

# STUDENT ACCEPTANCE AND PERFORMANCE OF A VIRTUAL PLATFORM FOR TRAINING AND EVALUATION OF STATICS COURSE

Jorge Luis Restrepo Ochoa  
School of mechanical engineering  
EAFIT University  
Medellin, Colombia  
jrestrep@eafit.edu.co

Jaime Leonardo Barbosa Pérez  
School of mechanical engineering  
EAFIT University  
Medellin, Colombia  
jbarbosa@eafit.edu.co

Julian Arenas Berrio  
School of mechanical engineering  
EAFIT University  
Medellin, Colombia  
jarenas5@eafit.edu.co

**Abstract**— Due to the poor performance of students in the Statics course in engineering between 2006 and 2011, whose approval rating was 48.8%, the Engineering School of EAFIT University has developed a virtual platform for students to train and for teachers to evaluate the learning of the subject with a series of exercises implemented in a dynamic system that generates a different version of the exercises for each attempt, the teacher can apply exams with confidence that the answers will not be copied and memorized, and the students have a self-evaluating tool which allows to know their level of learning in relation to the course goals. With the operation of the platform it has been achieved a decrease in dropout rates, and an increase in the approvals rates of the course and it has also generated a positive attitude and motivation in students towards the course. The dropouts have decreased by 21% and the approval of the course has increased by 17.2% according to official records in enrollment and students grades of the course for the period between 2011-2 and 2015 - 2. Regarding to the acceptance of the platform a survey of 10 questions were conducted on different aspects of the platform to 513 students who completed the course during the semesters 2014-2, 2015-1 and 2015-2. In the literature, there are cases of implementation of virtual environments for teaching and evaluation of Statics course in engineering, but studies on the acceptance of virtual tools from students for their classes are not included, and that is the reason why this approach is included in this article. To analyze the data two types of questions are distinguished: discriminative and approving questions. The discriminative type filters the students under what career they are enrolled, the number of semesters they spend to approve the Statics course, the number of hours per week they dedicate to study this course, the preferences and places from where they access to the virtual platform. The approving questions inquire about their experience in the training process, their adaptation taking the quizzes in the platform and their opinion about the implementation of this kind of tool in other courses. This paper presents the analysis of the collected data and draws conclusions in order to improve this platform for teaching and learning process in Statics course in engineering.

**Keywords**— *Engineering education, Statics, student assessment. Virtual platform.*

## I. INTRODUCTION

Statics is one of the basic courses in engineering programs related to technical systems and structures design [1] [2],

which is why the learning process is forwarded to the appropriation of concepts that are applied later on the career. Moreover, it is also known that Statics presents difficulties on its understanding due to the integration of mathematical and classic mechanics knowledge [3] [4] [5]. At EAFIT University, an average of 48.8% of the students enrolled to the course approve it, which is the reason why since 2012 a virtual platform has been implemented with the aim of improving the learning process in students [6].

At the same time, the evaluation is a crucial aspect to the students as it lets them guarantee the acquisition of skills and knowledge, as well as the approval and progress on their training process [7]. Considering the above, opinions about the mechanisms for the course's evaluation in the virtual platform are sought.

In the literature can be found cases on the implementation of virtual environments for teaching and evaluation of Statics course in engineering [8] [9], besides studies on the student's acceptance regarding the use of virtual tools for their classes [10] [11] [12]; nevertheless, they lack in information about the student's dropout rates as well as disapprobation when using virtual platforms. In this paper is shown the student's acceptance and the advances achieved on the implementation of the virtual platform for training and evaluation in Statics course.

## II. METHODOLOGY FOR RESEARCHING

### A. Course evaluation description

The course evaluation consists of three midterm exams, an accumulative final exam and weekly quizzes during twelve weeks under a professor supervision in a different time from the classes' schedule. Within the specific subjects of the Statics course the following topics are evaluated: Statics of particles; Statics of rigid bodies; Centroids and inertias; Structure analysis and machines: Trusses, frames and machines; Internal and external forces in beams with their respective diagrams; Hydrostatics pressure; Cables under concentrated and distributed loads; and Friction with application on wedges.

### B. The dynamic evaluation system

The evaluation system SIEVAL is the virtual tool which the engineering school has been implementing since year 2012 in a LMS (Learning Management System) platform named Dokeos, and the next semester another LMS based platform named Chamilo was used, but in both cases the required time on the creation of new content was high, whereby since semester 2014-2 Moodle is used because it reduces the creation and execution time of the evaluations, besides of being open source and having an online support community. The programming of the questions is made in JAVA language to create different versions of the exercise by modifying the variables in a range previously defined. It is worth noting that LMS platforms have been used in the learning context on the implementation of activities such as virtual laboratories and remote courses.

The evaluation system allows the teacher to program the tests' details (type and quantity of exercises, weight percentage of each question in the global grade, starting time and test duration, enabled students to take the quiz, evaluation results, among others). As the platform generates a different version of the exercise for each attempt, the teacher can enable the exam with the safety that the answer will not be copied, and the student has a tool for self-evaluating and knowing his learning level in relation to the course goals.

### C. The survey

In order to know the acceptance of the virtual platform a 10 questions survey is applied to the students who were attending Statics during semesters 2014-2, 2015-1 y 2015-2, the questions are show in TABLE I. In total, 513 opinions are collected to analyze, regarding both the virtual platform structure and the exercises' approach used.

TABLE I. APPLIED SURVEY TO ENGINEERING STUDENTS

Survey	Questions	
	Text	Type of question Subhead
1	What career are you currently studying?	Unique answer
2	How many times have you taken the Statics course?	Unique answer
3	What strategies do you generally use to study Statics?	Multiple answer
4	From what places do you use the platform to solve the workshops?	Multiple answer
5	Indicate which of the following devices do you use for login into the platform (You can choose several answers)	Multiple answer
6	Do you prefer to study the subject with exercises from: (being 1 the less preferred and 5 the most preferred)	Importance from 1 to 5
7	Your experience in the use of the platform has been:	Unique answer
8	About making the weekly quizzes in the platform, your opinion is:	Unique answer
9	Do you consider that the platform is a good tool to study?	Unique answer
10	In your opinion, should other courses implement a virtual platform to support the training and the evaluation as it is done in Statics?	Unique answer

To analyze the data obtained through the survey two types of questions are distinguished: discriminants and evaluative. The first type profiles the students regarding the course they belong to, the times they have attended the course, weekly study hours, preferences and places from where they login to the virtual platform. The evaluative questions register the score assigned by the students to the tool when consulted about the experience in the training, the weekly quizzes and the implementation of this system for training and self-evaluating in other courses that do not have one.

## III. RESULTS AND DISCUSSION

### A. Course's approval

Define EAFIT University's politics allow the student to cancel the Statics course from the beginning until the 80% of the grades are reported in the institutional system, for this study the course's cancellation report is shown in the Fig.1 from semester 2006-1 to the semester 2015-2.

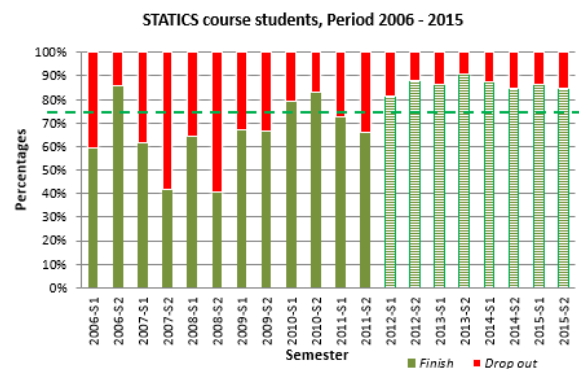


Fig. 1. Statics course: Finish and drop out 2006 - 2015

The evaluation grades are obtained quantitatively in a range from 0 to 5. The course is approved if the average grade during the semester is equal or higher to 2.95. The approval results for the second semester of 2015 are presented in the Fig.2

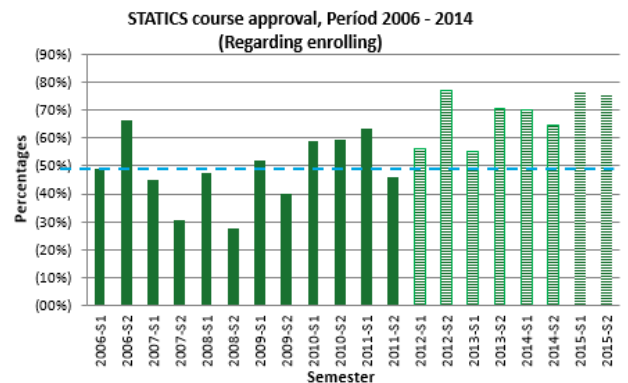


Fig. 2. Statics course: approval 2006 - 2015

### B. Survey's statistical data

The discriminant questions are those that profile the student and hypothetically condition the student's appreciation about the virtual platform, for the applied survey questions 1 to 5 are considered as discriminants.

For question No.1 the student's career is inquired and the results are shown in the TABLE II., in this case a unique answer is mandatory and it was answered by all the students.

TABLE II. ENGINEERING STUDENTS PER CAREERS

¿What career are you currently studying?	Frequency	
	Frequency	Relative frequency
Mechanical Engineering	168	32,7%
Civil Engineering	268	52,2%
Production Engineering	75	14,6%
Other	2	0,4%

For the previous frequency distribution, it can be observed that Civil Engineering has a higher number of students attending Statics course, in second place are Mechanical Engineering students and in fewer number the students who belong to Production Engineering. The other careers option was answered by students who belong to a special project and they take Statics to apply concepts in a specific development.

Question No. 2 asks about the times the student has attended Statics, in this case the majority of students (86.9%) attend the subject for the first time, on the other hand the 13% remaining they have attended the subject twice or more. Due to University's politics a person can attend any subject the necessary number of times as far as his accumulated average grade is equal or greater than 3.0.

TABLE III. TIMES THAT STUDENTS HAVE TAKEN STATICS COURSE

How many times have you taken the Statics course?	Frequency	
	Frequency	Relative frequency
First time	446	86,9%
Second time	51	9,9%
Third time	14	2,7%
Fourth time or more	2	0,4%

In the question that asks about the study strategies for this subject, the student is allowed to choose one or more answers, whence the number of times that each option is chosen is analyzed, in total 1090 mentions are obtained and the results are shown in TABLE IV.

It is worth noting that the review of books' content and exercises and the review of class' notes and examples have a low participation (34.76%) as a sample that the traditional methods of study are less preferred than interactive and dynamic tools, such as the workshops, videos and tutorials

uploaded in the virtual platform, whose participation on the answers was 65.2%.

TABLE IV. STUDENT STRATEGIES IN STATICS COURSE

What strategies do you generally use to study Statics?	No.	Percentages	
		Percentage in relation to the total amount of answers	Percentage in relation to the respondents
Review of books' content and exercises	77	7.06%	15%
Review of class' notes and examples	303	27,7%	59%
To do the virtual platform workshops	447	41%	87,1%
Review of digital contents (videos, tutorials, etc.)	263	24.2%	21,2%
Total amount of answers	1090	100,00%	
Total amount of respondents	513		182,3%

In question No. 4 the place from where the students use the virtual platform for training is consulted, multiple answers are allowed and the frequency of mention is shown in TABLE V. In this case, the house is the most used place to solve the platform's exercises with a frequency of 457 mentions, however the University as place used for studying has great participation (46%); the option others correspond to people who use the platform from their work place.

TABLE V. PLACES USED TO STUDY STATICS IN THE PLATFORM

From what places do you normally use the platform to solve workshops?	No.	Percentages	
		Percentage in relation to the total amount of answers	Percentage in relation to the respondents
House	457	53,1%	89,1%
University	397	46%	77,4%
Others	8	0,9%	1,55%
Total answers	862	100,00%	
Total amount of respondents	513		168%

With the goal of determine the login sources for the training in the platform, the students are asked about the devices they use to login to the virtual tool, the results are shown in TABLE VI. Multiple answers are allowed.

TABLE VI. DEVICES USED TO STUDY STATICS IN THE PLATFORM

Indicate which of the following devices do you use for login into the platform (You can choose several answers)	No.	Percentages	
		<i>Percentage in relation to the total amount of answers</i>	<i>Percentage in relation to the respondents</i>
Computer	506	63%	98,6%
Cellphone	137	17%	26,7%
Tablet	160	20%	31,2%
Other	0	0%	0%
<b>Total answers</b>	803	100,00%	
<b>Total amount of respondents</b>	513		156,5%

From the previous table can be observed that students keep a high tendency of using the platform through the computer, on the other hand approximately the third part of the students use a tablet or cellphone to log in. The LMS Moodle allows to visualize the contents in different devices what increases the possibilities of students to train themselves through the exercises.

Statics is a subject that requires the exercises solution during the training process as well as for the evaluation, which is the reason why the students are asked about the preferences in relation to the exercise's source. 5 options are shown in TABLE VII. which are ordered from 1 to 5, being 1 the less preferred and 5 the most preferred, in case the student does not order the 5 options the answer is not taken into account. In consequence 486 answers are valid.

TABLE VII. STUDENTS PREFERENCES TO STUDY STATICS

Do you prefer to study the subject with exercises from:	Frequency					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	Average grade
<b>Suggested textbook (Beer &amp; Johnston)</b>	206	101	106	45	28	2,15
<b>The platform</b>	25	11	30	66	354	4,46
<b>Classes' notes</b>	22	47	107	218	92	3,6
<b>Mates' summaries from previous semesters</b>	236	160	46	17	24	1,8
<b>Exams from previous semesters</b>	68	104	167	102	44	2,89

The Based on the information above, it can be observed that the virtual platform is the most preferred for doing exercises being mentioned 354 times in the scale 5, besides it gets an average grade of 4.46, above any other option. In the

second place of preference are the classes' notes where they find solved exercises and some suggested exercises. In the third place are found the others' semesters exams where the students get to know the evaluation methodology. Finally, the suggested textbook, Vector Mechanics for Engineers by Beer & Johnston can be found in the fourth position.

The platform is evaluated through the students' opinions in a qualitative scale of satisfaction that includes options from very satisfactory to less than satisfactory. It is observed in TABLE VIII. that the 17.5% of the students have a normal, less than satisfactory or no satisfactory experience in relation to the evaluation system, compared to the 82.5% remaining who have had a satisfactory or very satisfactory when doing exercises and being evaluated in the virtual platform.

TABLE VIII. STUDENTS EXPERIENCE IN PLATFORM

Your experience in the use of the platform has been:	Frequency	
	<i>Frequency</i>	<i>Relative frequency</i>
Very satisfactory	201	39,2%
Satisfactory	222	43,3%
Normal	75	14,6%
Less than satisfactory	14	2,7%
No satisfactory	1	0,2%

For question number 8 shown in TABLE IX., the student is asked about the fact that the weekly quizzes are done in the virtual platform, which correspond to the 20% on the final grade. The average duration for taking the quizzes is 30 minutes with multiple-choice questions with unique answer.

TABLE IX. OPINION WEEKLY QUIZZES

About making the weekly quizzes in the platform, your opinion is:	Frequency	
	<i>Frequency</i>	<i>Relative frequency</i>
I totally agree	244	47,7%
I agree	202	39,5%
I do not agree or disagree	42	8,2%
I disagree	19	3,7%
I totally disagree	4	0,8%

According to the results, 87,2% of students approve the weekly quizzes evaluation through the platform, that percentage shows the system acceptance as a complement for the regular classes. On the other side, 65 answers from the 511 not answered, show disagreement with the weekly quizzes in the platform.

The evaluation system was conceived with the aim of improving the students' learning processes through a dynamic platform that provides a different exercise to each person when they go to the respective exam, in consequence, the students' opinion, regarding the platform as a complementary tool for

studying is asked. The results for this question are shown in the TABLE X.

TABLE X. PLATFORM LIKE TOOL TO STUDY

Do you consider that the platform is a good tool to study	Frequency	
	Frequency	Relative frequency
I totally agree	375	73,1%
I agree	123	24,0%
I do not agree or disagree	13	2,5%
I disagree	1	0,2%
I totally disagree	1	0,2%

From the previous table can be observed that there are 498 students that consider the platform as a good tool, which represents the 97,1% from the studied population, a high percentage compared to the 2, and 9% who do not agree or totally disagree. This question shows the relevancy of including virtual platforms to support the regular classes.

In the last question asked in the survey, the student is asked about the relevancy of using virtual tools with dynamic exercises to support the regular classes, the results for this question are shown in the TABLE XI.

TABLE XI. VIRTUAL PLATFORM TO IMPLEMENT IN OTHERS COURSES

In your opinion, should other courses implement a virtual platform to support the training and the evaluation as it is done in Statics	Frequency	
	Frequency	Relative frequency
I totally agree	374	72,9%
I agree	105	20,5%
I do not agree or disagree	24	4,7%
I disagree	7	1,4%
I totally disagree	3	0,6%

From the results of question number 10 can be seen that 93,4% of the students agree or totally agree with the implementation of virtual platforms in their learning processes, a high rate of acceptance shows the relevancy of these kind of tools from the student's perception to the current education.

Finally, Cronbach's alpha is used to evaluate the reliability of the survey. This requires the calculation of variances of each question, the sum total of the variances and the total variance. The total number of items is also a required parameter.

TABLE XII. CRONBACH'S ALPHA FOR RELIABLE SURVEYS

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Variance	0,5	0,2	0,2	2,2	0,2	0,2	0,6	0,7	0,3	0,5
Summation Variances	5,69									
Total variance	21,37									
Cronbach's alpha	0,82									

## IV. CONCLUSIONS

Since the first semester of 2012 with the implementation of the virtual tool in the Statics course, a decrease in the dropouts rates can be noticed from 35.2% to 14.2%. In the same way, the percentage of people who approve the subject increased from 49, 3% to 68,1%. The percentage of people who failed was kept in 18%, but as the dropouts reduced, the chance of passes the course is increased.

The survey's results in questions like "Your experience in the use of the platform has been: (question number 7)"; "About making the weekly quizzes in the platform, your opinion is: (question number 8)"; "Do you consider that the platform is a good tool to study (question number 9)", reflect the high acceptance that the platform had. These results indicate a high motivation level in the students about the tool and a better performance in their academic results.

Validating the virtual tools trough surveys is a fast and economic alternative in order to determine aspects to improve on. These aspects are critical in the learning and evaluation process. A value of 0.82 in the Cronbach's alpha indicates that the results are considered of "good reliability".

Future work includes increasing the dynamic questions bank and validating it with the Item Response Theory.

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