IMPLEMENTATION OF COMPUTATIONAL TOOLS IN THE TEACHING-LEARNING PROCESS OF MATERIALS STRENGTH

Martínez Christian, Oñate Fernanda, Iza Johanna, Ramírez Ana and Pinto César

Teacher , Instituto Superior Tecnológico Pelileo , Ambato , Ecuador

ABSTRACT

With the development of this work, we seek to highlight the importance of implementing technological tools in the study of the subject of material resistance, in order to accompany the teaching-learning process. Bringing computational tools on par with traditional learning in the classroom by applying a series of innovative alternatives and work practices, outside the classroom and that meet your expectations of progress in teaching-learning in fields related to the resistance of materials , who are under their responsibility aligned with the objective of advancing in the career with practical knowledge.

This research topic was chosen due to the students' deficient knowledge in this area due to reasons such as late academic reintegration, work-related issues, among others. In addition to the little use of teaching material by the student, thus harming their comprehensive development. In this work, it is intended to contribute to the analysis of structures using design software and structural analysis. Interactive videos will be generated with their resolution, simulations of practices as well as innovative interactive content, which collaborate for the development of the academic and intellectual potential of the students who take the subject of resistance of materials.

KEYWORDS

Pedagogy Enhancement with E-Learning, Learning/Teaching Methodologies and Assessment

1. INTRODUCTION

In the last decade, due to the conditions of development of educational technology and its creative use in teaching both in the classroom and outdoors. This leads to the use of information technology to create virtual learning spaces; improving the teaching-learning process synchronously, asynchronously or a combination of both methods. These constructivist models promote teamwork in the learning environment, citing among others the motivation for reflection, continuous accessibility and the ability to adapt to the student's learning pace, among others (Silva-Quirós, 2010).

The educational system has retained small differences with its classic learning model (Gros and Silva, 2005); For this reason, the use of virtual learning environments (VLE) is seen as a pedagogical aid that takes education beyond the classroom. Therefore, educational institutions must include technological tools in the educational process to enhance the independence and responsibility of students, overcoming the limitations caused by the division of space - time between teachers and students, flexibility in time and space, and improvement of the collaborative learning (Raión and Adell, 2009).

To advance your career with practical knowledge, it is essential to take advantage of virtual learning environments as teaching and learning spaces. The digital culture that has emerged in 21st century societies gives us the opportunity to transform the educational process through information and communication technologies (ICT) (Bustos y la llama, 2010).

With the introduction of virtual learning spaces, the role of the teacher has evolved. Now it is necessary to acquire knowledge and skills from the educational community, diversifying and including aspects such as methodological strategies, pedagogical skills, communication skills, technology and education (Camacho Zúñiga, Lara Alemán and Sandoval Díaz, 2011).

In this sense, it is crucial to implement technological tools in the study of the subject of material resistance to accompany the teaching-learning process. Integrating computational tools with traditional classroom learning through innovative and practical alternatives outside the classroom is essential to progress in the field of teaching-learning in areas related to the resistance of materials.

The research addresses the deficient knowledge of students in this area due to causes such as late academic reintegration, issues related to jobs, among others. In addition to the little use of teaching material by the student, thus harming their comprehensive development. In this work, it is intended to contribute to the analysis of structures using design software and structural analysis. Interactive videos will be generated with their resolution, simulations of practices as well as innovative interactive content, which collaborate for the development of the academic and intellectual potential of the students who take the subject of resistance of materials.

Technological educational tools for learning design and structural analysis must have certain characteristics to be effective. Some of these features include:

1. Interactivity: Tools should allow students to interact with the content, whether through simulations, 3D models, or practical exercises. This promotes active and participatory learning.
2. Flexibility: Tools should adapt to different learning styles and skill levels. They should allow students to progress at their own pace and explore concepts in a personalized way.
3. Visualization: Tools should provide clear and realistic visual representations of structures and designs. This helps students better understand abstract concepts and visualize how they are applied in practice.
4. Feedback: Tools should offer immediate feedback on student performance, allowing them to correct errors and improve their understanding of concepts.
5. Integration with the curriculum: The tools must be aligned with the learning objectives and the course curriculum, so that they reinforce and complement what is taught in the classroom.
6. Accessibility: Tools should be accessible from different devices and platforms, allowing students to use them anytime, anywhere.

When choosing technological educational tools for structural analysis and design learning, it is important to consider these features to ensure that they truly enhance the learning experience for students.

The main aspects that can be mentioned about educational tools are those related to the different ways of maintaining learning rhythms, which is why it is teachers and students who establish the most useful and appropriate resources for the teaching-learning process. .

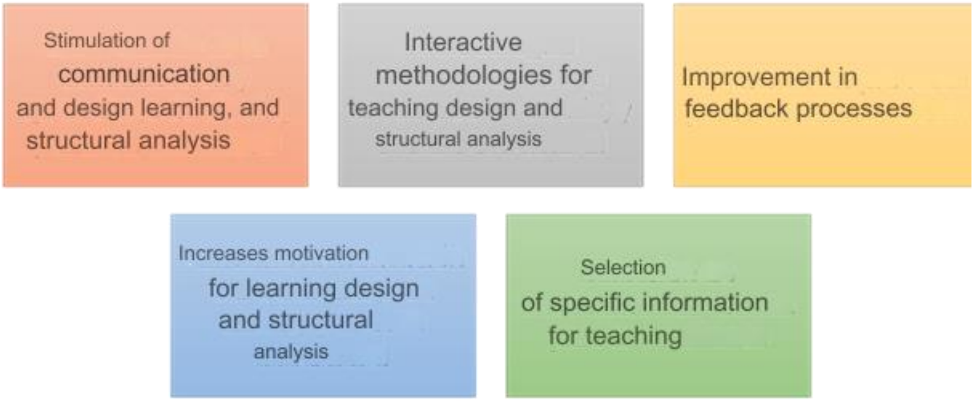

Figure 1 . Tool characteristics.

Education exposes its multiple development scenarios, and among them are those created with the help of technological tools and applications that help in educational achievement. Comparing the traditional educational environment with the virtual educational environment, using virtual education in teaching and learning, there are some benefits such as: greater cooperation and access to information, the educational process focuses on students, using different tools, for example. example in Table 1.

Table 1: Contrast traditional and virtual education

Traditional education environment	Virtual education environment
· Development of personal missions. Include specific information A unique medium Direct knowledge of the teacher.	· Mission development Free access to information A variety of media student centered

Even though there are differences between the different definitions of the concept of Virtual Learning Space (VLE), most authors agree that the main components are: the space, the students, the teachers, the materials and the didactic strategy for the development of the teaching-learning process (PEA).

2. METHODOLOGY

The study assumes a strong correlation aspect because the objective is to determine the degree of association between two variables: academic performance and the use of virtual space (EVA) by students. This type of research establishes the degree of relationship between two or more variables, where the first step is to measure the variables, then test the hypothesis using statistical methods and determine the presence or absence of the correlation. Also in this type of research, if correlations are not established directly, it is possible to establish possible causes and effects of the phenomenon studied by Arias (2006).

The study design was semi-experimental due to the contrary hypothesis, but there was no randomization in the experimental or control groups, shown in Table 2. Steps carried out in the project:

- Selected from an exploratory universe defined by second semester students, with a specific experimental (44 students) and control (43 students) sample; This is at the discretion of the researcher.
- Previously, it was coordinated with the teachers of the subject to master the contents that were considered difficult to carry out in the virtual learning space on the simulation platform and with the students learning the subject with this tool.
- The researcher selects the students from the experimental and control groups. Stimulation was applied only to the experimental group (via VAS) to allow comparisons to be made between the two groups (control group without stimulation).

Table 2 : Distribution of groups

Groups	Procedure
Experiment al	Learning structural analysis and design with the use of virtual learning spaces
Control	Learning structural analysis and design without the use of virtual learning spaces

- The design of the semi-experimental study was established as follows: in the experimental group, initial test, stimulation and final test were used; control group: use only pre- and post-tests, indicated in Table 3.

Table 3: Stimulus application

Groups	Pre-test	Stimulus	Post-test
Experi mental	YEAH	YEAH	YEAH
Control	YEAH	NO	YEAH

- The students and the subject teacher were trained, according to the roles assigned in Moddle to be able to implement the activities through it.
- The stimulus applied to the experimental group consisted of the use of a Virtual Learning Space designed on the Moddle platform for learning the resistance of materials. Figure 2 shows the planned activities and resources on the contents such as: inequalities, exponential functions. and logarithmic, linear equations, among others; highlighting all the topics considered most difficult.

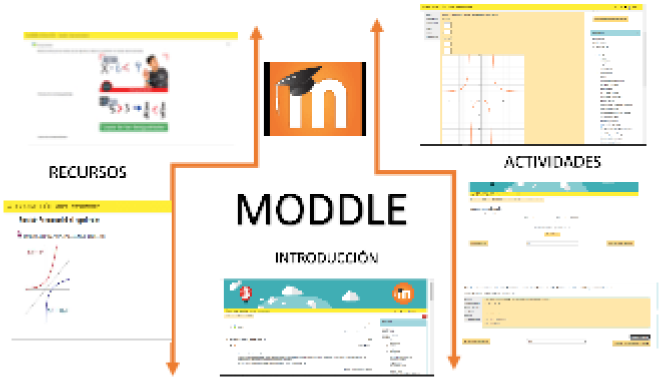

Figure 2. Evidence of the activities and resources applied in Moddle.

- The students in the control group did not carry out the activities related to the use of the designed EVA that the experimental group did use.
- Finally, the results (performance) obtained from the experimental and control groups obtained in the pre- and post-test were compared. The data used were the material resistance scores corresponding to partial 1 (the pre-test), and partial 2 (the post-test). This process is detailed and described in the subsequent section called: "Results of the student satisfaction survey when using the EVA for learning the resistance of materials."

2.1. Actions to collect and Process Data

To carry out the research project, the various designed instruments were applied to each group of participating individuals.

2.1.1. Study of the interview applied to teachers

An interview was conducted with two teachers of the second semester course who teach the subject of resistance of materials, to inquire about the usual activities they carry out when teaching their classes. It was also important to know their position regarding the use of Virtual Learning Spaces; It was also useful to identify important aspects about the contents to be implemented in the virtual tool to be designed.

The interview allowed us to know the level of knowledge and skills of the teachers in the use of this type of tools for the teaching process; and identify their weaknesses, in order to guide them in the use of this platform and make it a useful tool for the teaching process. In summary, the interview conducted consulted the following aspects:

- Regular activities developed in classes
- Teacher's position regarding the use of EVA's.
- Teacher's knowledge of technological tools or resources for teaching the resistance of materials.
- Contents chosen from the subject due to their complexity, to be included in the design of an EVA for teaching - learning the resistance of materials. This process is detailed and described in the subsequent section called: " **Results of the student satisfaction survey when using the EVA for learning the resistance of materials** ."

2.2. Selection of Material Resistance Contents for EVA

With the help of the subject teachers, a review and analysis of the material resistance content of the second partial was carried out. Based on their experience, the work material in the EVA was developed, taking into account the most complex topics for student learning. The topics agreed upon with the teachers were: Inequalities and functions, shown in Table 4.

Table 4: Resistance contents of materials selected for EVA application

Issue	Subtopic
Topic 1: Mechanical properties of materials	Subtopic 1: Elasticity - Elastic behavior of materials - Modulus of elasticity - Hooke's law - Elastic stress-strain diagram Subtopic 2: Plasticity - Plastic behavior of materials - Creep - Ductility - Elastic limit and yield limit
Topic 2: Analysis of stresses and deformations	Subtopic 1: Stresses in structural elements - Axial forces - Shear stresses - Bending stresses - Combined efforts Subtopic 2: Deformations in structural elements - Unitary deformations - Stress-strain relationship - Bending deformations - Torsion deformations

Prepared by: Oñate, 2023

In addition, we worked together with the teachers in planning the activities to be proposed in the EVA, which were worked on simultaneously with the contents covered in the class; and constitute a support for the teaching-learning process. The activities developed for students in the virtual classroom are autonomous (carried out by the student outside the classroom), which had due support and tutoring from the teachers; to generate in the student interest in practicing and learning in an interactive way.

2.3. Guidelines for the Use of Virtual Learning Spaces

Before using the EVA, training was carried out for students and teachers on access and use of the resources available in the virtual classroom, shown in Table 4. The participants were previously registered on the platform, with the corresponding roles. configured.

Table 4: Guidelines for using the Moddle platform

Steps to enter the designed virtual classroom
1. Enter your preferred search engine and place the following link https://resistencia dematerialessecond semester.milaulas.com/ 2. Click on access 3. Enter the username and password For the user and password, take the following into account. Your username is your first name followed by a period and your first last name. Example: Carlos Daniel Zapata Valle User: carlos.zapata Key: Alg_niv2019 Note: All users have been registered with the same password, which must be changed after the first access.

Source: Syllable of the subject of resistance of materials, 2023
Prepared by: Oñate, 2023

2.4. Application of the Quasi-Experimental Design

Firstly, the grades (averages) obtained by the students during the first partial were taken into account as a pre-test, in this way the level of knowledge (performance) of the students in the subject of resistance of materials could be established. , considering that these contents were studied in a similar way by the experimental and control groups during the second semester.
During the second partial, the students of the experimental and control group studied the same contents of the subject of resistance of materials in Table 4. The teaching methodology used in the classroom by the teacher was the same; The difference was that with the students of the experimental group they carried out the different activities proposed in the EVA that are described below:

1. A file was placed with organized and summarized information on each topic, and solved exercises of medium and high level of complexity.
2. A video was shared, with the explanation of the topics studied, where various ways of analyzing a certain case or topic are presented.
3. A chat was enabled for synchronous communication, whose objective was: to help students with their doubts or problems regarding the study content. The chat remained enabled during the class days corresponding to each parallel.
4. Tasks were proposed to be developed by the students; which were part of a workshop, and whose objective was work and collaboration between peers.
5. The last phase applied in this process was the evaluation, which was carried out through questionnaires, which made it possible to measure the level of knowledge acquired in each topic reviewed with the students (control group).

The estimated time of use of the EVA for the activities assigned by each topic was 2 hours; period in which it was estimated that the student could carry out the tasks planned in the different modules.

In addition, we worked with the tool for the study of the second topic corresponding to the analysis of functions, considering that it is complex for students to make graphs that facilitate their understanding.

Once the EVA application phase has been completed with the students in the experimental group, and the conventional work with the individuals in the control group; Both groups were evaluated with a similar post-test; That is, the same evaluation instrument and grading parameters used in the second partial were used; this to establish the level of learning (grades) of the contents studied. The results of this post - test were correlated with the data obtained in the pre - test.
To finish the process of applying the research design, a satisfaction survey was applied to the students of the experimental group of the use of the EVA designed for learning the resistance of materials, this to know their position and experiences of using the virtual classroom. , and the activities developed that were included in the work platform for learning this subject. All of this is evaluated and analyzed in the following section.

3. Analysis of Results

Several research techniques and instruments were included in the research design, with the purpose of gathering sufficient information to establish the presence of a relationship between the use of Virtual Learning Spaces and the level of learning resistance of materials. The results obtained from the application of each of these instruments are presented below.

In order to establish the relationship between the Use of Virtual Learning Spaces vs. Learning through academic performance in the subject of mechanics of materials by second semester students, the Fisher statistic was used, a test that allows establishing the relationship between two categorical variables, using a 2x2 cross table and in this way allows us to verify the hypothesis defined for the present investigation.

For which the grade records of the first midterm and second midterm were taken, both from the experimental group and the control group.

In relation to the experimental group shown in Table 5, 52.3% have low performance before receiving the stimulus to use the EVA, and after it, the percentage is reduced to 22.2%; That is, one in three (30.1%) of the second semester students improved their learning, measured by grades obtained in the second partial in the subject of mechanics of materials.

Table 5: Pre-test and post-test notes of the experimental group

	Pre-Test	Post-Test
Number of low-performing students	23	8
Number of students with acceptable performance	twenty-one	36

Source: Record of qualifications for materials mechanics subject, 2023
Prepared by: Oñate, 2023

On the other hand, the results of the control group in Table 6 determine that 80.9% have low performance before the experimental group received the stimulus (use of the EVA). The subsequent result (from the post-test) is 50.0%; with low performance; That is, like the experimental group, one in three (30.9%) of the second semester students belonging to it improved their learning in materials mechanics.

Table 6: Pre-test and post-test notes of the control group

	Pre-Test	Post-Test
Number of low-performing students	3. 4	14
Number of students with acceptable performance	8	28

Source: Record of qualifications for materials mechanics subject, 2023
Prepared by: Oñate, 2023

Based on these results, the experimental group has 22.2% of students with low performance, and the control group has 50.0%; That is, there is a percentage difference of 30%, which establishes that one in three second semester students improved their learning of materials mechanics by using the EVA.

To verify this result, the Snedecor F test was used with a significance level of 0.05. The p-value obtained for a one-sided test was 0.01 in Table 7: that is, it is below the level of significance, therefore, the null hypothesis is rejected (Ho) and the alternative hypothesis is accepted (H1), this is:

The use of a Virtual Learning Space (EVA) allows improving the level of learning (performance) of the subject of materials mechanics by second semester students of the period June - September 2023.

Table 7: Fisher statistics of the experimental and control group

	Exact significance (two-sided)	Exact significance (one-sided)
Experimental Group	.002	.001
Control group	,000	,000

Source: Record of qualifications for materials mechanics subject, 2023
Prepared by: Oñate, 2023

Finally, it is important to note that the students in the experimental and control groups have similar behavior, since the grades obtained in both groups improve notably in the second partial. Particularly, after analyzing it, it is given to an external factor, which is defined as the need for students to pass the second semester, so the grades obtained during the second partial for both groups are relatively better than those obtained during the first. partial. But also due to the results obtained, the experimental group improved the results compared to the control group due to the use of the Virtual Learning Space.

4. CONCLUSIONS

Researchers and theorists who study Virtual Learning Spaces establish and agree that it is pertinent and relevant to use these virtual technological spaces in the teaching-learning of the subject of materials mechanics. Its use will generate interest and motivation in students; Furthermore, it allows them to build their own knowledge in their own time and actively and participatively develop new skills and abilities in the area.

Theoretically, it is established that the activities planned in an EVA must be correctly selected and planned according to the theme, level of difficulty and contents that are to be taught; since adequate selection and planning will allow the learning objectives and achievements to be met.
The teachers of the materials mechanics subject work on the calculation of materials with traditional methods, but they do apply various technological tools in the development of their courses.

The teacher's knowledge of EVA's is limited, as are their skills for using this technological tool in the teaching-learning of the subject of materials mechanics.

Based on the teaching direction, the themes of inequalities and functions were selected to work on the relevant contents and activities that were integrated into the designed virtual classroom, which was used by the experimental group formed for the research, and which at the discretion of the students They were very suitable for their learning.

Since the calculated p-value was 0.01, and is less than the 0.05 level of significance, it was determined that statistically there is a relationship between the use of the EVA with learning (academic performance) in the subject of materials mechanics. the second semester students of the Pelileo Higher Technological Institute.

The satisfaction survey applied to the students made it possible to demonstrate the favorable position of the students with the use of the EVA's as a complement to their face-to-face study process; since according to their criteria, it allowed them to reinforce knowledge, provide feedback on content and awaken interest in collaborative work; being an active and fundamental part in the construction of their own knowledge.

Using the F test, it was determined that there is a relationship between the use of the EVAS and the learning of mechanics of materials. This was determined by comparing the scores obtained in the pre- and post-test applied to the students in the experimental and control groups.

The percentage comparison of the low performance of the students in the control and experimental group determines that there was no difference between the student groups; situation that can be associated with other factors that are always present in educational processes and that require research. One reason that may be associated with this result may be due to the need to complete the minimum required to pass the subject.

ACKNOWLEDGMENTS

The authors thank the higher education institutions that contributed to the research with their authors, as place of work such us: Instituto Superior Tecnológico Pelileo-Baños, Baños, Ecuador

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AUTHORS

María Fernanda Oñate Pico. **-** Master in Higher Education (Universidad de Fuerzas Armadas ESPE), Teacher in technical specialty (Instituto Superior Tecnológico Pelileo-Baños), Mathematics Teacher (La Salle Ambato Unit), Mechatronics Engineering (Universidad de Fuerzas Armadas ESPE), FINANCIAL MANAGER of the company IA-KUNTUR SASBIC dedicated to the development of artificial intelligence and data science located in the city of Latacunga-Ecuador.

Christian Andrés Martínez Andino, master in civil engineering with mention in metallic structures (Technical University of Amabto), Teacher in technical specialty (Pileo-Baños Higher Technological Institute), Mechanical Engineer Technical University of Ambato)

Johanna Estefanía Iza Iza. **-** Master in Electricity with mention in electrical power systems (Universidad Técnica de Cotopaxi), Teacher in technical specialist (Instituto Superior Tecnológico Pelileo-Baños), Mechatronics Engineering (Universidad de Fuerzas Armadas ESPE)

César Enrique Pinto Bocancho. **-** Industrial Engineer in Automation Processes (Universidad Técnica de Ambato UTA), Teacher in technical specialty (Instituto Superior Tecnológico Pelileo-Baños).

Ana del Cisne Ramírez Rivera - Engineer Systems (Universidad Técnica de Ambato UTA), Teacher in technical specialty (Instituto Superior Tecnológico Pelileo-Baños).