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ANALYSIS ON THE USE OF JAVASCRIPT AND ADOBE FLASH PROGRAMS FOR TEACHING PHYSICS IN CIVIL ENGINEERING

BY

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Abstract. In the last decade to make the learning of physics more effective for the first year students of the faculties of Civil Engineering and Building Services and Hydrotechnics, Geodesy and Environmental Engineering within the “Gheorghe Asachi” Technical University of Iași, Romania we have elaborated computer simulations of physics phenomena in Adobe Flash and JavaScript programs and created a virtual physics laboratory. In the process of teaching and learning physics the computer simulations have developed students’ interest and curiosity for physics phenomena and laws. Also, the use of the computer simulations and virtual physics laboratory has led to the increase of marks at laboratory tests and in final examinations. The paper presents the results obtained over the past two academic years at laboratory tests and in final exams by the students enrolled in the first year of Faculty of Civil Engineering and Building Services studying in Romanian and English (RO+EN) and the impact of the use of computer simulations and virtual physics laboratory on the

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improvement of their marks and, also establishes the differentiation of these results according to students' gender. In this view we have performed a statistical study whose subject was 351 students (RO+EN) among 70 was female students and 281 male students. Our statistical study illustrates that even though the male students are numerically more numerous the female students have outperformed male students in all in the academic years 2016-2017 and 2017-2018. Also, the students gave us their feedback to a questionnaire that includes questions about the usefulness of using computer simulations during the physics laboratory. We present the feedback and some considerations on student performance at laboratory activities and in final exams from students taking the Physics 1 course at the Faculty of Hydrotechnics, Geodesy and Environmental Engineering of our University. These are also first year students, enrolled at the Civil Engineering section and studying in Romanian.

Keywords: physics; Adobe Flash; JavaScript; Civil Engineering; statistical analysis.

1. Introduction

In the context of the development of new technologies of teaching and learning physics, making virtual applications as efficient as possible and optimizing the learning process of engineering students has become a real challenge. Nowadays, we report the presence of many high-quality virtual applications used in the learning process (Fang and Guo, 2016; Gómez *et al*., 2017; Gubsky and Zemlyakov, 2018; Jong *et al*., 2013; Lee and Hwan, 2015; Panagiotopoulos and Manolis, 2016; Phet. colorado, 2019).

In our turn, we have elaborated a series of computer simulations (Radinschi *et al*., 2008; Radinschi *et al.*, 2016; Radinschi *et al*., 2017) and we have organized a virtual physics laboratory for the students enrolled in the Physics 1 course (RO+EN) at the Faculty of Civil Engineering and Building Services and in the Physics 1 course in Romanian at the Faculty of Hydrotechnics, Geodesy and Environmental Engineering within the "Gheorghe Asachi" Technical University of Iași, Romania [server.ce.tuiasi, 2019]. Besides Physics, our students have included in the curricula a number of specialized disciplines that use the knowledge acquired in our course (Banu *et al*., 2014a; Banu *et al*., 2014b; Groll and Ţăranu, 2003; Groll *et al.*, 2007; Ibănescu and Toma, 2013; Olteanu, 2018; Rujanu and Groll, 1996; Ţăranu *et al*., 2013). Moreover, the use of primary phenomena of a physical nature is even more useful when it is necessary to describe new areas of competence, such as the lighting engineering that is to be released from the wider sphere of electrical engineering, in order to assert itself, according to the approach described in (Beu *et al*., 2016). The process of building competencies by "recovering" the physical phenomena that are manifested in engineering generates an intellectual satisfaction that turns into an authentic intrinsic motivation, but we must not neglect the extrinsic motivation and the phenomena that are manifested at group

level, with character often negative, as demonstrated in (Galatanu, 2017). The computer simulations have been designed using the Adobe Flash program [Adobe Flash, 2019], and JavaScript [JavaScript, 2019] language together with the modern facilities brought about by the HTML5 [HTML5, 2019] standard. The diversity of the studied physics phenomena and laws allowed us to choose from a wide range of applications the ones that we considered to be the most illustrative and which have the most important applications in Civil Engineering and Building Services, and to elaborate their virtual applications.

These computer simulations are placed on the faculty server in the virtual physics laboratory http://server.ce.tuiasi.ro/~radinschi/simulation/default.html and can be used by the students before the physics laboratory class or run during the real experiment.

The paper proposes to illustrate the role played by the computer simulations and virtual physics laboratory to the increase of the first year (RO+EN) students' marks in the last two academic years and, also to present a statistical study concerning the results obtained by the students at laboratory tests and in final examinations and highlights the differences between these results according to students' gender. The efficiency of the use of computer simulations in fostering the success of students in the Physics 1 course is highlighted by the students' answers to a questionnaire.

2. Methods

The activity at the physics laboratory was carried out in small groups of two up to five students being scored and being equal to 40% of the final exam mark. The work of the students in the physics laboratory has been guided and monitored by an instructor.

The virtual physics laboratory contains virtual applications developed in Adobe Flash (Adobe Flash, 2019), and JavaScript (JavaScript, 2019) and HTML5 (HTML5, 2019). The students had the opportunity of choosing between to work or not with the virtual applications and the virtual physics laboratory. Most of the students have chosen to work with the computer simulations and the virtual physics laboratory. Their options have been to work both before attending the physics laboratory and, also during the physics laboratory classes. Most of the students chose to use the computer simulations during the physics laboratory classes, but the percentage of the students who used the computer simulations from campus or from home is not negligible either.

3. Results and Discussion

The first year students from the Faculty of Hydrotechnics, Geodesy and Environmental Engineering have used the computer simulations for the first time in the academic year 2017-2018, so the collected data concerning the

marks at physic laboratory and in final exams were not enough to allow the elaboration of a statistical study. From the discussions with them, we have concluded that computer simulations have helped them to improve their knowledge concerning physical phenomena and laws, and however enabled them to obtain better marks at laboratory classes and in final examinations. Their feedback concerning the use of computer simulations was also positive and in the favour of this method of teaching and learning physics.

The statistical analysis has been carried out on a number of 351 students (RO+EN) of the first year of the Faculty of Civil Engineering and Building Services, of which the number of female students represents 20% of all students, and the number of male students represents 80% of all students, respectively over the total of the two years which were the subject of the statistical study. These percentages are represented in Fig. 1.

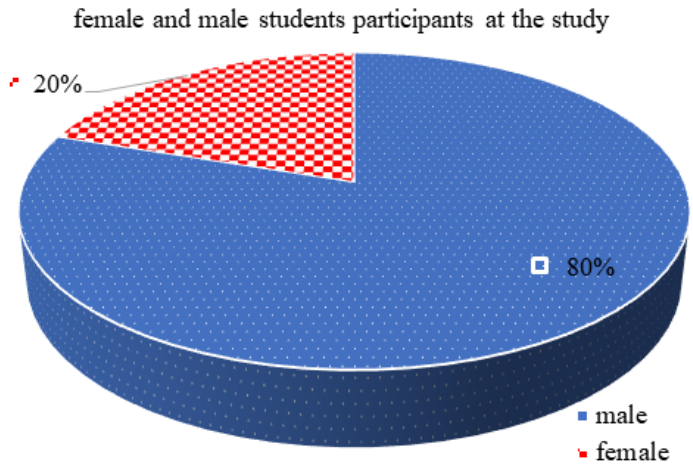

Fig. 1 – The percentages of female and male students participants at the statistical study.

From the statistical study it results the deviation from the general mean of male/female students' averages as in Table 1.

Table 1

The Deviation from the General Mean of Male/Female Students' Averages

Year	2017-2018		2016-2017	
	F	M	F	M
RO	0.7841	– 0.1697	0.4187	– 0.1015
EN	0.2857	– 0.0952	1.0067	– 0.2575
GEN	0.1326	– 0.0433	0.2809	– 0.0691

Also, in Table 2 we have the values of the average and standard deviations of final marks for each academic year 2016-2017 and 2017-2018, respectively.

Table 2
The Values of Average and Standard Deviations of Final Marks on Each Academic Year 2016-2017 and 2017-2018, Respectively

Year	average			Standard deviation		
	M	F	general	M	F	general
2017-2018	7.88	8.06	8.03	1.23	1.36	1.29
2016-2017	8.64	8.99	8.75	1.24	0.98	1.23

In Table 3 we present the values of averages of final marks on each academic year 2016-2017 and 2017-2018 for each gender.

Table 3
The Values of Averages of Final Marks on Each Academic Year for Each Gender 2016-2017 and 2017-2018

Year	2017-2018		2016-2017	
	F	M	F	M
RO	8.8095	7.8557	9.1667	8.6465
EN	8.0000	7.6190	9.6364	8.3721
GEN	8.0579	7.8820	8.9928	8.6428

The statistical analysis performed for a number of 351 students (RO+EN) of the first year led to the conclusion that the distribution of the marks in final examinations is as given in Fig. 2, resulting better performances of female students in both academic years.

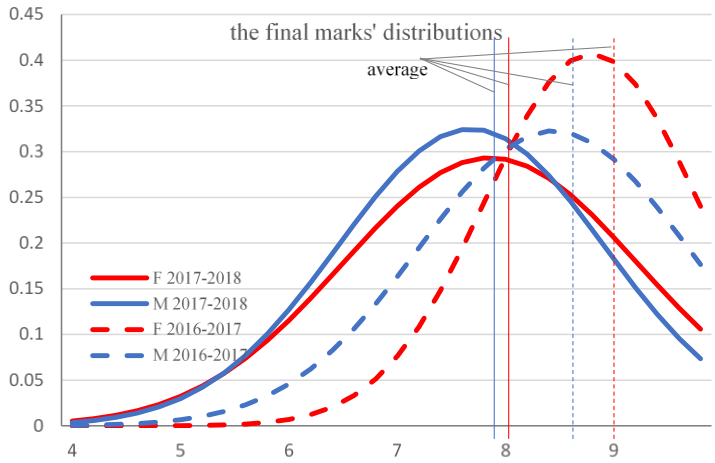

Fig. 2 – The distribution of final marks of the students for each gender for both academic years 2016-2017 and 2017-2018.

Fig. 2 also shows a more balanced distribution of students marks for female students vs. male students in the academic year 2017-2018, compared to

the previous academic year, for which we note that female students have a higher probability of higher marks than male students.

The distribution of laboratory marks of students for both academic year 2016-2017 and 2017-2018, for each gender is presented in Fig. 3.

Note that female students have a higher probability of higher laboratory marks than male students.

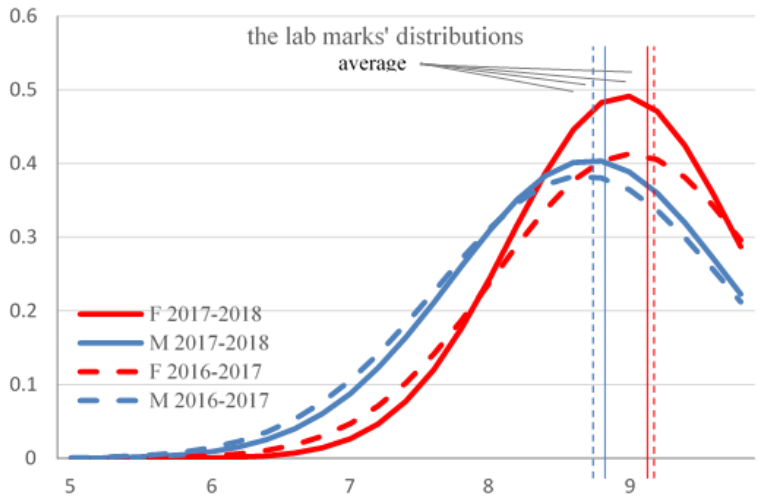

Fig. 3 – The distribution of laboratory marks of the students for each gender for both academic years 2016-2017 and 2017-2018.

According to the computed averages on each studied group, there is a difference between female students and male students' scores for each academic year. To confirm the hypothesis that female students' scores are higher than male students' scores we applied an Unequal Variance T-Test, comparing female students' and male students' marks for each academic year.

The established null hypothesis is that the mean scores of the two groups are equal, the alternative hypothesis being that there are differences between the averages of the two groups studied.

With the values calculated for the academic year 2017-2018, $t = -2.0236$, and $t = -2.357$ for the academic year 2016-2017, respectively and comparing these values with the values corresponding to the number of degrees of freedom ($nDOF = 45$ for 2017-2018 and $nDOF = 35$ for 2016-2017, respectively) and with a confidence level of 95% in the student distribution table, we can reject the null hypothesis, that the scores of the two groups studied for each academic year are equal.

Further, also according to the data of the statistical study it can be concluded that the students' users of the computer simulations and virtual physics laboratory have significantly increased their scores at the laboratory tests and in final examinations. The female students had a strong preference for

using the virtual applications and were less attracted to physics laboratory practice and this is also confirmed by the percentage of the female students who have worked with computer simulations in both academic years.

Moreover, our students have answered to a questionnaire about the usefulness of using computer simulations during the physics laboratory. For the Faculty of Hydrotechnics, Geodesy and Environmental Engineering the questionnaire has been applied to our first year students enrolled at the Civil Engineering section and studying in Romanian.

Among the questions of the questionnaire we list the most illustrative ones, such as:

1) Do you think that the use of computer simulations is useful for the understanding of physics phenomena and laws?

2) How often did you access the virtual physics lab?

3) Do you think that the use of computer simulations is useful for improving the marks at physics laboratory and in final exams?

4) What are the improvements that you suggest for the computer simulations?

Most of the students from both faculties have considered that the computer simulations are very useful for the understanding of physics phenomena and laws, and to improve the marks at physics laboratory and in final exams. Also, they have accessed the virtual physics laboratory quite often before the laboratory work from campus or from home. One of their main suggestions made for the improving of the computer simulations has concerned to their graphic and the need for more suggestive graphical interfaces.

In Fig. 4 we present the teachers' intended learning goals for using computer simulations.

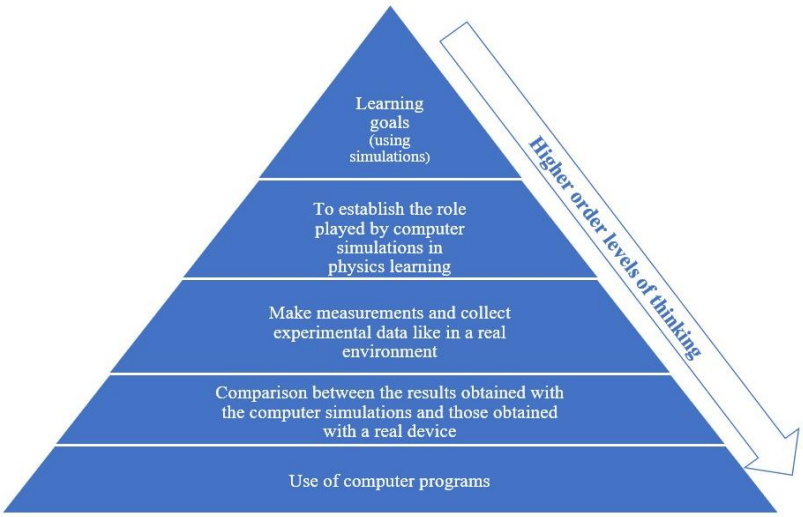

Fig. 4 – The teachers' intended learning goals for using computer simulations.

4. Conclusions

In the last several years we have completed the research on student learning of different topics in physics and developed teaching materials like computer simulations. The result of our effort consists in several sets of computer simulations for our first-year students.

This paper presents a statistical study about the results obtained in the last two academic years by the students enrolled in the Physics 1 course at the Faculty of Civil Engineering and Building Services within the "Gheorghe Asachi" Technical University of Iași, Romania. Also, the work carries out an investigation of the impact of the use of computer simulations and virtual physics laboratory on the increase of students' marks at laboratory tests and in final examinations and point out the differentiation of these results of the learning improvement according to students' gender. From the interpretation of the data resulting from the statistical analysis we have concluded that the female students' results at the laboratory tests and in final examinations are superior to those of the male students in both academic years 2016-2017 and 2017-2018. Further, it results that the computer simulations and virtual physics laboratory are powerful tools in physics learning and have improved students' marks. We also found that the female students were involved much more than the male students in the use of the computer simulations and virtual physics laboratory in the academic year 2017-2018 and represented the majority of the total number of students engaged in this activity. In the academic year 2016-2017 the number of the female students and male students who accessed the virtual applications was approximately equal, with a slight advantage to female students. Also, we have a positive feedback from our students of both faculties of Civil Engineering and Building Services and Hydrotechnics, Geodesy and Environmental Engineering concerning the use of computer simulations and some interesting suggestions for improving their graphical interfaces.

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ANALIZĂ PRIVIND UTILIZAREA PROGRAMELOR ADOBE FLASH ŞI JAVASCRIPT PENTRU PREDAREA FIZICII ÎN INGINERIA CIVILĂ

(Rezumat)

În ultimul deceniu, pentru eficientizarea învățării fizicii de către studenţii din anul I ai facultăţilor de Construcţii şi Instalaţii şi Hidrotehnică, Geodezie şi Ingineria Mediului din cadrul Universităţii Tehnice „Gheorghe Asachi" din Iaşi, România am elaborat o serie de simulări pe calculator a fenomenelor fizice cu ajutorul programelor Adobe Flash şi JavaScript şi am creat un laborator virtual de fizică. În procesul de predare şi învăţare a fizicii, simulările pe calculator au dezvoltat interesul şi curiozitatea studenţilor pentru fenomenele şi legile fizicii. De asemenea, utilizarea simulărilor şi a laboratorului virtual de fizică a condus la obţinerea unor note mai mari la testele de laborator şi la examenele finale. Lucrarea prezintă rezultatele obţinute în ultimii doi ani universitari la testele de laborator şi la examenele finale de către studenţii înscrişi în primul an al Facultăţii de Construcţii şi Instalaţii care studiază în română şi engleză (RO + EN) şi impactul utilizării simulărilor şi a laboratorului virtual de fizică asupra creşterii notelor şi, de asemenea, stabileşte diferenţierea acestor rezultate în funcţie de sexul studenţilor. În acest scop s-a efectuat un studiu statistic al cărui subiect au fost de 351 de studenţi (RO + EN), dintre care 70 au fost studenţi de sex feminin şi 281 studenţi de sex masculin. Studiul statistic ilustrează faptul că, deşi studenţii de sex masculin sunt mult mai numeroşi, studentele au depăşit studenţi de sex masculin referitor la rezultatele obţinute în anii universitari 2016-2017 şi 2017-2018. Studenţii ne-au oferit feedback-ul lor la un chestionar care include întrebări despre utilitatea utilizării simulărilor pe calculator în timpul laboratorului de fizică. De asemenea, am prezentat şi feedback-ul studenţilor care urmează cursul de Fizică 1 la secţia de Construcţii Civile în limba română a Facultăţii de Hidrotehnică, Geodezie şi Ingineria Mediului a universităţii noastre.