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Evaluation of Technical Education by Using a Modern Structured MOODLE Laboratory Course, in Relation to Recent Data

Gerasimos Vlassopoulos, George Albert Karikas, Efstathia Papageorgiou, Ioannis Psaromiligkos, Niki Giannouli, Pigi Vlassopoulou, Petros Karkalousos

Department of Biomedical Sciences, University of West Attica, Athens, Greece
Email: makisvlass@gmail.com, gvlassopoulos@uniwa.gr

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Abstract

E-learning platforms support education systems worldwide, transferring theoretical knowledge as well as soft skills. In the present study high-school pupils', and adult students' opinions were evaluated through a modern structured MOODLE interactive course, designed for the needs of the laboratory course "Automotive Systems". The study concerns Greek secondary vocational education pupils aged 18 and vocational training adult students aged 20 to 50 years. The multistage, equal size simple random cluster sample was used as a sampling method. Pupils and adult students of each cluster completed structured 10-question questionnaires both before and after attending the course. A total of 120 questionnaires were collected. In general, our findings disclosed that the majority of pupils and adult students had significantly improved their knowledge and skills from using MOODLE. They reported strengthening conventional teaching, using the new MOODLE technology. The satisfaction indices improved quite, with the differences in their mean values being statistically significant.

Keywords

Information and Communication Technologies (ICT), Distance Learning E-Learning, Students' Opinions, Education in Greece, I.C.T. in Greece, Students, Pupils, Adults, Adult Students, MOODLE, MOOC, (V.H.S.), Vocational High Schools, (S.H.V.T.), Schools of Higher Vocational Training, Vocational, Profession, Interactive Lessons, Courses, Training, Laboratory Course, Secondary Education, Automotive Systems, Car Systems

1. Introduction

MOODLE is open source software [1] for creating modern and innovative

online courses. Its functionality is not limited only to distance learning, but it also complements traditional "live" teaching in various ways (blended learning) [2].

Laurillard as early as 1996 suggested that a combination of teaching methods is the most effective way to succeed in learning because the student applies a variety of activities [3]. A relative recent study confirms that "blended" learning is clearly more effective than conventional teaching [4].

Blended learning achieves:

1) Acquisition of personalized learning experiences at home. Students set their own learning pace, referring to the educational material, completing the relevant tasks, practicing as many times as necessary.

2) Teachers' feedback. In the classroom, teachers focus on students' needs, strengths and weaknesses. Therefore, the teaching time is used and the spirit of cooperation is cultivated.

3) "Gamification" of teaching, since it combines traditional learning with interactive material.

4) Increase in the rate of student involvement in the educational process, because various types of educational material are used such as: charts, photos, interactive videos, quizzes, etc.

5) Direct access of students to content from anywhere and anytime.

6) Immediate students' feedback about their progress.

Blended learning and distance learning using MOODLE have many common features. With the application of MOODLE, teachers can present their lessons in various and interesting ways, modify them, improve and save them [5]. Teachers introduce information from different sources and in different formats, assign tasks, communicate with learners, using asynchronous or synchronous media (teacher-student interaction) [6]. Teachers can edit the results of teaching and student participation by evaluating their performance (instant feedback). Learners learn to analyze, research and above all to collaborate with other learners (student-student interaction) [7]. With MOODLE, teaching is enhanced due to the interaction between student—content [8] and student—interface [9]. By using the appropriate MOODLE Teaching Tools [10], personalized learning is supported and the student is allowed to adapt the teaching content to their individual needs [11]. Personalized learning stems from constructivism theory [12] on which the MOODLE philosophy is based. According to this theory, people learn best by actively constructing their own learning [13].

Educational investigators have proven the effectiveness of MOODLE in teaching. A Japanese university literature review [14] on the use of MOODLE in teaching cites 155 published articles from 104 journals, in 55 countries for 10 different disciplines. Most of the literature (75%) focuses on university settings, with the majority (96%) on undergraduate studies. Studies agree that MOODLE is a powerful tool used to support learning in a variety of ways. Indicative studies are those of the University of Portugal [15] and South Australia [16]. The studies

conclude that the use of MOODLE is simple and facilitates not only learning but also the evaluation of the learning process and the preparation of students for final exams.

The above studies concluded that:

1) Students with more frequent access to MOODLE performed better. The number of clicks and the degree of use of the applications were strong factors in improving learning outcomes.

2) Enthusiasm for various educational activities enhances learning.

3) Quizzes significantly improved learning outcomes compared to simply attending online courses.

4) Students, who submitted assignments close to the due date, had lower grades than students who submitted them on time.

5) Some students showed an increase in the use of MOODLE just before exams (lack of motivation to study).

6) Students considered it an advantage that they can have their own study program with MOODLE.

7) 25% of students reported that they forgot the assignment deadline. The flexibility of MOODLE courses has been a barrier for some students.

8) The combination of multiple applications maximizes learning outcomes.

9) Teachers must allocate time for the construction of pedagogical plans.

10) Adaptive learner-centered teaching is based on the needs of the learner, taking into account their learning goals and interests.

11) Courses through MOODLE must be more than a simple presentation of course content (active participation of students).

2. Objectives and Methods

2.1. Purpose of the Research

The purpose of this project was to investigate the opinions of pupils and adult students regarding distance learning issues (MOODLE) in the laboratory course "Automobile Systems". Data were collected both at the beginning (02/2023) and at the end (05/2023) of the laboratory courses.

Three research questions were asked to pupils of V.H.S., and adult students of S.H.V.T., related to:

1) The degree of acquisition of knowledge and skills (pupils and adult students) using MOODLE courses.

2) The degree of attractiveness of MOODLE distance learning courses.

3) The degree of reinforcement of conventional teaching by the use of asynchronous distance learning courses.

2.2. The Study Sample

The "Automotive Systems" laboratory course, which has the same educational content but a different name is taught at two different levels of education. The first level includes secondary vocational education (V.H.S.) [17] and the second

level comprises higher vocational training (S.H.V.T.) [18]. The end of one stage and the beginning of the other signify adulthood. The transition to adulthood implies a series of changes that cannot be ignored in education. In this case, we are referring to about adult education where adult students have fixed opinions, perceptions, and ideas, while many of them work in the profession. Adults have different learning characteristics [19]. These two different population groups were chosen as the subjects of the study to investigate how teaching the modern structured interactive lesson affects each group separately.

A total of 60 pupils of V.H.S., and adult students of S.H.V.T., participated in the research. The same sample was examined both at the beginning and at the end of the survey.

In February 2023, all the pupils of the 3rd grade (30 in number), of the V.H.S.'s Vehicle specialty, of the 3rd School of Sivitanidios (one of the largest and the oldest in the prefecture of Attica) were selected.

In the same month, all the adult students (30 in number) of the 2nd semester, specializing in Mechanotronics Technician of the S.H.V.T., of the Sivitanidios School, were selected.

The final sample consisted of a representative number of students (boys and girls) to ensure the reliability and validity of the study. A total of 120 questionnaires were collected (60 before using MOODLE and 60 after using MOODLE at the end of the school year).

2.3. Method of Sampling

Data were collected from the multi-stage, equal size Simple Random Cluster Sample [20] [21]. The sampling was random because in its various stages, the composite units were selected by simple random sampling, *i.e.* by lottery [22]. The hierarchical sampling plan that starts from the educational regions of the country continues in school units of each region and ends in the classrooms of the schools [23]. The researcher had direct access to the sample of the population, however, the members of the population were approached indirectly, through larger groups (clusters) to which each member belongs.

Cluster sampling involves several stages [24]. The design of the sample survey included three stages:

- **1st stage**, with simple random sampling, the selection of the **primary sampling unit** was carried out. From the four regions of the prefecture of Attica, the fourth "D" region of Athens (one of the largest educational regions of the country) was chosen.
- **2nd stage**, with simple random sampling, the **secondary sampling unit** was selected which concerns the school where the research was carried out. By lottery from the 8 schools in the region, the 3rd V.H.S. of the Sivitanidio School was chosen. According to the sampling plan of cluster sampling, between two clusters there must be as little dispersion as possible, *i.e.* great homogeneity of the group [22]. For this reason, S.H.V.T., was chosen as a

secondary sampling unit by the same school.

- **3rd stage**, from all the departments of the schools (V.H.S. and S.H.V.T.), the departments concerned with the specialties of Technical Vehicles and Technical Mechanotronics (**tertiary sampling unit**) were selected. These departments were the sample of the research. The selection of the sample was carried out at the group level and not at the level of individual members of the population [23]. In this phase, a census of the members of the final clusters was carried out not a sampling of individual members.

Within the clusters (according to the sampling design) there should be as much dispersion as possible (group heterogeneity) [22]. A cluster with heterogeneity implies a representative sample of the population and therefore a more accurate estimate of the population. The condition of a heterogeneous group is satisfied because at Sivitanidio School, due to its uniqueness, (it is the oldest and most famous technical school in Greece) pupils (V.H.S.) and the adult students (S.H.V.T.) from all over the country study (great heterogeneity).

The researchers determined in advance the population to be studied and chose a representative sample that corresponded to 60 respondents, 30 of them were pupils and 30 were adult students. The number of 30 questionnaires per cluster corresponded to more than 5% of the total population of the respective region. There is no absolute rule stating the exact percentage of each sample. The survey sample size is closely related to: a) the research question, b) the population (in terms of size and characteristics), c) the sampling method, d) the sampling error, e) the level of confidence that has been defined, f) the techniques of data analysis [25]. For the reliability of the research, the number of 30 participants was considered necessary to reduce errors.

2.4. The Structure of Questionnaires

Clear, closed-ended questions were used to write the questionnaires, using simple language and having appropriate explanations [26]. In terms of structure, the questionnaires consisted of two parts:

Part 1: Demographics, (4 questions).

Part 2: Satisfaction questions about the use of MOODLE courses in the Automotive Systems laboratory course, (6 questions).

Responses were given on a 10-point Likert scale, graded with "1" corresponding to "not at all satisfied" and "10" corresponding to "completely satisfied". The time to complete the questionnaires was approximately 5 minutes. The questionnaires in a pilot phase were distributed to 10 secondary school students and answered in the presence of the researcher, after the necessary clarifications were made. Data were collected either directly in MOODLE or in the Lime Survey.

2.5. Statistical Data Analysis

Data analyzed with SPSS 29.0 (academic license). The analysis includes:

1) Normality check using Kolmogorov-Smirnov and Shapiro-Wilk test [27].

2) Descriptive statistical analysis to calculate the mean and range of values in 95% confidence interval of the responses (**Table 1**), with the corresponding Bloxplots (**Chart 1**) and (**Chart 2**) [28].

3) Testing the reliability of the measurement scale with Cronbach's Alpha reliability index [29].

4) Two-Way ANOVA [30]. It was checked whether the independent variables (implementation or not of MOOLDE and the level of study), influence the dependent variables concerning the research questions (**Table 1**).

5) Investigating opinions (pupils-adult students) about the quality of the course before and after the implementation of MOODLE. Testing means by t-test for independent samples (**Table 1**) [31].

6) Investigating views of (pupils-pupils) and (adult students-adult students) before and after the implementation of MOODLE. Testing means by t-test for paired samples (**Table 1**) [31].

7) Investigation by Wilcoxon Signed-Rank test. It was checked whether the final responses after the application of MOODLE became more negative, neutral or more positive (**Table 2**) [32].

8) Checking the correlation with the Pearson coefficient of the variable (VAR2) regarding satisfaction with the knowledge gained from the application of MOODLE with all other variables [33]. In more detail it was investigated: a. the degree of correlation and b. its statistical significance.

9) Investigating the customer satisfaction index (C.S.I.) [34] [35] to assessment the improvement of the survey participants' satisfaction index (**Table 3**).

10) Factor Analysis to categorize the variables into broader groups [33].

2.6. Limitations of the Study

Methodological limitations related to sample size and lack of prior research on the topic were presented, as well as time and bias limitations [36]. MOODLE was applied to specific population groups. It would be ideal to increase the study sample. Several statistical tests require a larger sample size to ensure the reliability of the research. During the literature review, there were many topics related to MOODLE in university courses. For high school courses involving a laboratory course, there was none (bibliographic sources mention it), so no comparison of the results could be made [14]. The time constraints did not concern the researcher or the training structures in which MOODLE was implemented, but the participants. Some of them refused to deal with MOODLE as they saw it as a hindrance and a time-consuming medium. Some adult students were working, while some pupils were either taking university entrance exams or were frustrated with the educational process and were indifferent to the whole process. At first, most participants compared the MOODLE interactive courses to the courses conducted during the pandemic. These courses had no structure, were hastily made to serve educational needs, and were not engaging. So there was a bias in the answers given before the implementation of MOODLE.

3. Results

1) Normality check

From the control of normality with the Kolmogorov-Smirnov and Shapiro-Wilk test criteria, it was found that most variables follow the normal distribution with $p > 0.05$. According to the Central Limit Theorem, if the random variables (X_1, X_2, ..., X_n) are independent and equal with $E(X_i) = \mu$, $V(X_i) = \sigma^2 < \infty$, I = 1, 2, ... n, then the random variable (Z), $Z = \frac{\sum_{i=1}^{n} X_i - n \cdot \mu}{\sqrt{n \cdot \sigma^2}}$ follows asymptotically for large n, (usually equal to or greater than 30) the standard normal distribution N (0, 1). Therefore, in our research, we can consider that the rest of the distributions also approach the normal ones.

2) Descriptive statistics

The results of the descriptive analysis are summarized in Table 1, as well as comparing the mean values and range of values at 95% confidence interval for pupils-adult students or only pupils or only adult students. The lines refer to the average values of their opinions before and after the implementation of MOODLE. Columns C, D refer to two different populations (pupils and adult students).

For the direct comparison of pupils and adult student response data, the following charts are presented.

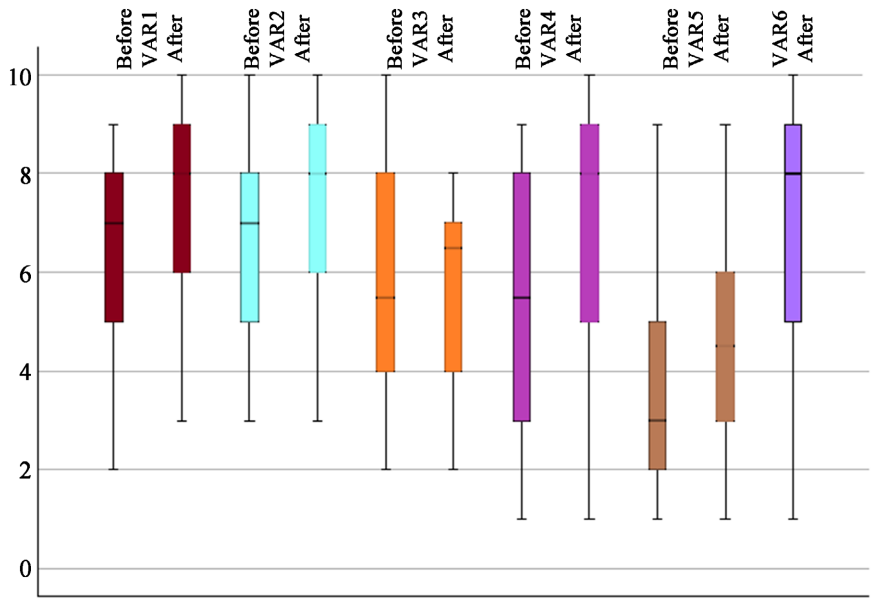

Chart 1. Range of pupils satisfaction values before and after the implementation of MOODLE.

3) Test of the reliability of the measurement scale with the Cronbach's Alpha reliability index was satisfactory since ($\alpha = 0.795$).

4) Two-Way ANOVA test

We examined whether the dependent variables of satisfaction are affected by

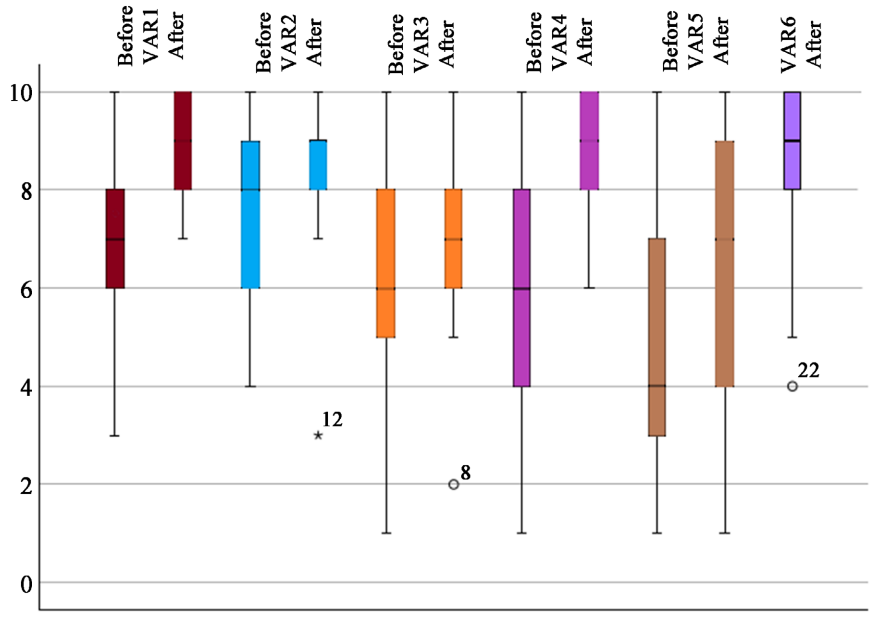

Chart 2. Range of adult student satisfaction values before and after the implementation of MOODLE.

the independent variables which were: a) the level of study (V.H.S. or S.H.V.T.) where MOODLE was implemented and b) the implementation or not of MOODLE (before or after).

The results of the Two-Way ANOVA (Tests of Between-Subjects Effects) are presented in the last three columns of Table 1. An example for VAR2 follows.

VAR2. Degree of knowledge enhancement from using a well-structured interactive MOODLE course in the Automotive Systems laboratory course.

- The level of education and the age of the participants influence their opinion on the enhancement of their knowledge, from the use of MOODLE. The effect is statistically significant ($p = 0.010$).
- The implementation or not of MOODLE, affects the participants' opinion of enhancing their knowledge ($p = 0.008$).
- There is no interaction between the implementation of MOODLE, the level of studies and the variable VAR2, which concerns the degree of knowledge enhancement, $p = 0.404$.

For all other variables, a corresponding analysis was followed (Table 1).

The inability to use: a) the L.S.D., control. (Least Significant Difference) and b) the ANOVA's Post Hoc test to test the equality of the population means, led us to use the t-test for independent samples.

5) Investigation of the opinions between (pupils-adult students) about the quality of the course before and after the implementation of MOODLE. Use of the t-test for independent samples (Table 1).

The statistical significance of the differences in the mean values of the opinions of the two populations (pupils and adult students) was tested. The test was carried out both before and after the implementation of MOODLE.

Table 1. Descriptive statistics of two samples, Tow-Way ANOVA analysis, t-test (paired samples test), t-test (independent samples test).

								Tow-Way ANOVA		
								Sig.	Sig.	Sig.
Columns	A	B	C	D	E	F	G	H	I	J
Indicators Variables	Time of period	Number of participants	Mean V.H.S.	Mean S.H.V.T.	Stat. Significance Difference of Means t-test (dif. populations	Number of participants	Overall average (C+D)/2	Influence of MOODLE implementation (before-after)	Influence of the level of studies (V.H.S.-S.H.V.T.)	Interaction of MOODLE implementation and study level
VAR1 Evaluate the pre-existing and acquired knowledge in Automotive Systems (before and after MOODLE).	before	30	6.40(•)	6.93(•)	0.260	60	6.67	0.004	<0.001	0.253
		95% Confidence Interval for Mean	5.74 - 7.06	6.24 - 7.63			6.20 - 7.14			
	after	30	7.47(•)	8.70(•)	0.002	60	8.08			
		95% Confidence Interval for Mean	6.78 - 8.16	8.31 - 9.09			7.67 - 8.50			
	Overall average C (before + after)/2 D (before + after)/2		6.93(•)	7.82(•)	0.009					
Stat. Significance Difference of Mean with t-test (paired samples)			0.067	<0.001						
VAR2 Evaluate the extent to which your knowledge is enhanced by using a well-structured interactive MOODLE course in Automotive Systems.	before	30	6.73	7.37(•)	0.249	60	7.05	0.008	0.010	0.404
		95% Confidence Interval for Mean	5.91 - 7.56	6.62 - 8.11			6.50 - 7.60			
	after	30	7.33(•)	8.53(•)	0.004	60	7.93			
		95% Confidence Interval for Mean	6.69 - 7.98	8.02 - 9.05			7.50 - 8.36			
	Overall average C (before + after)/2 D (before + after)/2		7.03(•)	7.95(•)	0.009					
Stat. Significance Difference of Mean Prices with t-test (paired samples)			0.298	0.014						

Continued

VAR3 Evaluate the extent to which your skills are enhanced by using a a well-structured interactive MOODLE course in Automotive Systems.	before	30	5.83	6.20(•)	0.557	60	6.02	0.014	0.291	0.119
		95% Confidence Interval for Mean	4.93 - 6.73	5.30 - 7.10			5.40 - 6.63			
	after	30	5.63(•)	7.23(•)	0.002	60	6.43			
		95% Confidence Interval for Mean	4.89 - 6.38	6.59 - 7.88			5.91 - 6.96			
	Overall average C (before + after)/2 D (before + after)/2		5.73(•)	6.72(•)	0.014					
Stat. Significance Difference of Mean Prices with t-test (paired samples)			0.709	0.046						
VAR4 Evaluate the degree of efficiency of an Asynchronous distance learning course (MOODLE) versus a Synchronous distance learning course (e.g. ZOOM).	before	30	5.27(•)	5.63(•)	0.591	60	5.45	0.007	<0.001	0.057
		95% Confidence Interval for Mean	4.28 - 6.26	4.66 - 6.61			4.77 - 6.13			
	after	30	6.83(•)	8.87(•)	<0.001	60	7.85			
		95% Confidence Interval for Mean	5.81 – 7.85	8.43 - 9.30			7.25 - 8.45			
	Overall average C (before + after)/2 D (before + after)/2		6.05(•)	7.25(•)	0.016					
Stat. Significance Difference of Mean Prices with t-test (paired samples)			0.016	<0.001						
VAR5 Evaluate the extent to which digital distance learning is enjoyable.	before	30	3.63	4.93	0.055	60	4.28	0.002	0.013	0.675
		95% Confidence Interval for Mean	2.78 - 4.49	3.88 - 5.98			3.60 - 4.96			
	after	30	4.63(•)	6.33(•)	0.015	60	5.48			
		95% Confidence Interval for Mean	3.75 - 5.51	5.25 - 7.41			4.77 - 6.19			

Continued

	Overall average C (before + after)/2 D (before + after)/2	4.13(•)	5.63(•)	0.002					
Stat. Significance Difference of Mean Prices with t-test (paired samples)		0.125	0.060						
VAR6 Evaluate the extent to which conventional teaching is enhanced by the use of MOODLE.	before 30	-	-	-	60	-	<0.001	1.000	1.000
	95% Confidence Interval for Mean	-	-	-	-	-			
	after 30	6,87(•)	8,47(•)	0.004	60	7.67			
	95% Confidence Interval for Mean	5.94 - 7.80	7.89 - 9.04			7.10 - 8.24			
	Overall average C (before + after)/2 D (before + after)/2	-	-	<0.001					

The pink lines show the results of the paired-samples t-test. The pink columns show the results of the t-test for independent samples. Columns (H, I, J) show the significance coefficients of the Two-Way ANOVA for the effect of the independent variables concerning: a) the implementation or not of MOODLE, b) the level of study and c) the interaction between the level of study and the MOODLE implementation. With (•) are presented the mean values whose differences are statistically significant.

The t-test was used, which assumes normality and common variance of the populations.

a) The Kolmogorov-Smirnov and Shapiro-Wilk tests were used for the normality of the distributions. The distributions are approximate normal. Small deviation from normality does not significantly affect the use of the t-test and does not affect the type I error rates [37].

b) Levene's test was carried out for the equality of the dispersion of the two populations. The non-significance of Levene's test ($p > 0.05$) led to the conclusion that the variations were homogeneous and the t-test can be used, [32].

Comparison of the means of two independent populations.

For the variable (VAR1) concerning prior knowledge, it was shown: $t = 1.14$, $df = 58$, $p = 0.260$. Since $p > 0.05$, we accept the null hypothesis. The sample means of the two populations do not differ significantly. The pupils' previous knowledge (6.40/10) and the adult students (6.93) were almost identical. From **Table 2**, it is easy to compare the percentages of participants with negative, neutral and positive opinions.

From the presentation of the frequencies in **Table 2**, it is observed that the adult students (before the application of MOODLE) had more knowledge as 63.3% had a more positive opinion, compared to 53.3% of the pupils. Upon completion of the courses, these percentages changed to 100% for adult students and 73.3% for

Table 2. Comparison of two independent populations (pupils-adult students). Presentation of frequencies.

Indicators Variables	Before the MOODLE implementation Students and Adult students Frequency Table				After the MOODLE implementation Students and Adult students Frequency Table				Wilcoxon Signed-Rank test		
	Population	Negative	Neutral	Positive	Population	Negative	Neutral	Positive	Negative	Neutral	Positive
VAR1 Previous or acquired knowledge in vehicle systems	**(S.H.V.T.) adult students**	6.7%	30%	**63.3%**	**(S.H.V.T.) adult students**	0%	0%	**100%**	**16.7%**	**10%**	**73.3%**
	(V.H.S.) students	3.3%	43.3%	**53.3%**	**(V.H.S.) students**	3.3%	23.3%	**73.3%**	33.3%	16.7%	50%
VAR2 Enhancing knowledge using a well-structured MOODLE e-course in vehicle systems	**(S.H.V.T.) adult students**	0%	36.7%	**63.3%**	**(S.H.V.T.) adult students**	3.3%	0%	**96.7%**	23.3%	13.4%	63.3%
	(V.H.S.) students	13.3%	26.7%	**60%**	**(V.H.S.) students**	3.3%	23.3%	**73.3%**	43.3%	10%	46.7%
VAR3 Reinforcement of skills using a well-structured MOODLE e-course in the vehicle systems	**(S.H.V.T.) adult students**	10%	50%	**40%**	**(S.H.V.T.) adult students**	**3.3**	36.7%	**60%**	30%	13.4%	56.7%
	(V.H.S.) students	20%	33.3%	**46.7%**	**(V.H.S.) students**	20%	30%	**50%**	40%	20%	40%
VAR4 Effectiveness of an asynchronous distance learning course versus a synchronous distance learning course.	**(S.H.V.T.) adult students**	23.3%	46.7%	**30%**	**(S.H.V.T.) adult students**	0%	3.3%	**96.7%**	3.3%	16.7%	80%
	(V.H.S.) students	33.3%	26.7%	**40%**	**(V.H.S.) students**	23.3%	10%	**66.7%**	23.3%	13.4%	63.3%
VAR5 Attractiveness of digital distance learning.	**(S.H.V.T.) adult students**	33.3%	33.3%	33.3%	**(S.H.V.T.) adult students**	23.3%	23.3%	**53.3%**	26.6%	16.7%	56.7%
	(V.H.S.) students	63.3%	20%	**16.7%**	**(V.H.S.) students**	43.3%	36.7%	**20%**	23.3%	23.2%	53.4%
VAR6 Reinforcement of conventional teaching using MOODLE lessons.	**(S.H.V.T.) adult students**	-	-	-	**(S.H.V.T.) adult students**	0%	13.3%	**86.7%**	-	-	-
	(V.H.S.) students	-	-	-	**(V.H.S.) students**	16.7%	13.3%	**70%**	-	-	-

In Table 2 presents the frequencies of positive, neutral, and negative responses. The values of the Wilcoxon Signed-Rank test are presented in pink, indicating how many answers (ranks) turned into more positive, more negative or remained the same (ties).

pupils. After the implementation of MOODLE and according to the Wilcoxon Signed-Rank test, 73.3% of the adult students' responses and 50% of the pupils' responses turned into more positive.

6) Investigation of the opinions between (pupils-pupils) and (adult stu-

dents-adult students) about the quality of the course before and after the implementation of MOODLE. Use of the t-test for paired samples (Table 1).

Paired-sample means were compared before and after MOODLE for both pupils and adult students. It essentially tested whether the mean values of two population groups differed.

The measurements come from pairs of (pupils-pupils) and (adult students-adult students) observations from the same population. Table 1 shows the difference in mean values in the responses of the populations. Mean values whose differences are statistically significant are presented with (•). From the analysis of VAR2 (degree of knowledge enhancement) we conclude that the difference in the average values (8.53 > 7.37) of the adult students before and after the application of MOODLE was statistically significant ($p = 0.014$). The difference in the average values (7.33 > 6.73) of the pupils before and after the application of MOODLE, was not statistically significant $p = 0.298$. Therefore, adult students had a more positive view of the knowledge gained after using MOODLE. The same interpretation was followed for the remaining variables.

7) Investigation with Wilcoxon Signed-Rank test

Data classifications were checked after applying MOODLE. The percentage of opinions that became more positive, more negative, or remained the same after the implementation of MOODLE was examined (Table 2).

8) Correlation test with Pearson's correlation coefficient

From Pearson's correlation analysis, a common behavior is observed on the part of pupils and adult students before and after the implementation of MOODLE courses.

Before implementing asynchronous MOODLE courses:

Those who thought that their knowledge would be further enhanced by the use of MOODLE: a) they were already knowledgeable in subjects related to the laboratory course (positive correlation 0.417, $p < 0.05$). b) they simultaneously believed that their skills would be enhanced (positive correlation 0.504, $p < 0.05$) and c) reported that asynchronous courses were more effective than synchronous distance education courses (positive correlation 0.445, $p < 0.05$).

After implementing MOODLE:

Those who acquired knowledge in the laboratory course, in a small percentage, considered that their skills improved (positive correlation 0.507, $p < 0.05$). In addition, they reported that conventional teaching is enhanced by the use of distance education (positive correlation 0.508, $p < 0.05$) and that e-courses were enjoyable (positive correlation 0.514, $p < 0.05$).

9) Investigation Customer (Participants) Satisfaction Index (C.S.I.).

The test regarding satisfaction with the use of MOODLE was carried out with the Customer Satisfaction Index (C.S.I.). The index is a powerful tool for measuring people's satisfaction with goods or services [38]. As an indicator, it approaches the degree of satisfaction holistically by reflecting the overall satisfaction of individuals at a given time [39]. Several different factors-variables that determine quality were used when assessing the satisfaction of research partici-

pants [40]. In our case, the variables are defined by the researchers. An index value greater than 80% is considered very satisfactory [41]. To measure the satisfaction level of the participants using the Customer Satisfaction Index (C.S.I.) method, the following steps were followed [34] [35].

a) The overall average of all the data of all the satisfaction variables in total (Mean Importance Score, M.I.S.) was determined.

$$MIS = \frac{\sum_{i=1}^{n} Y_i}{n}$$

where: n: Number of participants, Y_i: data of all variables.

b) The mean satisfaction score for each variable was determined separately (Mean Satisfaction Score, M.S.S.).

$$MSS = \frac{\sum_{i=1}^{n} X_i}{n}$$

where: n: Number of participants, X_i: data of each variable.

c) The weight factor (%) was determined for each variable (Weight Factors, W.F.), (weight percentage of the M.I.S value for each variable to the total M.I.S of all variables).

$$WF = \frac{MISi}{\sum_{i=1}^{p} MISi} \cdot 100$$

where P: Number of variables.

d) The weight score (W.S.) was determined by multiplying the weight factor (W.F.) by the average satisfaction degree of each variable (M.S.S.).

$$WSi = WFi \cdot MSSi$$

e) Added weight scores (W.S.) for all variables (Total Wight, T.W.)

f) C.S.I. was calculated:

$$C.S.I. = \frac{WT}{y} \cdot 100$$

where, y: degree of the Likert scale.

Table 3. Criteria evaluation of index results [42].

A/A	C.S.I.	C.S.I. criteria
1	>81%	Very satisfied
2	66% - 80.9%	Quite satisfied
3	51% - 65.9%	Satisfied
4	35% - 50.9%	A little satisfied
5	0% - 34.9%	Not satisfied

The value of the C.S.I. index of the survey sample before the implementation of MOODLE was 65.54% and corresponds to satisfaction (**Table 3**). After the implementation of MOODLE the value of the index increased to 73.64% which corresponds to being quite satisfied (**Table 3**).

10) Application of Factor Analysis not to reduce the variables but to categorize them into more general groups (factors) in order to better interpret the results. From the analysis, it was found that the variables that were included in the first two factors (components) of the analysis, explain 66.87% of the total variation (a satisfactory percentage for the extracted factors). This fact, combined with the high values above (0.6) of the variables in the Extraction - Communalities table of the Factor Analysis and the high value of the Kaiser Meyer Olkin statistical criterion (0.797) make the following factors useful and reliable. The new factors concerned:

1) Reinforcement of knowledge and skills from the use of MOODLE.

2) Attractiveness of distance education and reinforcement of conventional teaching.

4. Conclusions

The following variables have been categorized into the two new factors.

1) ***Reinforcement of knowledge and skills from the use of MOODLE.***

VAR1. Pre-existing and acquired knowledge in the "Automotive Systems" laboratory course.

Two-Way ANOVA (Table 1) demonstrated that:

a) The use of MOODLE affected the grade that pupils and adult students give themselves ($p = 0.004$). The partial analysis showed, (before the implementation of MOODLE), that pupils and adult students gave themselves average grades. After the implementation of MOODLE, pupils improved enough their grades, (new mean value 7.47/10 vs. initial 6.40/10, $p = 0.067$), Table 1, Chart 1, while adult students significantly improved their grades (new mean value 8.70/10 vs. initial 6.93/10, $p < 0.001$, Table 1, Chart 2.

b) The level of study applied MOODLE influenced the final score they gave themselves, $p < 0.001$ (*). The initially observed significant difference in the opinions of the groups (t-test, $p = 0.009$) is due almost exclusively to the students. From Chart 1, Chart 2 and Table 1, it can be seen that adult students put pre-existing and acquired knowledge higher marks but with a smaller range of values compared to pupils. This fact shows an awareness of the extent to which they are truly worth. Adult students were more informed about the subject of study, hence the high values in the initial scores. They also benefited more from the implementation of MOODLE courses.

63.3% of adult students and 53.3% of pupils, Table 2, (before MOODLE) reported that they had enough knowledge in Automotive Systems. After the implementation of MOODLE, the percentage of adult students rose to 100%, while of pupils to 73.3%.

From the Wilcoxon Signed test, 73.3% of adult students' and 50% of pupils' responses changed to more positive, Table 2.

Therefore:

- The more we use MOODLE the more our knowledge increases. Aida's

(2023), [14] research reported that the systematic use (intensity and frequency) of MOODLE courses has a significant impact on learning outcomes.

- MOODLE offers greater help in acquiring knowledge, at a higher level of study. Orhani's research (2024) [43] reported that secondary school students prefer synchronous form of education over asynchronous education like MOODLE.

There are two similar questions in the research.

The first one concerns pre-existing and acquired knowledge (VAR1), while the second concerns the reinforcement of this knowledge (VAR2). E-learning consists of two basic teaching elements: a) the acquisition of new knowledge and b) the reinforcement of existing knowledge [44]. The question about prior knowledge was important for the interpretation of the research. Aida (2023) [14] indicated that the formation of learning outcomes and understanding of MOODLE courses depend on prior knowledge.

With (*) the analysis concerns the total answers given by all participants, before and after the implementation of MOODLE.

VAR2. Reinforcement of knowledge using a well-structured MOODLE lesson in the laboratory course "Automotive Systems".

Two-Way ANOVA (Table 1) demonstrated that:

a) The application of MOODLE affected the degree of knowledge acquired by pupils and adult students ($p = 0.008$).

The partial analysis initially showed, before MOODLE, that pupils believed that their knowledge would improve slightly (6.73/10), while adult students believed that their knowledge would improve considerably (7.37/10).

After the implementation of MOODLE, the pupils reported that their knowledge improved considerably, (new mean value 7.33/10 against the original 6.73/10, $p = 0.298$), Table 1, Chart 1, while the adult students reported that their knowledge was significantly enhanced (new mean 8.53/10 versus initial 7.37/10, $p = 0.014$), Table 1, Chart 2.

b) The level of study where MOODLE was applied influenced the degree of knowledge acquired, $p = 0.010$ (*). The initially observed significant difference in the opinions of the groups (t-test, $p = 0.009$) is due almost exclusively to the adult students.

63.3% of adult students and 60% of pupils reported Table 2, (before MOODLE) that their knowledge would be significantly enhanced. After MOODLE, the percentage of adult students rose to 96.7%, while of pupils to 73.3%. From the Wilcoxon Signed test 63.3% of adult students' responses and 46.7% of pupils' responses were converted to more positive, Table 2.

VAR4. Effectiveness of an Asynchronous versus a Synchronous distance learning course.

The research groups evaluated on a 10/point Likert scale, which type of education (Synchronous or Asynchronous) they considered more efficient. In more detail, from (1/10) to (4/10) asynchronous education was not as effective as

synchronous, *with* (*5/10*) *both types of education were equally effective and from* (*6/10*) *to* (*10/10*) *asynchronous* was more effective than synchronous distance learning.

Two-Way ANOVA (Table 1) demonstrated that:

a) The application of MOODLE influenced the opinion of pupils and adult students on which type of education (synchronous or asynchronous) is considered more effective ($p = 0.007$). The partial analysis showed, before MOODLE, that both pupils (5.27/10) and adult students (5.63/10) considered both types of education to be equally average.

After MOODLE, the pupils but especially the adult students showed their preference for asynchronous education. The new mean for pupils was (6.83/10) versus the original (5.27/10), $p = 0.016$ and the new mean for adult students was (8.87/10) versus the original (5.63/10), $p < 0.001$, Table 1, Chart 2.

b) The point of view of both study groups, on the effectiveness of synchronous or asynchronous distance learning, is influenced by their level of studies, $p < 0.001$ (*).

The initially observed significant difference in opinions between pupils and adult students (t-test, $p = 0.016$), Table 1, is due to the adult students.

30% of adult students and 40% of pupils**,** Table 2 (before MOODLE) reported that asynchronous was more efficient than synchronous distance learning. After the implementation of MOODLE the percentages changed to 96.7% for adult students and 66.7% for pupils. From the Wilcoxon Signed test, it can be seen that 80% of adult students' responses and 63.3% of pupils' became more positive after applying MOODLE, Table 2.

The use of asynchronous distance learning anywhere and anytime and the attempt to gamify the lessons are considered components that affected its efficiency over asynchronous distance learning [45].

At higher levels of education, asynchronous distance learning is considered more effective. This finding coincides with the profile of students in adult education as the older the learner, the more the way he learns changes [46].

Pupils and adult students chose the type of education they consider effective, however, the orientation of e-learning (synchronous or asynchronous) does not have a significant effect on learning results, as much as the correct planning when implementing learning tools [14].

VAR3. Enhancing skills using a well-structured MOODLE lesson in the Automotive Systems laboratory course.

Two-Way ANOVA (Table 1) demonstrated that:

a) The implementation of MOODLE influenced the degree of skills acquired by pupils and adult students ($p = 0.014$).

The partial analysis showed, before MOODLE, that pupils believed that their skills would remain almost the same (5.83/10), while adult students believed that their skills would improve (6.20/10).

After the implementation of MOODLE, pupils reported that their skills did not improve, (new mean value 5.63/10 versus initial 5.83/10, $p = 0.709$), Table 1,

Chart 1. Adult students reported that their skills were significantly enhanced (new mean 7.23/10 versus initial 6.20/10, p = 0.046), Table 1, Chart 2.

b) The level of study at which MOODLE was applied did not affect the degree of skills acquired, p = 0.291(*). The initially observed significant difference in the views of pupils and adult students (t-test, p = 0.014), Table 1 was due almost exclusively to the adult students.

40% of adult students and 46.7% of pupils Table 2 reported (before MOODLE) that their skills would be significantly enhanced.

After the implementation of MOODLE, the satisfaction rate of the adult students reached 60%, while that of the pupils remained at 50%. From the Wilcoxon Signed test 56.7% of adult student responses and 40% of pupils responses were converted to more positive, Table 2.

It was found that:

a) The professional skills acquired are independent of the level of study in contrast to the knowledge. According to the neuroanatomical background of memory, the stages of memory and the mechanism by which the human brain recalls images and movements, analyzes them and tries to apply them are the same whether one studies at a lower or higher level of education [47].

b) The more one engages with MOODLE, attends interactive lessons, receives information and captures movements and images, the more one increases one's professional skills. The opinion was conducted by the research and there is no relevant reference in the literature review.

2) ***Attractiveness of distance education and reinforcement of conventional teaching.***

VAR6. Reinforcement of conventional teaching, using MOODLE courses.

Before the implementation of MOODLE courses, the research teams were not asked if the conventional teaching is enhanced by the use of MOODLE, it did not make sense, because the students did not know exactly what the interactive MOODLE courses are and what exactly they are going to attend.

Two-Way ANOVA (Table 1) demonstrated that:

a) The use of MOODLE influenced the opinion of pupils and adult students on whether conventional teaching is enhanced by digital distance education, ($p < 0.001$).

The partial analysis showed, after the implementation of MOODLE, that pupils were satisfied with the reinforcement of conventional teaching thanks to the use of MOODLE digital courses (6.87/10), Table 1, Chart 1. A more positive view was presented by adult students (8,47/10), Table 1, Chart 2.

b) The reinforcement of conventional teaching by digital e-learning is non-negotiable and is not affected by the level of study carried out by MOODLE, p = 1.000 (*).

The initially observed significant difference in opinions between pupils and adult students (t-test, p = 0.004), Table 1, is due almost exclusively to adult students.

86.7% of adult students and 70% of pupils Table 2 after the implementation of MOODLE considered that conventional live teaching is significantly enhanced by the use of digital courses. The same is supported by the international literature according to which:

a) Distance education approaches learning in a variety of ways, thereby surpassing the traditional way of learning [44].

b) Techniques such as the flipped classroom and self-regulated learning can be applied to live teaching with distance education [48].

c) The application of MOODLE as an online education is a method that combines self-learning and reinforces conventional teaching [49].

VAR5. Attractiveness of digital distance learning

Two-Way ANOVA (Table 1) demonstrated that:

a) The use of MOODLE influenced pupils' and adult students' opinion that digital e-courses are attractive, ($p = 0.002$).

The partial analysis, before the implementation of MOODLE, showed that the pupils did not find digital education attractive (3.63/10) while the adult students had a neutral opinion (4.93/10). After the implementation of MOODLE, pupils reported a small increase in the level of attractiveness due to gamification of digital lessons, (new mean value 4.63/10 versus initial 3.63/10, $p = 0.125$), Table 1, Chart 1.

Adult students, for their part, noted an increase in satisfaction with the attractiveness of MOODLE courses, (new average value 6.33/10 against the original 4.93/10, $p = 0.060$), Table 1, Chart 2.

b) The degree to which someone sees digital distance courses as more or less attractive is influenced by the level of study at which MOODLE is applied, $p = 0.013$ (*). The initially observed significant difference in opinions between pupils and adult students (t-test, $p = 0.014$), Table 1, is due almost exclusively to adult students.

33.3% of adult students and 16.7% of the pupils Table 2, before the implementation of MOODLE, expressed the belief that they would be satisfied with the gamification of the distance courses. After the implementation of MOODLE, the percentage of adult students rose to 53.3% and of pupils to 20%.

From the Wilcoxon Signed test it can be seen that 56.7% of adult students' responses and 53.4% of pupils' responses were converted to more positive, Table 2.

The fact that population groups are not satisfied with the gamification of distance courses lies in the fact that students have been familiar with various sophisticated video games and electronic programs from a young age [50]. However, the design of MOODLE courses was based on modern pedagogical approaches. Gamage, Ayres, & Behrend, (2022) report that of all those who create courses through MOODLE, only 5% follow educational theories, while Aida (2023), [14] stated that if proper preparation has not been done, if foundations have not been laid and if appropriate teaching techniques that follow modern

pedagogical approaches are not applied, MOODLE courses not only are unattractive but they are an obstacle to drunkenness. It is striking that the younger ages are less interested in teaching based on "fun learning".

5. Discussion

In summary, 96.7% of adult students and 73.3% of pupils reported a significant improvement in their knowledge while 60% of adult students and 50% of pupils reported an increase in their skills. 96.7% of adult students and 66.7% of pupils considered asynchronous distance learning more efficient than synchronous. 53.3% of adult students and 20% of pupils reported that asynchronous distance learning was attractive. 86.7% of adult students and 70% of pupils reported significant enhancement of conventional teaching using MOODLE courses. The satisfaction indices improved quite a bit, with the differences in their mean values being statistically significant. Only exception was the indicator regarding satisfaction with the acquisition of skills.

Suggestions for Improving MOODLE Course Design

- Application of more teaching tools of MOODLE during the construction of the courses.
- Take advantage of MOODLE's lessons option because students can manage their learning and decide whether to take the next step of distance learning.
- Strengthening the role of feedback at student and teacher level.
- Using MOODLE plug-ins such as H5P to create engaging interactive courses.
- Creation of courses based on theoretical knowledge (teaching methods) on which the entire MOODLE course will be structured.
- Familiarization of students with MOODLE before the start of lessons.

Moral Ethics

Present research project was approved (with registration number 12/27-05-2019) by the Ethics Committee of the University of Western Attica, in Athens, Greece.

Author's Statement

We hereby declare that academic ethics are observed, supporting the rigorous style of study.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

V.H.S.	Vocational High Schools of Greece
S.H.V.T.	Schools of Higher Vocational Training
MOODLE	Modular Object-Oriented Dynamic Learning Environment