

## **The impact of different learning approaches based on MS Teams and Moodle on students' performance in an on-line mechanical CAD module**

**Zoe Kanetaki, Constantinos Stergiou, Georgios Bekas, Christos Troussas & Cleo Sgouropoulou**

University of West Attica  
Athens, Greece

**ABSTRACT:** During the Covid-19 pandemic, various on-line tools have been employed to support both synchronous and asynchronous education in universities. Several efforts have been made towards investigating the influence of various factors on students' academic performance in higher education. However, investigating the effectiveness of different learning methods during the pandemic is still an under-researched area. The goal of this study was to investigate if different teaching approaches, based on the usage of two distinct learning tools (MS Teams and Moodle) and a combination of those two, have an impact on students' academic performance in a higher education engineering module. In this study, an analysis of variance test has been performed to explore the factors affecting students' learning achievements. Hypothesis testing has also been conducted to examine whether different learning approaches have an impact on first-year students' academic performance in a mechanical engineering CAD module. A major conclusion is that even though the investigated teaching approaches may not have a direct impact on distinct variables, e.g. students' enjoyability and familiarisation of the learning platforms, they can still affect their performance. Also, the utilisation of a different learning tool used for asynchronous support (i.e. Moodle) may result in high levels of learners' dropout cases.

**Keywords:** Mechanical CAD, engineering education, e-learning methods, Covid-19, student performance, Moodle, MS Teams

### **INTRODUCTION**

Due to the Covid-19 outbreak, Web-based tools seemed to be the most important features in the context of exclusive e-learning environments. Sharing learning materials with students while ensuring on-line accessibility for both learners and educators, monitoring student involvement, and support communication has been the primary goal of using learning management systems (LMSs) in education [1]. LMSs have been widely used at all levels of education [2] during the last decades, with Moodle playing a vital role as an asynchronous learning platform or a course management system (CMS). To support synchronous education during the Covid-19 pandemic, the use of MS Teams has become extremely popular starting with the first semester in the pandemic, since it enabled real-time on-line meetings, based on the integration of Microsoft (MS) Teams in Office 365 and the user-friendly environment offered therein to both students and educators. Both platforms are currently being used for supporting on-line university modules.

During the spring semester of 2020, MS Teams has been introduced to Greek universities, and specifically to the University of West Attica in Athens, for the transmission of on-line lectures, alongside with Moodle and e-classes for sharing learning materials, module notes and task assignment and gradings. Before and during the pandemic, several efforts have been made to investigate the factors that influence students' academic performance in higher education [3-5]. In the study outlined in this article, an analysis of variance (ANOVA) test has been performed to investigate the factors affecting students' learning achievements. Hypothesis testing has also been conducted to examine whether different learning approaches have an impact on students' academic performance, during the pandemic circumstances in a 3D mechanical engineering CAD module, offered to first-year university students.

### **STUDY CONTEXT**

In the School of Engineering, Department of Mechanical Engineering at the University of West Attica, Athens, Greece, the mechanical design CAD II module was offered exclusively on-line for the first time during the second semester of the 2019-2020 academic year. Ten on-line groups had been examined for the purposes of a previous study [4], seven of which were using MS Teams for e-lectures transmission, and Moodle for tasks' assignments and grading, learning material and notes of the module. Furthermore, three of the examined groups were using MS Teams for all tasks, as a single platform. During the spring semester of the 2020-2021 academic year and throughout the pandemic restrictions period, the module was carried out for the second time exclusively on-line, in ten groups, each one

coordinated by one instructor, with synchronous e-lectures on MS Teams. Three out of those groups were using only MS Teams for all purposes, three were using MS Teams for e-lecture transmission only and Moodle as the primary LMS. Students in the remaining four groups had a mixed option: while all students were expected to attend e-lectures via MS Teams, lecture notes, videos and tasks' assignments could be undertaken in both LMSs (MS Teams and Moodle).

The aim of the analysis presented in this article was to explore a method of testing the effectiveness of those three different learning approaches in on-line teaching, during extreme circumstances and social restrictions, and conclude on whether the results of this method can be generalised. An ANOVA test was conducted to reveal which parameters affect the most the teaching process. As a result of this test, several values with statistical significance ( $p < 0.05$ ) have been determined, revealing the effectiveness of the examined parameters which influence the students' academic performance. The sample data has been partitioned into distinct groups in ANOVA, aiming to test a hypothesis related to the three groups (subsamples) mentioned above with teaching approaches.

## LITERATURE REVIEW

A learning management system (LMS) is a software application used in personal computing that helps in face-to-face and on-line learning, as well as in managing all aspects of the learning process [6][7]. E-learning is about combining two aspects of education: learning and technology [8]. LMS users can be divided into three categories: learners/students, instructors and administrators [9]. During the last decade, the use of learning management systems has been rising in higher education, with Moodle seemingly one of the most favourable LMS [1]. MS Teams works with similar principles as Moodle, but has a big advantage as MS Teams may be used as a communication tool, which does not require SIM cards or the exchange of a phone number [10][11]. In terms of computability, it has been integrated with Microsoft Office 365, which is offered by several higher education institutions, among them the University of West Attica at no cost. It includes all MS Office software used on-line for educational purposes. Calls can be easily made and answered using the interface of the application in mobile computing devices when students attend synchronous lectures. This communication facility provided them an additional easiness of use [12].

Researchers have previously evaluated the effectiveness of LMSs regarding their benefits for freshman students enrolled on a computer literacy level course, based on a survey including major components and supportive issues [13]. Data analysis has been performed by Safsouf et al. by launching a questionnaire investigating constructs, such as student enjoyment of the course, system quality in terms of technical difficulties and social interactions [3]. In similar cases of using ANOVA, the focus was on determining whether the whole sample was homogeneous or whether there was evidence that subsamples were chosen from diverse populations [14][15]. As a result, the mean values of several variables were used in these instances, with relation to one or more parameters.

According to the nature of the classification, the total variance included in a collection of data can be partitioned into a number of non-overlapping components. Analysis of variance is the method used for this purpose [15]. Therefore, some hypothesis testing can be done with the use of such partitioning [15][16]. The Kruskal-Wallis test is essentially another hypothesis testing process, similar to ANOVA [15][16]. When one nominal variable and one ranked variable must be compared, this method can be utilised. It determines whether the mean ranks in all of the subgroups are the same. In the present study, that would refer to the three subgroups with different teaching approaches.

## RESEARCH HYPOTHESIS AND METHODOLOGY

Based on the methods outlined above, two statistical tests have been performed in the present study. An ANOVA test has determined the variables that impacted on the academic performance of the students. Furthermore, a Kruskal-Wallis test has assessed the effectiveness of each applied teaching approach, on the grades of the students. Both methods rely on the concept of statistical significance; a derived  $p$ -value below 0.05 is an indication that a hypothesis can be generalised. Therefore, to evaluate the effectiveness of those three educational approaches, the following hypotheses have been formulated and tested:

Null hypothesis (H<sub>0</sub>): Different learning approaches based on LMSs have no effect on students' academic performance.

Alternative hypothesis (H<sub>A</sub>): Different learning approaches based on LMSs have an effect on students' academic performance.

In Figure 1, the three teaching approaches are presented: the first one involves the use of a single platform (MS Teams) for synchronous lectures including tasks' assignment and grading, and asynchronous support. The final examination test has been uploaded on MS Teams as well. The second approach involves using the MS Teams platform for synchronous lectures only, and tasks' assignments, gradings and asynchronous support has been performed in Moodle. The final examination test has been uploaded on Moodle. The third, mixed learning approach, combines the two platforms (MS Teams and Moodle) enabling students to choose asynchronous support via MS Teams or Moodle. In this case, the final examination test has been uploaded on MS Teams.

When referring to *performance* the dependent variable used is *a learning approach*, which contains the three potential values previously mentioned. The independent variable is *the final grade* of students' final examination of the mechanical design CAD II module.

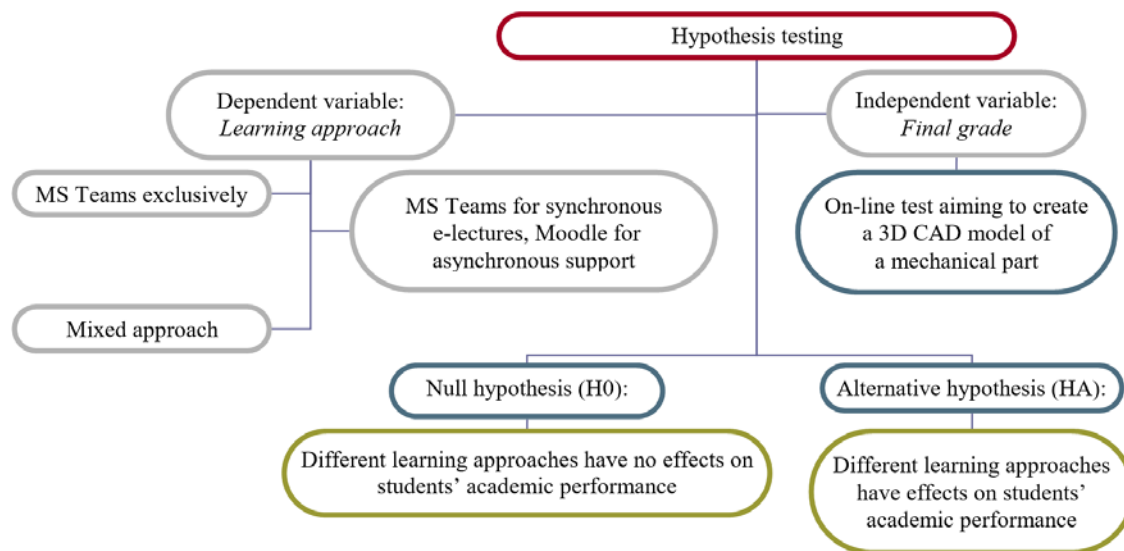


Figure 1: The research methodology schematised.

A matrix of 36 variables has been created which were filtered out of an on-line survey uploaded on MS Forms, containing 80 questions. The survey has been launched to students at a post course stage, one week before the final examinations. Constructs of this survey have been determined according to previous studies [4][13] during the emergency remote teaching environment (ERTE) phase [17]. Those 36 variables have been found to be highly correlated with the final grade in the module [4]. The survey included 212 students. The population number used for this analysis has been limited to 118 students, since a large number of students (55.66%) did not attend the final examination.

An ANOVA test has been performed with SPSS V20 integrating those three groups of students of non-equal size, based on the learning approach that was followed by their instructor. A Kruskal-Wallis test has been applied in order to compare a continuous variable, in this case the *final grade* and a nominal variable, in this case a *learning approach*. The mean ranks of students' final grades have been examined to establish whether they were equal in all groups, assisted by three different class coordinators (z, b, k) and one instructor (a), who has been strictly following the k approach, i.e. the mixed approach. During the University's internal evaluation procedure, students rated all professors' teaching abilities equally highly, in regards to the quality of their teaching skills. In the present study, the Kruskal-Wallis test was used to prove if there was no statistical difference in the efficacy of the three learning approaches, when compared with students' academic achievements upon completion of the specific module.

## OUTCOMES AND DISCUSSION

According to Table 1a, the asymptomatic significance of the Kruskal-Wallis test is 0.167 which means that a 16.7% possibility for new values would occur, if the test were re-conducted. The significance value is  $> 0.05$  (more than 5%), which leads to rejecting the alternative hypothesis. Therefore, the null hypothesis remains, indicating that no actual statistical relation and significance exist when observing the effect of those three teaching approaches on students' final grades. The percentage of 16.7% is close enough to 5%, which validates the hypothesis testing to be conducted. In Table 1b, the mean rank values are very close between the first and the third approach, while lower values can be observed in the second approach, where Moodle has been the primary LMS. It can be deduced that the students that were using Moodle as their primary LMS had lower mean academic performances than the ones who followed the other two approaches.

Table 1a: Kruskal-Wallis test statistics.

	Final grades
Chi-square	3.584
df	2
Asymp. sig.	0.167
a. Kruskal-Wallis test	
b. Grouping variable: 1. MS Teams 2. Moodle 3. Mixed	

Table 1b: Mean ranks of the three approaches.

	1. MS Teams 2. Moodle 3. Mixed	N	Mean
Final grades	MS Teams exclusively	41	61.10
	Moodle primary LMS, MS Teams	23	47.28
	Mixed, MS Teams and Moodle	53	62.46
	Total	117	

Although the alternative hypothesis has been rejected, the ANOVA results in Table 2 reveal eight variables of the survey whose significance ( $p$ -value) is  $< 0.05$ . It can be deduced that those specific variables even though they cannot confirm the basic null hypothesis alone, they are, when further analysed, indicators of differentiation as demonstrated in the following table and bar charts. Therefore, the variables that affect students' academic achievements when attending the on-line module are: enjoyability [4], familiarisation with the MS Teams platform, geometry conception, the number of active students and the number of students quitting the module in each group, as well as the evaluation of the module vs other on-line modules they have attended during this semester.

Table 2: One-way ANOVA.

ANOVA					
Variables (differences between groups)	Sum of squares	df	Mean square	F	Sig.
1. Previously attended CAD II and failed at the examinations	0.583	2	0.292	3.030	0.052
2. Enjoyability vs other laboratory modules	3.046	2	1.523	3.109	0.048
3. Familiarisation with MS Teams vs other courses	5.655	2	2.827	3.073	0.050
4. On-line CAD II vs other on-line modules	3.212	2	1.606	3.265	0.042
5. Conceived geometry projection	9.856	2	4.928	4.824	0.010
6. Number of lectures performed during the semester	30.395	2	15.197	382.59	0.000
7. Number of students quitting the module (no-show at the final examination)	451.095	2	225.548	36.077	0.000
8. Number of active students	401.381	2	200.690	11.293	0.000

In Figure 2, it is demonstrated that the on-line module is more enjoyable when MS Teams is used for synchronous lectures as a single platform for all educational purposes, including tasks' assignment and asynchronous support. Significantly lower values of enjoyability are seen when Moodle is used as the primary LMS. Results regarding the conception of geometry projections and the creation of planes shown in Figure 3 are significantly lower in the second learning approach, where Moodle is the primary LMS. It can be seen that fewer students have very well and fully conceptualised this specific aspect of the module in the groups that followed the second learning approach.

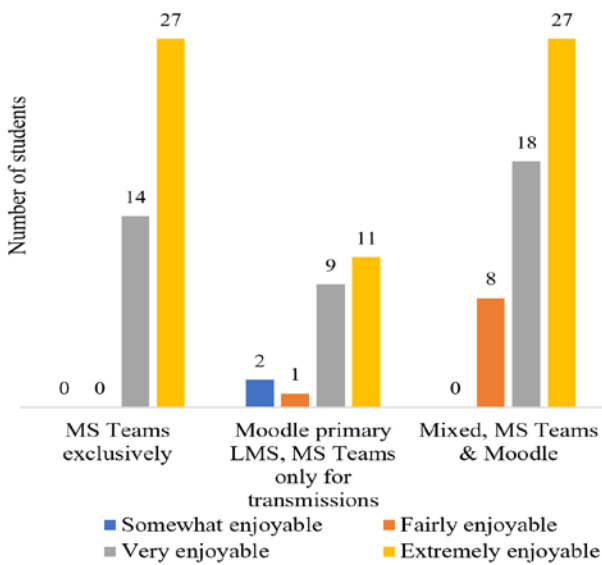


Figure 2: Enjoyability of each approach.

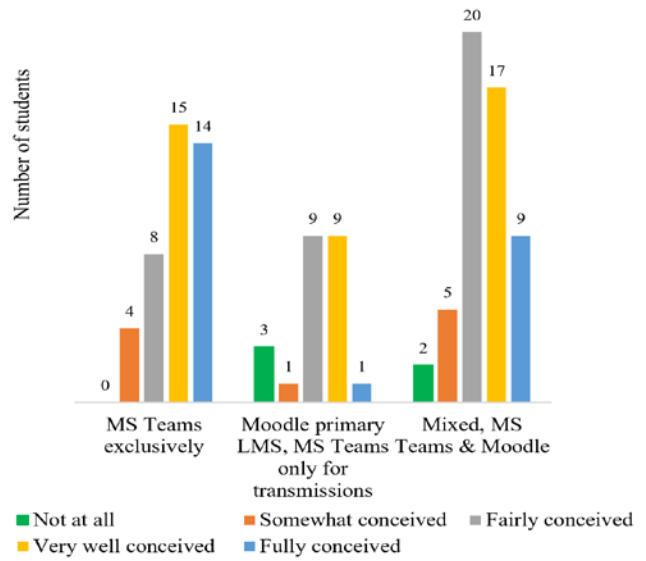


Figure 3: Conceiving the geometry projection of planes.

Figure 4 presents the differences in grades that students achieved in the final examination. Higher grades can be noticed in the groups where the first approach has been used, concentrated in the third quartile. The lower whisker displays a large difference from the majority of students that achieved high grades. It can be noticed that the median rank in grades between the three teaching approaches is not highly differentiated. In the second learning approach, the mean is slightly lower (8.5), but the grades' scale is wider, with more students achieving lower grades than in the first group. In Figure 5, the number of students quitting the module, with Moodle as the primary LMS is higher than the other two groups, which seem to be at the same level.

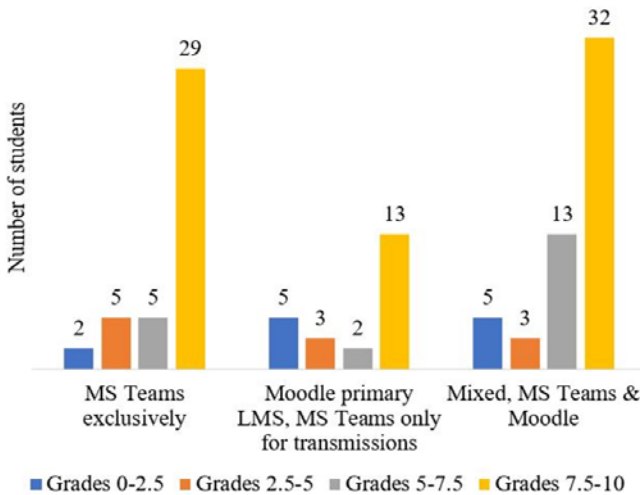


Figure 4: Boxplot of final grades by learning approach.

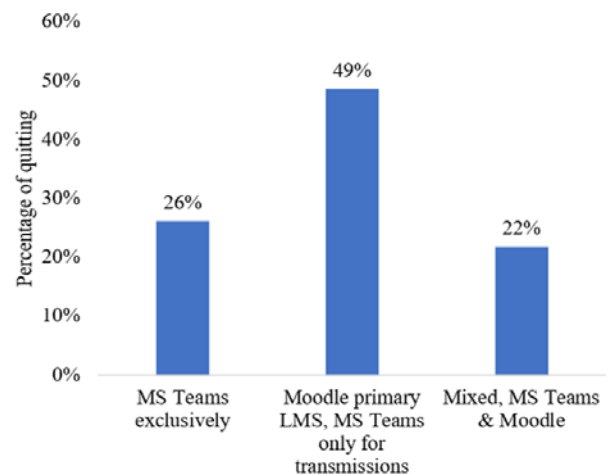


Figure 5: Number of students quitting the module in each approach.

## CONCLUSIONS

The goal of this study was to investigate if different teaching approaches based on the usage of two distinct LMSs, as well as a combination of those two, have an impact on students' academic performance in a higher education engineering module. A research hypothesis testing has been undertaken and an analysis of variance performed in order to accept or reject the null hypothesis.

After performing a Kruskal-Wallis test, the result of an asymptomatic significance of 0.167 led to the rejection of the null hypothesis, i.e. that different learning approaches based on LMSs have no effect on students' academic performance. Nevertheless, 36 variables, which have been filtered out of an on-line questionnaire launched at a post-course stage, have been analysed for evaluation of their significance and their impact on students' achievements.

Eight variables, have been revealed as indicators of differentiation through an ANOVA test performed on SPSS V20. Those indicators have shown that most students that considered the module more enjoyable have attended the group based on MS Teams exclusively and the mixed MS Teams and Moodle. More students fully conceptualised specific geometric aspects of the module in the MS Teams and mixed learning environments, than those that had Moodle as the primary LMS. Another finding is that students in the groups with Moodle as their primary LMS, had a higher dropout rate.

As mentioned in the literature review, during the last decade, Moodle has shown to be one of the most favourable LMSs [1], but when the pandemic restrictions limited learning to merely on-line methods, more user friendly and less sophisticated learning platforms than Moodle started to emerge in the learning process. The statistical analysis performed in the present study indicated that the three teaching approaches based on MS Teams, Moodle and a combination of these two platforms, have no effect on students' academic performance. However, the analysis results also indicate the need to investigate the factors that led several students to quit the module based on Moodle only and not to attend the final examination.

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## BIOGRAPHIES



Zoe Kanetaki is a lecturer in the Department of Mechanical Engineering at the University of West Attica, Athens, Greece. She received her degree in architecture from E.S.A. and her MSc degree in urbanism and regional planning from the National Technical University of Athens, Greece. Her research interests include on-line learning, data analysis, engineering education and CAD.



Constantinos Stergiou is a Professor and Head of the Mechanical Engineering Department at the University of West Attica, Athens, Greece. He received his degree in mechanical engineering from the National Technical University of Athens, Greece, and his PhD from Technische Universität Darmstadt, Germany. His research interests lie in the field of engineering design, CAD/CAM/CAE and additive manufacturing.



Georgios Bekas holds a PhD in civil and structural engineering. His research interests include operations research, machine learning, and optimisation of civil and energy engineering works.



Christos Troussas is a post-doctoral researcher in the Department of Informatics and Computer Engineering at the University of West Attica, Athens, Greece. He received the BSc, MSc and PhD degrees in informatics from the Department of Informatics at the University of Piraeus, Greece. His current research interests include software engineering, multiagent systems, adaptive HCI and artificial intelligence.



Cleo Sgouropoulou is the Vice Rector of the University of West Attica, Athens, Greece, and Professor in the Department of Informatics and Computer Engineering of the same University. She received her BSc and PhD degrees in electrical and computer engineering from the Department of Electrical and Computer Engineering at the National Technical University of Athens, Greece. Her research interests include artificial intelligence in education and software engineering.