextual transactions" (p.213-214). They further point out "We believe that motivation waxes and wanes according to ones history of success and failure and the relative incentives provided in different situations . . . This means that we should avoid categorizing people according to types or degrees of motivation that they display and also avoid identifying environmental events as motivational or not because neither alone is sufficient to predict motivation across contexts or people" (p. 216).

College student success is typically defined in terms of performance, and grades and degree completion represent the most obvious indicators of performance. Educational psychologists have challenged this definition by suggesting a student's interest in the course material or discipline area should also be considered as an important outcome of the educational process[84,91]. Students with an intrinsic interest in the material desire to pursue an activity for its own sake and often this interest continue beyond a particular course[91]. There are several reasons why intrinsic motivation is especially important for college students. First, intrinsic motivation affects the quality of a student's educational experience. Students who are genuinely interested in the course material are actively involved in the course and are concerned with mastering the course content rather than simply doing well on an exam. Second, student's interests play a major role in determining their choice of major and direction of their continuing studies. Thus, a student's interest in a particular course can develop into a broader discipline-based interest[92]. Finally, researchers have found that students' intrinsic motivation is reciprocally related to their achievement goal orientation, which has significant consequences for student success[82-84]. Does making learning interesting mean faculty members should attempt to guarantee learning is entertaining and/or fun? We shift next to the final misconception discussed in this paper- that learning should be fun.

Misconception #5. "Learning should be fun."

Within many disciplines, perhaps including engineering, there is a common belief that "learning should be fun." Some university professors go as far as encouraging "edutainment" to hold students' attention and foster student interest. At the opposite end of this theoretical debate is the "no pain, no gain" educational philosophy. In fact, a 2003 ASEE paper by Desrochers, Hein, Raber, and Wright[93] titled "Fun and Games…. In the Classroom?" demonstrates the commonly held belief that college student learning can and should be fun.

The view that leaning should be fun is not limited to engineering education. According to Langer[94], a well known educational psychologist, there is a prevalent belief in our educational system that when there is "no pain" there is "no gain". Langer writes "I argue that not only should learning be fun on its own terms, but that learning or gain that is not fun is mindless". She is critical of teaching practices that encourage vigilance, focused attention, and repetitive practice. Instead, of the "no pain, no gain" philosophy, Langer argues *vigilence* should be replaced by *mindfulness*. She defines mindfulness as:

> A state of mind that results from drawing novel distinctions, examining information from new perspectives, and being sensitve to context. It is an open, creative, probabilistic state of mind in which the individual might to led to finding differences among things thought similar and similarities among things thought different. (Langer, 1993, p. 44).

She contrasts this definition to vigilence which she claims is a state where one has to have a particular concept or stimulus in mind, and therefore the individual has an expectation of what the stimulus *is* rather than what it *could be*. According to this perspective college teachers would not base their teaching practices on a single optimal perspective, but rather would design instructional practices that allow students to see many possible perspectives on the same situation. Viewing multiple perspectives may be in contrast to the intelligence perspective whereby researchers and teachers consider cognitive processing as a linear process, where students are moved from problems to answers and questions to answers.

Some of the teaching practices suggested by Langer that will engage students in mindful learning include:

1. **Change multiple-choice tests**. Instead of asking for the right question, instead ask students how each answer might be right. This testing practice encourages students to engage in thoughtful comparisons of all answers simultaneously and sill results in a learning process that is never complete as there is no one right answer.
2. **Avoid absolute language**. Absolute language rather than conditional language (e.g., a particular fact "is" rather than "could be") has been found to lead to students' premature cognitive commitments. A premature cognitive commitment is "a rigid belief that results from the mindless acceptance of information as true without consideration of alternative versions of that information" (Langer, 1993, p. 45).
3. **Novelty is essential**. Langer is critical of focused attention and concentration mainly when it involves concentrating on familiar material. Thus, students will benefit more from situations where they are presented novel perspectives. Previous investigators have postulated that novelty or incongruence between prior experience and new information will stimulate student motivations. This view, however, has been criticized by those who warn that there is little evidence towards the optimal level of incongruence. While novelty may raise a student's interest, how much may lead to student frustration and actually decrease curiosity.

In this perhaps extreme view, Langer wrote "we would do better to ask ourselves what would be fun for our students and trust that learning inevitably will follow". Moreover, she argued we should discontinue the mindless assessment practices of memorized facts and instead assess whether or not student report they are interested in the educational process. Langer criticized educators who try to move students from questions to answers and said a mindful education is when individuals see the question from many vantage points. Thus, the purpose of this article was not to answer the question "should all learning be fun", but rather is was to raise this question from multiple perspectives. Finally, Langer argues that educators should not teach students "to learn if something is true" rather we should teach students "when it is true". Perhaps, the question is not "should all learning be fun?" but rather "when should learning be fun?"

The view that learning should be fun is typically challenged on two grounds. First, many educators challenge the use of fun and games (e.g., ice-breakers or other team building activities) because they occupy precious and limited learning time. Educational researchers "study time on task, engaged time, or academic learning time", which is narrowly defined as actual time spent actively engaged in the learning task at hand. Time on task is an important issue given that most college students have previous learning experiences of being off-task. Research has shown that of the 1,000+ hours of time mandated for school in most states in elementary schools, typically only 333 hours is spent on quality academic learning time[95].

The second criticism against using fun and games in the classroom is that faculty members may send the message that learning is both fun and should be easy or come naturally. The core assumption that "learning is fun on its own terms" is in direct opposition to the Expert-Novice Problem-Solving Paradigm[96-101], which postulates learning is hard work and repetition and practice are necessary for further learning. From this perspective, faculty members are encouraged to model and remind students that learning and the development of expertise in a domain is very hard work and requires years of deliberate practice and study.

Instead of games and other entertainment tasks, engineering faculty members are encouraged to consider the recommendations made by Hansen[102], who proposed faculty members should increase students' interest and motivation by focusing on teachable moments. In particular, he urged faculty to make the most out of students' myths, blind spots (i.e., ignorance about a topic), misconceptions, and overgeneralizations. He further argued that simple teaching strategies aimed at getting students' attention will not be sufficient for making long lasting results. A critical aspect of Hansen's conception of teachable moments includes the frequent use of students' self-assessment of their own learning processes and outcomes. In addition to engaging students in assessment of their content mastery, faculty members are also encouraged to ask students to frequently self-assess their interest in the course topics and discipline.

CONCLUSION

In summary, this paper discusses several misconceptions held by some faculty members on college campuses. Numerous teaching strategies were recommended and further readings were suggested. In conclusion, the focus of this paper is to suggest that combating certain misconceptions about college student learning may lead to an increase in college student achievement motivation. I also believe it is important to point out that students' motivation to learn is a necessary, but not sufficient, condition of a successful learning experience. Having motivated students is simply not enough; students still need to master the content of a required unit, course, or degree program. From this perspective, motivation is considered to be both a mediator and outcome of learning, but cannot replace the acquisition of discipline specific knowledge. This view is consistent with current cognitive frameworks on academic achievement that stress the importance of will, skill, and content knowledge acquisition[103].

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GYPSY DENZINE is a Professor of Educational Psychology at Northern Arizona University. She serves as the Associate Dean in the College of Education at NAU. She teaches courses on human learning, human development, adolescent psychology, and college student development. She has been an active member of the Engineering Schools of the Southwest Initiative, which is funded by the Hewlett Foundation. Her research interests focus on understanding college student achievement motivation, teacher efficacy, faculty development, and the creation of positive learning communities for college students.