Exploring the Influence of Academic Self-Efficacy, Engagement, and Test Anxiety on Students' Success at Exam

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Academic self-efficacy and engagement are closely related to successful results in exams. On the other hand, test anxiety may negatively affect students' success. The negative effects of test anxiety are stronger at exams in fundamental disciplines, like mechanics for civil engineering students. In this case, passing the exam may be difficult and require a three-step trial. This research explores the relationship between success at exams and the students' perceptions as regards their academic self-efficacy, learning engagement, and test anxiety. The approach is based on a comparison between students' perceptions and multiple regression analysis. The findings show that students who passed this exam reported higher self-efficacy and engagement, and lower test anxiety. The regression analysis revealed that keeping up with academic work, getting involved in class discussions, and nervousness during the exam were the main predictors of test results. Gender analysis showed that male students reported higher involvement in class discussions and female students reported more time spent on their studies.
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1 Introduction

Several studies relate academic success and students' satisfaction with academic self-efficacy and engagement [3, 15, 24]. Academic self-efficacy refers to the student's belief that he can accomplish academic tasks [4]. In this study, self-efficacy refers to effective time management, good concentration on school subjects, and keeping up with deadlines.

Student engagement refers to participation in behavioral, emotional, and cognitive involvement in educational activities [2, 10, 20, 26]. It also includes participation in discussions and interaction with teachers and colleagues.

A problem that arises during academic activities is test anxiety which may negatively affect students' success [7, 8, 18, 22, 28]. Anxiety is higher during exams and refers to negative emotions like fear of failure, panic, nervousness, and difficulty while concentrating on test subjects.

Understanding factors influencing first-year students' results is an important issue since failure may lead to dropout. This is even more critical in the case of so-called "barrier exams" [27,31], i.e. exams in fundamental disciplines, like mechanics in civil engineering curricula.

This research explores the relationship between exam success and students' perceptions of academic self-efficacy, learning engagement, and test anxiety. Two additional objectives are to analyze gender differences and identify the main factors that predict the results.

A comparative analysis between groups has been done on a sample of 107 engineering students from the University of Civil Engineering in Bucharest. In this respect, three categories of results have been considered: success at the first session, success after three sessions, and failure after three sessions. Then, a multiple regression was done to analyze the influence of these variables on examination results.

The rest of the paper is organized as follows: The next section presents the theoretical background. Section 3 presents the method, followed by sections 4, and 5 which present and discuss the study's results.

2 Related work

Self-efficacy refers to judgment about the task's successful accomplishment rather than actual performance [4]. Self-efficacy is a multifaceted concept that depends on the context of use [5, 23]. Perceived academic self-efficacy manifests in cognitive, motivational, affective, and selection processes. Self-efficacy influences students' school performance [4].

Jan analyzed the relationship between academic self-efficacy, computer self-efficacy, and satisfaction with online learning [14] and found that academic self-efficacy was the main predictor of student satisfaction.

Academic engagement is also a multifaceted variable [2, 20]. For Soria and Stebleton [26], academic engagement means interaction and participation in class discussions with new ideas, and insightful questions. They found that first-generation students have a lower academic engagement than other students.

Kinzie et al. [16] analyzed gender differences in student engagement in a large sample and found that female students are more engaged in academic activities. They also found differences in student engagement between types of colleges.

Vasconcelos and Almeida [29] investigated the academic expectations for future engineering first-year students. Their results showed that future enrolment correlates with high expectations as regards their future employment. The student's engagement is also related to the academic activities in the online environment. Martin & Bolliger [20] showed that engagement is important since it stimulates active learning, participation in collaborative workgroups, reflection, and discussion.

Nolte et al. [21] compared the effects of traditional exams and design practice on first-year students' design self-efficacy. They found that introducing a mid-semester design practice increases self-efficacy more than a traditional exam.

Trifoni & Shahini [28] analyzed how exam anxiety affects performance in a sample of 109 university students. They found that anxiety negatively affects their performance since they may forget what they learn and experience concentration difficulties. Among the causes of anxiety, they mentioned time pressure during the exam, lack of systematic study, poor exam preparation, the difficulty of the course, and bad results at previous tests.

Vitasari et al. [30] investigated the relationship between study anxiety and the academic performance of engineering students. They found that students reporting study anxiety had lower academic performance measured with GPA (Grade Point Average).

The study of Yanik et al. [32] investigated the sources of test anxiety in the case of engineering students. They found two major sources: time management and consequences of success/failure. As the main consequences that worry students, they mentioned success in specific coursework, degree completion, finding a job after graduation, and managing accumulated debt.

As Wingate et al. [31] pointed out, mechanics is a hard exam with a serious effect on student retention in engineering. Moreover, these kinds of "barrier courses" influence success in engineering studies. Their results based on a study at Georgia Institute of Technology show that students getting high scores in physics and mechanics exams have better GPAs.

The paper of Goldfinch et al [12] presented a knowledge engineering framework for the analysis of mechanics exams in engineering universities. The framework distinguishes between four types of knowledge: factual, procedural, conceptual, and principle areas and facilitates the analysis of errors students make during the exam. They found that students make more mistakes in the problem-solving procedure followed by mistakes in conceptual understanding. The authors conclude that students put more effort into solving the problem rather than gaining a deeper understanding of mechanics concepts.

Fengler & Ostafichuk [9] highlighted the importance of emotional and cognitive engagement during the examination and proposed a two-stage exam in mechanical engineering as a practice of team-based learning. Their findings showed that this format of exam leads to

better understanding and most students preferred it.

Nunez-Pena et al. [22] analyzed gender differences in test anxiety in a sample of 168 Spanish university students. Their findings showed that although female students experienced higher test anxiety and trait anxiety, their academic achievement was similar to their male colleagues.

Another work related to the effect of test anxiety on students' success has been published by Major et al. [17]. The study targeted first-year engineering students. Contrary to the findings of other studies, their study showed that students reporting higher test anxiety had better GPAs.

The study of Singh & Malespina [25] analyzed the influence of self-efficacy and test anxiety on the results of physics examinations in a research university in the US. While both predictors were significant, test anxiety also had an indirect effect on results mediated by self-efficacy. They explained the direct effect of test anxiety on the results by its effect on cognitive resources during the examination. They also analyzed gender differences and found that women reported lower self-efficacy and higher test anxiety.

Abdi-Zarrin et al. [1] investigated the role played by self-regulation and fear of failure on academic procrastination in a sample of Iranian university students. They found that academic procrastination correlates negatively with self-regulation and positively with fear of failure.

Emeka et al. [8] analyzed second-chance testing as a way to reduce text anxiety at STEM course exams. Their study found that students preferred this exam format, and the second trial reduced the reported text anxiety.

Another finding was that the second chance did not affect the student's attitude toward the first trial.

3. Method

3.1 Target discipline

This study refers to the exam in the first-year Mechanics I course, which is part of the Civil, Industrial, and Agricultural Construction specialization. This is a 5 credits course, with 2 course hours and 2 seminar hours per week. The learning results are verified through an exam scheduled in the summer session, after the end of the semester. Students who do not pass the exam may retake it twice in the outstanding session (which lasts 2 weeks in late July).

The exam consists of three problems and a theoretical subject. The results consist of a mark on a 1-10 evaluation scale. The problems are:

- Centers of gravity: compute the position of the center of gravity concerning a given reference system for a homogeneous flat plate made up by assembling flat plates of a simple shape.
- Equilibrium of systems of rigid bodies: compute the reactions in the external restraints for a statically determinate and stable system of three rigid bodies. Students must check if the system is statically determinate and stable, they must draw the free body diagram, write, solve, and verify the equilibrium equation.
- Plane simple trusses: compute the internal forces in the members of a plane simple truss; compute the reactions in the external restraints of the truss; compute the internal forces in the indicated members of the truss using "method of joints" and "method of sections".

3.2 Research questions

This study aims to answer four research questions:

Q1. Why do students fail the exam?
Q2. Why do students fail at the first session?
Q3 Which variables have the highest influence on the results?
Q4 Are there gender differences?

The first research question refers to students who failed after all sessions. The second refers to students who failed in the first session.

Several variables influence success or failure. In this study, three latent variables are considered: academic self-efficacy (ASE), learning engagement (LE), and test anxiety (TA).

For each latent variable, several measures have been collected.

3.3 Data collection

A questionnaire was administered to students after the first exam session. Completing the questionnaire was done voluntarily and students were told that anonymity is guaranteed. Students were invited to evaluate several items on a 5-point Likert scale.

Items have been adapted from existing measurement scales of academic self-efficacy, engagement, and test anxiety [2, 5, 6, 8, 11, 13, 19, 24].

107 students (64M/43F) answered the questionnaire. Two students are 40-49 years old, two are over 50, and the rest are between 18 and 29 years old.

Table 1 presents the measures of the three latent variables, their mean values, and standard deviations.

Table 1. Variables (N=107)

	Item	Statement	M	SD
ASE	ASE1	I believe I can keep up well with academic work	4.00	0.78
	ASE2	I believe I can manage my time effectively	3.67	0.82
	ASE3	I believe I can concentrate well on school subjects	3.83	0.82
LE	LE1	I get involved in things I do in class	3.62	0.98
	LE2	I get involved in class discussions	3.16	1.00
	LE3	I spend a lot of time on my studies	3.48	0.97
TA	TA1	During tests, I think about the consequences of failing	3.21	1.32
	TA2	During tests, I forget what I really know	2.73	1.23
	TA3	When I take a test, nervousness causes me to make errors	2.74	1.31

3.4 Procedure

For comparison reasons, the sample was split into four sub-samples, as follows:

- Students that passed the exam (N=91)
- Students that failed after all exam sessions (N=16).
- Students that passed the first exam session (N=61)
- Students that passed the second and third exam sessions (N=30).

Then, the mean value of each variable has been computed. The first two sub-samples are compared to answer the first research question, and the next two are compared to answer the second research question.

To answer the third research question, two regression analyses have been conducted by regressing the exam results on the variables under consideration.

A one-way ANOVA has been carried out to analyze the statistical significance of differences between sub-samples and to analyze gender differences about the students' perceptions.

4 Results

4.1 Why students fail the exam

Overall, 16 students out of 107 did not pass this exam, which means almost a 15% failure rate. The success rate was 83% for male students and 88% for female students.

Male students scored higher in the first session (M=6.22, SD=2.21) than female students (M=5.72, SD=2.11) but the difference was not statistically significant.

Figure 1 shows the differences in students' perceptions of self-efficacy, engagement, and test anxiety (mean values). The comparison is made between students who passed the exam and students who failed it. The items of academic self-efficacy vary between 3.73 and 4.05 for the first group and between 3.38 and 3.69 for the second showing that students who failed the exam after three sessions have a lower perception.

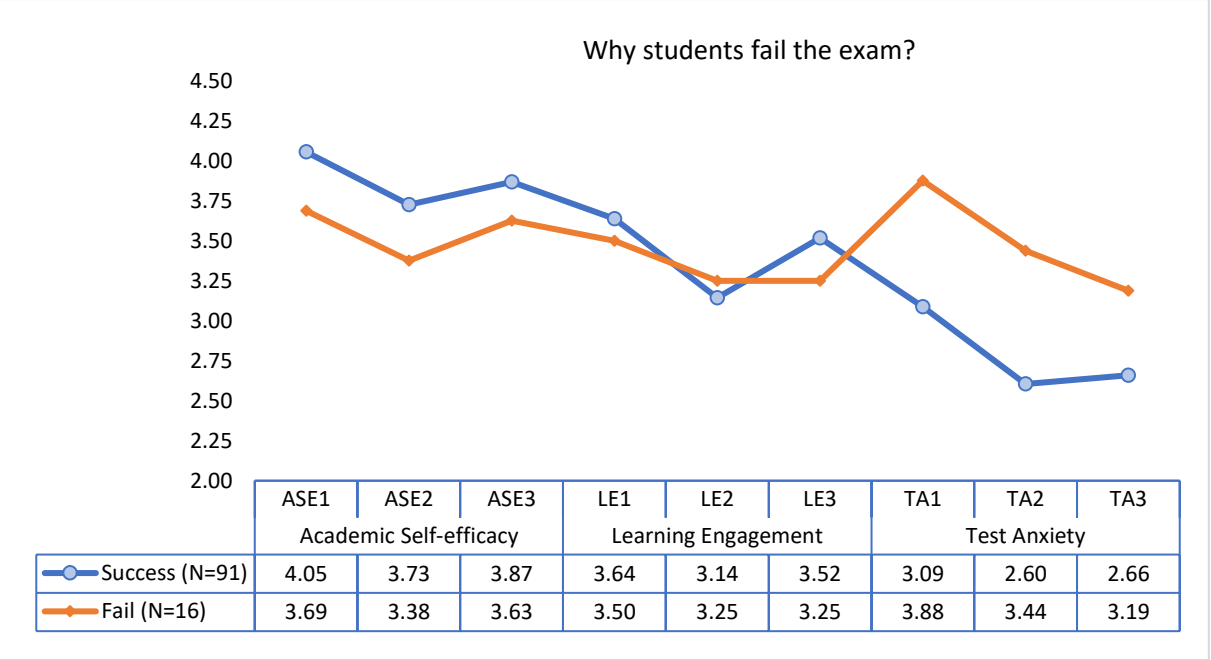
One-way ANOVA (1, 105, 106) test for significance shows that differences are statistically significant for ASE1 ($F=3.10$, $p=0.08$).

In both groups, the second item has the lowest mean value, suggesting that effective time management is a problem.

The situation is quasi-similar as regards the learning engagement, with one exception: students who failed the exam seem to be more active in class discussions.

Figure 1 shows that text anxiety is a serious barrier for students aiming to pass the exam.

In the first group, the test anxiety varies between 2.60 and 3.09; in the second, all measures are over the neutral value of 3.00, varying between 3.19 and 3.88. Overall, all students reported test anxiety.



	ASE1	ASE2	ASE3	LE1	LE2	LE3	TA1	TA2	TA3
	Academic Self-efficacy			Learning Engagement			Test Anxiety		
Success (N=91)	4.05	3.73	3.87	3.64	3.14	3.52	3.09	2.60	2.66
Fail (N=16)	3.69	3.38	3.63	3.50	3.25	3.25	3.88	3.44	3.19

Fig. 1. Comparison between students' perceptions (mean values)

One-way ANOVA (1, 105, 106) test for significance shows that differences are statistically significant for TA1 (F=5.057, $p=0.03$) and TA2 ($F=6.625$, $p=0.01$).

Both groups' first item (thinking about the consequences of failing) has the highest mean value. The differences between students' perceptions are higher for text anxiety than for the other two variables.

4.2 Why students fail at first session

Overall, 61 students out of 91 did not pass this exam in the first session, which means about a 67% success rate.

Figure 2 illustrates the differences in students' perceptions by comparing students who passed the exam in the first session with students who passed it in the second and third sessions.

As in the previous analysis, students with better results have a higher perceived self-efficacy, which varies between 3.84 and 4.31.

One-way ANOVA (1, 89, 90) test for significance shows that differences are statistically significant for all three measures of academic self-efficacy: ASE1 (F=25.327, $p<0.001$), ASE2 ($F=3.494$, $p=0.06$), and ASE3 ($F=15.702$, $p<0.001$).

Also, students who passed the exam at the first session reported higher learning engagement by getting much more involved in things they do in class, including class discussions. An exception is the third item, suggesting that they spend less time on studies.

One-way ANOVA (1, 89, 90) test for significance shows that differences are statistically significant for LE2 ($F=11.551$, $p=0.001$).

Test anxiety is much lower for students who passed the exam at the first trial which is similar to the situation in the previous section: students with better results at exams are experiencing less test anxiety.

One-way ANOVA (1, 89, 90) test for significance shows that differences are statistically significant for TA2 ($F=19.970$, $p<0.001$) and TA3 ($F=16.023$, $p=0.001$).

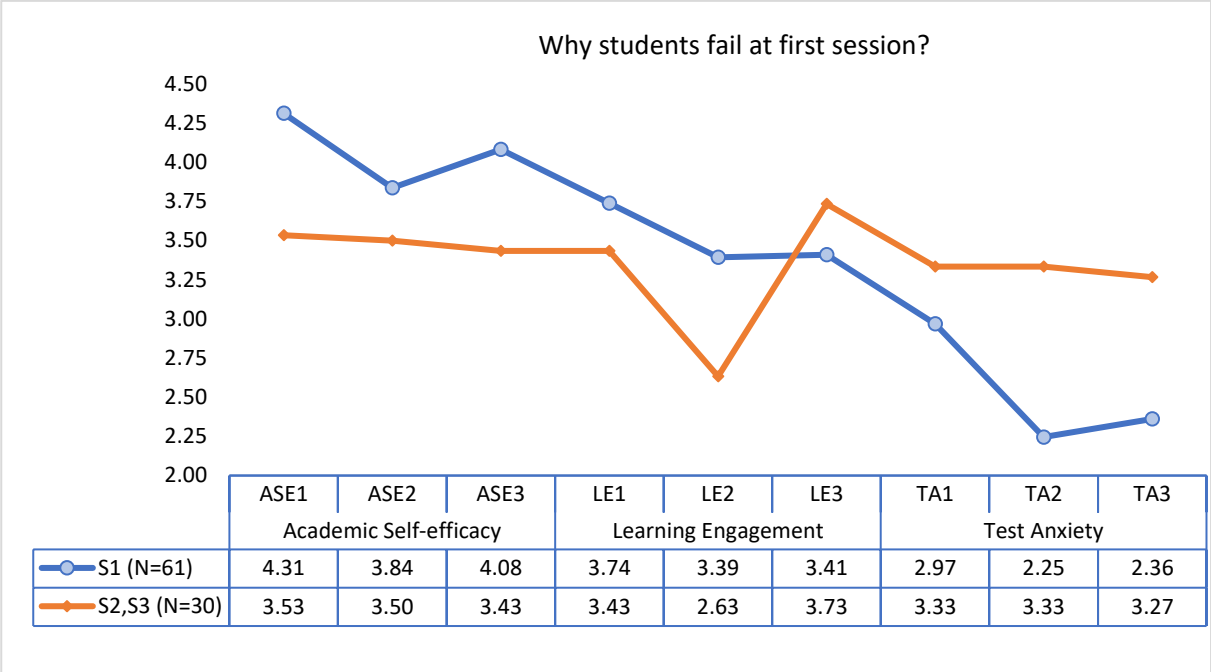


Fig. 2. Comparison between students' perceptions (mean values)

4.3 Regression analysis results

To answer the third research question, two regression analyses were conducted using the results (score on a 1-10 scale) as a dependent variable at the first exam session. The first was made on the whole sample (N=107), and the second on the sub-sample of students who passed the exam (N=91).

Table 2 presents the first regression results. Three of the nine independent variables were statistically significant, and one was marginally significant.

Multiple correlation (R=0.581) for regression was significantly different from zero, F (9,97) = 5.491, p = 0.000. The adjusted R^2 value indicates that 27.60% of the variability in exam results is predicted by the independent variables.

Table 2. Regression analysis results (N=107)

Variable	Coefficient	Standard err	t-value	p-value
intercept	2.534	1.424	1.779	0.078
ASE1	0.871	0.307	2.839	0.006
LE2	0.592	0.241	2.455	0.016
TA2	-0.378	0.211	-1.791	0.076
TA3	-0.416	0.185	-2.251	0.027
R^2=0.338, Adjusted R^2=0.276, F(9,97)=5.491, p=0.000				

The results show that keeping up well with academic work (ASE1) and getting involved in class discussions (LE2) have a significant positive influence on the result. The best predictor of success in this exam is academic self-efficacy (β=0.871, p=0.006), followed by learning engagement.

The other two variables show a negative influence of test anxiety on results: forgetting what the student knows (TA2) and making errors because of nervousness (TA3). The first is only marginally significant s (β=-0.378, p=0.076) and the second is significant (β=-0.416, p=0.027).

The results of the second regression are presented in Table 3.

Multiple correlation (R=0.611) for regression is significantly different from zero, F (9,81) = 5.367, p = 0.000. The adjusted R^2 value indicates that 30.40% of the variability in exam results is predicted by the independent variables.

Table 3. Regression analysis results (N=91)

Variable	Coefficient	Standard err	t-value	p-value
intercept	2.918	1.499	1.947	0.055
ASE1	0.804	0.324	2.479	0.015
LE2	0.783	0.251	3.115	0.003
TA1	0.418	0.196	2.131	0.036
TA3	-0.558	0.196	-2.842	0.006
R^2=0.373, Adjusted R^2=0.304, F(9,81)=5.367, p=0.000				

The results are similar to the previous regression in that keeping up well with academic work (ASE1) and getting involved in class discussions (LE2) have a significant positive influence on the results. The best predictor of success in this exam is academic self-efficacy (β=0.804, p=0.015), followed by learning engagement (β=0.783, p=0.003).

The influence of text anxiety is different for students who passed the exam. One measure of test anxiety (making errors because of nervousness) has a significant negative influence (β=-0.558, p=0.006) and is the next important predictor of success (negative influence).

Another measure of test anxiety, which points to thinking about the consequences of failing (TA1), has a positive influence on results (β=0.418, p=0.036), which suggests that this acts as a motivator for students during the exam.

4.4 Gender analysis

Gender analysis on the whole sample shows several differences as regards the variables under consideration. The gender differences are presented in Table 4.

Men reported slightly higher two measures of academic self-efficacy. However, a one-way ANOVA (1, 105) showed no statistically significant differences.

Women reported higher test anxiety than men but again none of the differences was statistically significant.

Concerning learning engagement, statistically significant differences were found for the last two items: LE2 *(F=11.598, p=0.002*) and LE3 *(F=12.343, p=0.001*). While male students reported higher involvement in class discussions (LE2), female students reported they spent more time on their studies.

Table 4. Gender differences (N=107)

Item	Gender	M	SD
ASE1	M	4.00	0.82
	F	4.00	0.72
ASE2	M	3.66	0.91
	F	3.70	0.67
ASE3	M	3.83	0.86
	F	3.84	0.75
TA1	M	3.11	1.33
	F	3.35	1.29
TA2	M	2.58	1.31
	F	2.95	1.07
TA3	M	2.58	1.32
	F	2.98	1.26
LE1	M	3.61	1.11
	F	3.63	0.76
LE2	M	3.41	1.00
	F	2.79	0.89
LE3	M	3.22	1.02
	F	3.86	0.77

5. Discussion

This study contributes to a better understanding of variables that influence students' success in fundamental disciplines.

The results show that students with higher academic self-efficacy and learning engagement perform better. Another finding is that although all students experienced test anxiety, students who failed reported higher test anxiety. Both findings are in line with similar results in the literature [20, 26, 28].

The findings are supported by two comparisons: between students who pass and students who fail after three exam sessions and between students who pass the exam at the session and students who need one or two more trials.

The comparison of learning engagement revealed two exceptions. The first, between success and failure, shows that students who couldn't pass the exam were more involved in class discussions. Since the discussions are mainly during seminars (practical works) this suggests they are looking for support in problem-solving. The second, concerning success at the first session, shows that students who failed spent more time on studies which suggests that some concepts are not so well understood. This may also be due to their little involvement in class discussions.

Regression analysis results confirm the comparison results and highlight important indicators of academic self-efficacy and learning engagement: keeping well with academic work and getting involved in class discussions had the highest influence on results.

An interesting finding concerns the first indicator of test anxiety which refers to the consequences of failing. The regression analysis revealed that for students who passed the exam, thinking about the consequences of failing was a motivator. This is in line with the findings of Major et al. [17].

Another interesting finding concerns the contrasting gender differences in learning engagement. Male students reported higher involvement in class discussions, but less time spent on their studies. This could be explained by the multidimensional nature of academic engagement which manifests in different forms of engagement.

There are several limitations of this study, mainly related to the relatively small sample size and the fact that the sample is drawn from only one university.

6. Conclusion

This study highlighted several specific aspects regarding the influence of academic self-efficacy, learning engagement, and test anxiety on the student's success in exams.

Educators should pay more attention to the mastering of conceptual knowledge by students as a precondition for better results in problem-solving.

Teachers should be aware that test anxiety is an important issue and help students to reduce it. In this respect, teacher support should be diversified, by including better preparation of exams, mid-semester tests, and team-based learning strategies.

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