Perceived Motivational Constructs and Engineering Students’ Academic Performance

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Abstract

In this research paper, we studied the role of students' perceived motivational constructs on their academic performance.

Education literature showed that students' motivation affects their academic performance. Highly motivated students tend to be more determined or persistent in their performance. Similarly, engineering education studies have established that engineering students performed well with an appropriate intrinsic and extrinsic motivation in engineering courses. However, limited literature has explored the particular achievement-related motivation that has a relatively more profound effect on students' academic performance. In this research paper, we investigated the unique contribution of perceived motivational constructs on 120 first-year engineering students' academic performance in a required engineering course while accounting for their prior success. The motivational constructs include students' self-reported achievement goals (mastery goals, performance goals, and mastery avoidance), self-efficacy beliefs, and task value. We collected the data by administering surveys at the beginning of the course. We used AGQ-R for achievement goals and subscales of the MSLQ survey for students' course-related beliefs about self-efficacy and task value. Also, SAT scores and prior GPA determined students' prior success. We used students' scores in three exams as a measure of their academic performance in the course. We used stepwise hierarchical regression to identify the motivational constructs relatively account for the most variance to predict exam scores. Through simultaneous regression analysis, we determine the unique contribution of each motivational constructs. The results showed that students' prior success is the most significant predictor and accounted for the most variance in predicting students' academic performance in all three exams. In addition to prior success for exam1 and exam3, students' achievement goals played a significant role, while for exam2 students' self-efficacy beliefs accounted for the most variance. In this full paper, we discuss these results with the study's implications, limitations, and directions for future research.

Introduction

Several studies in education and engineering education have investigated the indicators and factors that play a role in students' academic success [1], [2]. These studies have suggested that the students' academic motivation related constructs and students' prior success have a strong effect on students' learning and achievement in courses [3], [4]. The academic motivation (both intrinsic and extrinsic) helps students to energize their learning behavior and stay persistent in their performance [5], [6], which results in overall academic success and achievement. Similarly, students' prior success appeared as a strong predictor of their current academic performance [7], [8] in the literature as well.

Although many studies have studied the role of multiple motivational constructs in engineering education (e.g., [9]), limited literature has explored the unique and relative contribution of these constructs in one single sample [10]. Also, not many studies have accounted for cognitive factors such as students' prior success when studying the relative role of these motivational constructs.

In this study, we focused on understanding the particular achievement-related motivation construct has a relatively more profound effect on students' academic performance. We used three motivational constructs in this study. These constructs are students' achievement goals
(mastery goals, performance goals, and mastery avoidance), self-efficacy beliefs, and task value. We, in this study, collected the data of these motivational constructs from a single sample while accounting for the contributing factor of students' prior success. More specifically, this study is guided by the following research question:

RQ: What is the unique contribution of 'perceived' motivational constructs (i.e., achievement goals, self-efficacy, and task value) to predict students' academic performances after controlling for their prior success?

The next section reviews the existing literature on these strategies and their tools in engineering education, followed by sections of research design and methods, results, discussion, and conclusion.

Literature Review

Research in education, educational psychology, and engineering education has emphasized the role of motivation and students' academic success, performance, learning, and achievement [6], [11], [12]. Many of these studies have shown that motivation and especially academic-related motivation is one of the key determinants of students' success as it directs students' behavior towards academic achievement [13]–[15].

Contemporary education literature on students’ academic motivation is grounded in two fundamental theories 1) achievement goal theory [16], [17], and 2) expectancy-value theory [18], [19]. Schunk, Pintrich, & Meece [20] described that both of these theories focus on how students reflect their experiences in the context of achievements. Students' experiences help them to develop an understanding of the learning task and motivate them to see engagement in the task as important. Studies have also suggested that motivation includes various constructs such as beliefs, goals, task values, engagement, etc. [15], [21]. The few most commonly used motivational constructs in engineering studies include 'self-efficacy beliefs, ' achievement goals, and task value [6], [22], [23], which are derived from these two strands of theories.

From expectancy-value theory, one commonly used motivational construct is self-efficacy belief. Self-efficacy is defined as students' beliefs "about their capabilities to produce the designated level of performance" [24]. These self-efficacy beliefs determine the way students think, feel, and behave in a certain situation [24]–[26]. These beliefs help students to approach difficult tasks and perform well by showing intrinsic interest [25]. As a consequence, these beliefs influence students' achievements and accomplishments [27]. Studies in engineering education found a strong role of self-efficacy beliefs in predicting students' academic performance [28], [29]. For example, Loo & Choy [28] reported that self-efficacy was highly correlated with students' achievement on a study conducted on 178 third year engineering students. Looking at various sources of self-efficacy beliefs, they found that mastery experiences (results of prior experiences on certain tasks) were the main predictor of students' academic performance.

The second motivational construct from expectancy-value theory is task value that is being associated with students' academic performance. Task value refers to students' beliefs about the importance and value of the task [30] and describes students' reasons for doing a task [31]. Joo, Lim, & Kim [32] in their study investigated the role of task value on 897 students' academic performance. Their results showed that the task value is a significant predictor of students' academic performance and persistence.
Achievement goal theory suggests that students' purpose or achievement-related goals are important for that achievement outcomes. Students' achievement goals indicate that an individual's motivation is driven by a specific purpose [13]. Students' achievement goals guide students' positive or negative behaviors based on their competence relevant possibilities [33]. Based on the mechanism to evaluate the competence and positive or negative behavior, achievement goals are subdivided into approach vs. avoidance categories [27]. In the approach category, two commonly used goals are mastery goals and performance goals. The mastery goal focuses on learning and understanding materials, whereas the performance goal focuses on performing well compared to others [13]. In the avoidance approach, performance-avoidance goals may be associated with adverse academic outcomes [34]. Also, it is noteworthy that studies have mostly focused on three types of achievement goals, which are mastery, performance-approach, and performance-avoidance (e.g., [35], [36]). For example, Jagacinski [37] conducted a study on gender-based performance differences based on achievement goals. He reported that students' approach goals have a direct or indirect effect on students' achievement. However, he reported that such an effect was not visible in the case of the avoidance approach. Similar to other studies, in this study, we also focused on the three types of achievement goals.

Besides motivation, other factors such as students' prior success [38], gender and ethnicity [39], [40], and socioeconomic status [41] have shown significant contributions. Many studies also suggested students' prior achievement, success, or performance as the best single predictor of their academic success and achievements [42], [43].

Although many studies have used these motivational constructs in predicting performance, however, they were investigating the role of a single motivational construct on students' academic performance [10]. Also, in the case of the use of multiple constructs, none of these studies focused on investigating the unique contribution of each motivational constructs in predicting students' academic performance. Along the same line, most studies have explored the role of multiple motivational constructs with cognitive predictors [10]. This limited focus warrants the need for future studies in this direction and validates the need for the current study.

Research Methods

Participants

We collected the data from 120 first-year second-semester engineering students, belonging from a single section in a required engineering course at a large R1 Midwestern university. The university offers various undergraduate and graduate degrees to a diverse student population. However, the highest undergraduate enrollment of the university (~28%) is in the college of engineering. At the beginning of their degree (before declaring their major), engineering students enroll in the First-Year Engineering Program for a common first-year curriculum. This first year engineering curriculum introduces students to common core engineering concepts. Also, this course equipped students with knowledge of MATLAB programming, design thinking, and mathematical modeling to solve engineering problems. The faculty of engineering education teach this course. All participants in the study were full-time undergraduate students who voluntarily participated in this study. Table 1 provides the gender and ethnicity distribution of the students.
Table 1
Gender and ethnicity distribution of 120 engineering students

<table>
<thead>
<tr>
<th>Gender</th>
<th>No of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>100</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>International student of any race/ethnicity</td>
<td>26</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>0</td>
</tr>
<tr>
<td>Asian American</td>
<td>9</td>
</tr>
<tr>
<td>Black or African American</td>
<td>3</td>
</tr>
<tr>
<td>Hispanic or Latin American</td>
<td>2</td>
</tr>
<tr>
<td>Native Hawaiian or other Pacific Islander</td>
<td>1</td>
</tr>
<tr>
<td>White or European American</td>
<td>74</td>
</tr>
<tr>
<td>Two or more races</td>
<td>5</td>
</tr>
</tbody>
</table>

In this study, we specifically focused on studying first-year engineering students as all the students go through the same curriculum. Further, as this study emphasis is on studying the role of students' motivation on their performance, we assume that at first-year students' motivation is not influenced by the selection of their major or is not due to the major they get placed in.

Data Collection

We collected the data for three aspects required to answer the research question. These three aspects are:

1) Students' self-reported motivation on three constructs (i.e., achievement goals, self-efficacy, and task value).
2) Students' prior success information.
3) Students' academic performance in an engineering course.

For the first aspect and to collect the data on three motivational constructs, we used validated surveys. For students' achievement goals (mastery goals, performance goals, performance-avoidance), we collected the data using the "Achievement Goal Questionnaire-Revised (AGQ-R) survey [44]. For students' self-efficacy beliefs and task value, we used the subscales of Motivated Strategies for Learning Questionnaire (MSLQ) Survey [45]. We conducted these surveys at the beginning of the semester and gathered information about students' motivation. The data was collected using 6-Likert scale value, where one indicated "strongly disagree," and six indicated "strongly agree."

For the second aspect of students' prior success information, we used two measures students' SAT scores and students' prior GPA (GPA of the first semester in a first-year engineering program). For students who had ACT scores, we converted their ACT scores into SAT scores using standardized calculations.

To collect the data of students' academic performance in the course, we used the score of three exams. The students could score a maximum of 120 marks in each exam. Although each exam focused on the different content aspect of the course, there was no difference in the format
or difficulty level of each three exams. The course assigned teaching assistant and instructor graded the exams without any involvement from the research team.

**Procedure and Analysis**

For this study, we considered each motivational construct as an independent set. In the set of students' achievement goals, we used three items: 1) average of students' responses to mastery goals items, 2) an average of students' responses to performance goals items, and 3) an average of students' responses to performance-avoidance items. In the self-efficacy beliefs set, we used all five items responses (labeled as Self-efficacy1 to Self-efficacy5). Similarly, in the task value set, we used the responses of all six items (labeled as Task value1 to Task value6).

For the set of students' prior success, we used two items: 1) SAT score and 2) prior GPA and entered them as a single set. We used both measures (SAT score and prior GPA) as a set of hierarchical regression due to small and nonsignificant correlation between them ($r = .135, p = .171$).

We used sets of students' motivations (achievement goals, self-efficacy, and task value) to predict exam1, exam2, and exam3 scores while accounting for students' prior success.

To address the research question of determining the unique contribution of motivational constructs (achievement goals, self-efficacy beliefs, and task value) to predict students' academic performances after controlling for students' prior success, we used two methods. 1) we used stepwise hierarchical regression analysis to explore which of these motivational constructs accounts for most variance when predicting academic performance, and 2) we used the simultaneous hierarchical regression analysis for determining the unique contribution of each construct.

**Results**

Before conducting a regression analysis, we checked for the statistical assumptions. We tested the linearity assumption using scatter plots. Multicollinearity in the data is verified, using the multicollinearity diagnosis variable - Variance Inflation Factor (VIF). We found moderate or no multicollinearity between predictor variables. Besides, we looked at the descriptive statistics for each exam and found that exam1 mean = 101.699, SD = 9.004. For exam2 mean = 87.380, SD=15.135. For exam3, mean = 92.687, SD =18.455.

In the first method, to explore which of these motivational constructs, achievement goals, self-efficacy, or task value accounts for the most variance. We used stepwise hierarchical regression analysis by accounting for students' prior success to predict students' academic performance in all three exams. We followed the three-stage model of stepwise hierarchical regression analysis, where at the first stage, we used $R^2$ to determine motivational construct, and prior success set accounts for the most variance. The set that accounted for most variance became the first set in the hierarchy. In the second stage, we used the change in $R^2$. The set with more considerable change is $R^2$ became the second set in the hierarchy. Table 2 shows the values of variances in both steps. Similarly, at the third stage, we used the biggest change in $R^2$ to determine the next sets in the hierarchy.
Table 2
Variance to predict exam scores – Determination of variable accounting for the most variance

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Exam 1 R²</th>
<th>Exam 1 ΔR²</th>
<th>Exam 2 R²</th>
<th>Exam 2 ΔR²</th>
<th>Exam 3 R²</th>
<th>Exam 3 ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achievement goals</td>
<td>.087*</td>
<td>.031</td>
<td>.063</td>
<td>.036</td>
<td>.063</td>
<td>.036</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>.041</td>
<td>.064</td>
<td>.036</td>
<td>.036</td>
<td>.063</td>
<td>.036</td>
</tr>
<tr>
<td>Task value</td>
<td>.022</td>
<td>.079</td>
<td>.026</td>
<td>.026</td>
<td>.079</td>
<td>.026</td>
</tr>
<tr>
<td>Prior success</td>
<td>.163**</td>
<td>.289**</td>
<td>.213**</td>
<td>.213**</td>
<td>.213**</td>
<td>.213**</td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior success with Achievement goals</td>
<td>.045</td>
<td>.009</td>
<td>.042</td>
<td>.009</td>
<td>.042</td>
<td>.009</td>
</tr>
<tr>
<td>Prior success with Self-efficacy</td>
<td>.028</td>
<td>.049</td>
<td>.015</td>
<td>.049</td>
<td>.015</td>
<td>.049</td>
</tr>
<tr>
<td>Prior success with Task value</td>
<td>.028</td>
<td>.043</td>
<td>.017</td>
<td>.043</td>
<td>.017</td>
<td>.043</td>
</tr>
<tr>
<td><strong>Stage 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior success with Achievement goals and Self-efficacy</td>
<td>.028</td>
<td>.017</td>
<td>.049</td>
<td>.017</td>
<td>.049</td>
<td>.017</td>
</tr>
<tr>
<td>Prior success with Achievement goals and Task value</td>
<td>.049</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
</tr>
<tr>
<td>Prior success with Self-efficacy and Achievement goals</td>
<td>.018</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
</tr>
<tr>
<td>Prior success with Self-efficacy and Task Value</td>
<td>.049</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
<td>.017</td>
<td>.015</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ΔR² represents the changes in R²

At stage 1, for all three exams, prior success accounted for the most variance to predict all three exams scores. In this hierarchy, prior success thus became the first set in all three cases of regression. At stage 2, to decide the next set in the hierarchy and for increased predictability in the model, we used the change in R² value. The results in changes in R² value showed that for exam1 and exam3, achievement goals accounted for most change in the model, while for exam2, students' self-efficacy beliefs accounted for most change in the model. The order of hierarchy at this stage is: for exam1 and exam3, prior success with achievement goals, while for exam2, it is the prior success with self-efficacy beliefs. At stage 3, for exam1 and exam3 between task value and self-efficacy, task value accounted for most change and increased predictability in the model, which made task value the third set in the model. For exam2, between task value and achievement goals, task value accounted for most change and increased predictability in the model, which made task value the third set in the model. The results indicated the following order of good models:

For exam1: Prior success, Achievement goals, Task value, and Self-efficacy
For exam2: Prior success, Self-efficacy, Task value, and Achievement goals
For exam3: Prior success, Achievement goals, Task value, and Self-efficacy

Overall, these independent regressions also showed that students' prior success is the most significant predictor and accounted for the most variance in predicting students' academic performance in all three exams. In addition to prior success for exam1 and exam3, students'
achievement goals increase the predictability and variance in model, while for exam2 students' self-efficacy beliefs accounted for the most variance.

After identifying the order of the sets, we conducted the stepwise hierarchical regression analysis for in the order of best fit model for each exam to determine the variance accountability by each construct.

Table 3 Result of change in $R^2$ to explain the variances accounted for by each set

<table>
<thead>
<tr>
<th></th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>$\Delta R^2$</td>
<td>$R^2$</td>
</tr>
<tr>
<td>Prior success</td>
<td>.163</td>
<td>.163</td>
<td>.289</td>
</tr>
<tr>
<td>Prior success, Achievement goals</td>
<td>.208</td>
<td>.045</td>
<td>.255</td>
</tr>
<tr>
<td>Prior success, Achievement goals, Task value</td>
<td>.254</td>
<td>.045</td>
<td>.298</td>
</tr>
<tr>
<td>Prior success, Achievement goals, Task value, Self-efficacy</td>
<td>.275</td>
<td>.021</td>
<td>.314</td>
</tr>
<tr>
<td>Prior success, Self-efficacy</td>
<td>.338</td>
<td>.049</td>
<td>.314</td>
</tr>
<tr>
<td>Prior success, Self-efficacy, Task value</td>
<td>.388</td>
<td>.049</td>
<td>.388</td>
</tr>
<tr>
<td>Prior success, Self-efficacy, Task value, Achievement goals</td>
<td>.411</td>
<td>.024</td>
<td>.411</td>
</tr>
</tbody>
</table>

The results of the conducted regression analyses to determine the variance of each set while predicting academic performance in all three exams in order of increased predictability are presented in Table 3. These results of the changes in $R^2$ indicate that students' prior success determined by their SAT score and prior GPA accounts for 16.3% variance to predict exam1, 28.9% variance to predict exam2, and 21.3% variance to predict exam3. In motivational constructs, achievement goals additionally account for 4.5% variance to predict exam1, 2.4% variance to predict exam2, and 4.2% variance to predict exam3. Students' self-efficacy beliefs additionally account for 2.1% variance to predict exam1, 4.9% variance to predict exam2, and 1.6% variance to predict exam3. Students' reported task value accounts for 4.5% variance to predict exam1, 4.9% variance to predict exam2, and 4.3% variance to predict exam3.

The final model of the hierarchical regression analysis to predict exam scores using three motivational constructs while accounting for students' prior success shows a significant regression. Table 4 shows the results of each regression, with the values of the coefficients of each significant predictor for each exam.

Table 4 Results of the final model hierarchical regression with significant predictors for each exam

<table>
<thead>
<tr>
<th></th>
<th>Regression</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F(16,85)$</td>
<td>$p$</td>
</tr>
<tr>
<td>Exam 1</td>
<td>2.018</td>
<td>.021*</td>
</tr>
<tr>
<td>GPA</td>
<td>5.242</td>
<td>.014*</td>
</tr>
<tr>
<td>Mastery goals</td>
<td>4.810</td>
<td>.018*</td>
</tr>
<tr>
<td>Exam 2</td>
<td>3.713</td>
<td>.000**</td>
</tr>
<tr>
<td>GPA</td>
<td>7.332</td>
<td>.003*</td>
</tr>
<tr>
<td>Self-efficacy3</td>
<td>-4.987</td>
<td>.000**</td>
</tr>
</tbody>
</table>
Exam 3  
GPA  
Mastery goals  

<table>
<thead>
<tr>
<th></th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sets</td>
<td>.275</td>
<td>.411</td>
<td>.314</td>
</tr>
<tr>
<td>Prior success, Achievement goals, Self-efficacy</td>
<td>.236</td>
<td>.357</td>
<td>.272</td>
</tr>
<tr>
<td>Prior success, Achievement goals, Task value</td>
<td>.254</td>
<td>.344</td>
<td>.298</td>
</tr>
<tr>
<td>Prior success, Self-efficacy, Task value</td>
<td>.223</td>
<td>.388</td>
<td>.247</td>
</tr>
<tr>
<td>Achievement goals, Self-efficacy, Task value</td>
<td>.174</td>
<td>.224</td>
<td>.165</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01

As a second method, and to determine the unique contribution of each of these sets (Prior success, Achievement goals, Self-efficacy, and Task value) to predict exam1, exam2, and exam3, we conducted simultaneous hierarchical regression analysis. Table 5 shows the results of $R^2$ in a simultaneous regression analysis.

Table 5 Summary of simultaneous regression analysis for the unique contribution of each set

The results of simultaneous regression analysis indicate that prior success has a unique contribution of 10.10%, 18.70%, and 14.90% to predict exam1, exam2, and exam3, respectively. Achievement goals appeared as the second-best unique contributor for exam1 and exam3. Achievement goals uniquely accounts for variances 5.20% for exam1, 2.30% for exam2, and 6.70% for exam3. Students' self-efficacy beliefs appeared the second strongest unique predictor of exam2. Self-efficacy accounts for 2.10% for exam1, 6.70% for exam2, and 1.60% for exam3. Similarly, Task value accounted for 3.90% variance for exam1, 5.40% variance for exam2, and 4.20% variance for exam3. Overall, the results indicate that students' prior success accounts for the most variances in predicting students' performance.

Discussion

Keeping students motivated and engaged is one of the fundamental and critical aspects of today's teaching. Studies have indicated that motivated students show more directed behavior and make them effective learners [5], [9]. Students' perceived motivation towards the course also helps them in the performance and achievements in the course [6]. In addition to students' perceived motivation, students' prior success also helps them in their courses and have an impact on their performance [8], [46]. Engineering studies have focused on studying the role of some motivational construct or students' prior success in predicting students' performance [47], [48]. Studies have also emphasized integrating multiple motivational constructs for a better understanding of students' experiences and course-related achievements [9]. In this study, we focused on another critical aspect of this relationship, which is about identifying the unique contribution of different motivational constructs while accounting for students' prior success. For the present study, we studied three motivational constructs 1) students' achievement goals (mastery goals, performance goals, and performance-avoidance), 2) students' self-efficacy beliefs, and 3) students' perceived task value. We also accounted for students' prior success using two measures 1) prior GPA and 2) SAT scores. As a measure of students' performance, we used their three exam scores in a single first-year engineering course.
For our research question, we used stepwise hierarchical regression analysis to determine which motivational construct achievement goals, self-efficacy, and task value account for the most variance in the data while predicting students' academic performance and after accounting for students' prior success. Also, we used simultaneous hierarchical regression analysis to determine the unique contribution of each motivational construct and prior success to predict the three exams.

Our results indicate that students' prior success accounts for the most contribution and predicts higher variance for all three exam scores. The coefficients of the regression analyses indicate that a prior GPA appeared as a significant predictor. In addition to students' prior success, students' achievement goals (especially mastery goals) appeared as the most significant and unique predictors for exam1 and exam3. These results are analogous to existing studies on engineering education, where mastery goals have a significant effect on students' final exams and total learning outcomes [49]. For exam2, students' self-efficacy beliefs accounted for most contributions and predicted higher variance after students' prior success.

Limitations and Future Directions

Being one of the preliminary studies, which evaluated the unique contribution of each motivational construct, this study has some limitations. First, the study had a relatively small sample size (i.e., 120 students). These preliminary findings need to be confirmed by applying similar analyses on a more extensive data set. Second, the data were collected from first-year engineering students and a single class. These results might vary in the case of sophomore, junior, or senior students, as many first-year engineering students are novices about engineering. Third, in this study, for motivational constructs, we relied on students; perceived and self-reported evidence, which may have caused an inflation effect or inaccuracies. Also, we collected the data on students' motivation related constructs at the beginning of the semester, which may have changed during the semester. Also, for this study, we used validated surveys and did not test the validity of individual items' reliability to their construct. Also, This study only accounts for the students' prior success based on their first semester GPA and SAT scores. However, there may be other variables of interest, such as 'gender and racial/ethnic diversity, students' math or science GPA, or students' socioeconomic status, etc.

Based on these explorations and limitations, there are multiple future directions. Future studies can focus on other motivational constructs and other factors into account. For example, students' information on gender and cultural identity or students' engagement in the course can be another valuable addition. A future study may be designed to see the effects on underrepresented groups. Also, a longitudinal study can be designed which examines students' perceived motivation and their changes across their many years in the degree program. Third, although students' self-reported evidence provides excellent evidence of information, other sources of process data can be used to identify students' motivation towards the course and how it changes. For example, the study can be triangulated with the information based on students' interviews on their motivation and performance. Another study can be designed, which may focus on the temporal evidence of students' motivation. Also, studies can focus on other variables-based variations; for example, gender and ethnicity-based variation can be included in future studies.
Conclusion

In this current study, we discussed the unique contribution of students' prior success and three motivational constructs: students' achievement goals, self-efficacy, and task value. We used validated surveys to collect the data from 120 students about their perceived motivation at the beginning of the semester. We used AGQ-R for achievement goals and subscales of MSLQ for self-efficacy and task value. For students' prior success, we used the data from two measures 1) GPA and 2) SAT score. The data were collected in an engineering classroom of 120 students and studied their unique contribution in predicting students' performance evaluated through three exams. The results of the study showed that students' prior success accounted for the most variance and had a higher unique contribution in predicting all exams, i.e., exam1, exam2, and exam3. In addition to students' prior success, we saw a profound effect of students' achievement goals on exam1 and exam3, and good increased predictability of self-efficacy for exam2.

In light of these results, this study shows two dimensions of results. First, this study confirms the results of the existing studies by indicating the role of motivational constructs and prior success in predicting students' performance [8], [42], [46]. Also, this study advances the engineering education literature as it evaluates the effect of three motivational constructs and prior success in a single sample of engineering students. These results are novel as we can see that at the beginning and end of the semester, students' performance is more influenced by their prior success and mastery goals. However, at the time of persistence, which is in the second half of the course (time of exam 2), students' self-efficacy beliefs (ones' judgment of his or her ability to perform the task) play a more significant role. These results are novel given that all exams varied based on content only, and there was no variation in format and difficulty level of the exams.

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References


