Moodle Interactive Model to Strengthen Mathematical Competencies in Eighth-Year Basic Education Students

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Abstract: This study aims to design a virtual learning platform for the Francisco Pizarro Educational Unit, based on a Moodle pedagogical model that offers a variety of flexible tools and functions that make it easier for students to build their own knowledge, the methodology is a research with a focus quantitative based on empiricism, experience, observation and analysis of facts, the research design is quasi-experimental, the survey and questions were used for the pair of variables, 74 students participated. It is concluded that the Shapiro-Wilk test (n < 50); points out that in the pretest, both the control group and the experimental group obtain a sig. = 0.000. Consequently, in all cases, the groups obtained a sig. < 0.05, in this way the H0 is rejected and the HI is accepted: which means that the data analyzed does not follow a normal distribution. Therefore, the Mann Whitney U statistic was used for independent samples and the Wilcoxon statistic for related samples respectively, and finally it is proposed to design a virtual classroom as a crucial interactive teaching strategy to provoke the contribution and commitment of the learners.

Keywords: Interactive Model, Virtual Platform. Moodle, Mathematical Skills

1. INTRODUCTION

Current education is in constant transformation, incorporating technological tools that expand the sources of information and multimedia resources for learning. In this context, Moodle stands out as a virtual learning management application that allows interaction between teachers and students, offering advantages to strengthen mathematical skills and improve the effectiveness of training in this area. Moodle offers student-centered instruments that enable interactive activities, reinforcing the learning process and contributing to improving educational quality [1]. According to the statistical data report of the United Nations Cultural, Scientific and Educational Organization-UNESCO [2], it mentions that around 617 million children and young people in the world have not achieved minimum skills in mathematics. This highlights the importance of mathematics for the intellectual development of children, it is the basis that allows them to understand and progress in the reality that surrounds them.The educational context in Latin America and the Caribbean continues to be critical, with students not reaching minimum levels in reading and mathematics, a situation that was aggravated by the pandemic. According to the results report of the International Educational Assessment Program-PISA 2018, the National Institute for Educational Assessment-PISA [3], Ecuador, Guatemala, Honduras and Paraguay had the worst results in the world, with mathematics being their weakest subject. In Peru, one in two 15-year-old students does not obtain the minimum level in mathematics [2], and in the ECE 2019 test, only 34% achieved a satisfactory grade [4]. Colombia during 2018 was also located below the average in mathematics, Chile and Uruguay were the Latin American countries with the best results in mathematics, but still below the world average [5]. In Ecuador, only 29% of students reached a minimum level in mathematical competencies [3], and in the evaluation of the Ministry of Education 2021-2022, the average was insufficient (6), possibly due to the scarcity of resources, little support and little teaching preparation that contradicts what is stipulated in the Regulation of Intercultural Education, RLOEI [7], as evidenced in the results of basic operations, algebra and functions of eighth-year students of a school in the province of Santa Elena , Ecuador. Based on the above, the following formulation is proposed to address the research difficulty: What would be the impact of using the interactive model Moodle on the development of mathematical skills of eighth-grade students in Santa Elena, Ecuador. The rationale for this study highlights the need for an interactive Moodle-based educational approach to address difficulties in students' mathematical understanding, encouraging significant progress through a methodology that promotes logical thinking, ordered reasoning, and critical and abstract skills. From this perspective, the objective of this study is to determine the effect of the Moodle interactive model in strengthening mathematical competencies in eighth-grade students, Santa Elena, Ecuador.This study is framed in an epistemological perspective supported by pedagogical theories and research. Based on the theoretical framework, the aim is to establish a cognitive constructivist paradigm that facilitates the understanding of learning through interactive models, thus contributing to the strengthening of mathematical

competencies. According to constructivism and epistemological theory, knowledge emerges through experiences and interaction with the environment, transforming students into creators and designers instead of passive recipients of external information [8]. This perspective, supported by Benítez, has demonstrated success in the creation of virtual learning courses and tools. Online education, carried out through virtual platforms on the Internet as they are also called education 5.0, has become an essential contribution to effective learning, eliminating the gap between traditional methods and new forms of teaching [9]. These platforms, such as Moodle, play a crucial role in providing digital resources that favor the personalization of learning and facilitate collaboration and community learning [9]. Moodle, a digital learning platform, stands out for its usefulness by offering adaptive tools and resources, quality monitoring and high customization to meet the specific needs of each institution and teacher [10]. According to a study at the University of Santander, Colombia, the majority of students positively evaluated the usefulness of Moodle in face-to-face clinical practice courses, highlighting its versatility and popularity with more than 37 million users in 212 countries [11].The indicators of the Moodle Interactive Model to improve mathematical skills can be evaluated considering various aspects, such as participation in the interaction with the content, feedback, collaboration, time dedicated to learning, achievements and progression. These indicators include the frequency of use of tools, the generation and sharing of content, the interaction with multimedia elements and the use of different devices [12]. The interactive model combines learning, research and an active student perspective, structurally adapting to different learning moments and needs [12]. In terms of interaction design [13] propose five dimensions: words, visual representations, space or physical objects, time and behavior. These dimensions seek to ensure that the interactive product is audience-oriented and easily understandable. The importance of using simple and clear words to identify interactive areas is highlighted, considering visual elements that facilitate navigation, paying attention to the physical environment and objects, managing system uptime and understanding how users interact with the previous dimensions to define clearly the points of interaction and reactions to the system, it is also important to identify the mental processes:The internalization that begins the process of assimilation of the initial idea, integration, occurs when two or more operations interact in an action or process, while in encapsulation mathematical concepts coexist and actions and processes are combined for their integration [14]. Mathematical skills encompass competencies in arithmetic, algebra, geometry, statistics, probability, critical thinking and problem solving, contributing to the development of analytical, critical and decisive thinking [15]. Energizing these practices in school fosters understanding of truth, fairness, and objective and honest participation in a free and fair society [15]. Understanding mathematical skills involves the use and application of concepts and knowledge in various situations, covering a wide range of areas and levels. The development of mathematical skills is linked to intelligence and thinking impacting the academic performance of students from an early age [16]. The adoption of Moodle as an educational tool can represent a significant advance in addressing deficiencies in mathematical learning, especially in contexts where access to quality education is a challenge. The need to strengthen mathematical skills not only responds to the improvement of academic performance, but also to the comprehensive development of students and their ability to understand and face the challenges of the reality that surrounds them.

2. MATERIEL AND METHODS

This research follows a quantitative approach, based on the observation and analysis of facts, using techniques to develop active learning models [18]. It employs a quasi-experimental design [19], where researchers randomly assign participants to two treatment and control groups. One group used model interactions in Moodle as the experimental group, while the other was the control group. For a pre-test and a post-test; considering the dependent variable: mathematical skills, with an effect on the independent variable: Moodle Interactive Model, since it is a type of quantitative research, it was based on a descriptive methodology [20], a population group was selected for a systematic process of collecting and analyzing information that allowed the production of knowledge related to mathematical skills. The quasi-experimental design is presented in Table 1.

Table 1. Quasi experimental

G. EXPERIMENTAL	01	X	02
G. CONTROL	P1	----	P2

Where:

GE = Experimental group, O1 = Pretest results, X = The Moodle interactive model
O2= Pretest results, CG= Control group
P1= Pretest results__ = The Moodle interactive model is not applied
P2= Posttest results.

The general population corresponds to 74 students belonging to the eighth grade of basic general education of a fiscal training institution located in the province of Santa Elena, comprised between two parallels: parallel B with 37 students and C with 37 students, as shown in table 2.

Table 2. Population size of the subjects according to the gender factor

	Population	
Gender	*N*	%
Men	37	%53
Women	37	%47
Total	**74**	**100**

The gender distribution in 2 teams, one control and the other experimental, and highlights that in the control team 54.0% are women and 46.0% are men, in the experimental group 41.0% are women and 46.0% are men. 0% are women and 59.0% are men. This suggests that gender is balanced between the two groups, which may be important to eliminate any gender bias in the study or experiment being conducted. as can be seen in this table 3

Table 3. Sample population Control and experimental group

		Control Group		Experimental Group	
		F	%	F	%
Gender	Female	20	54,0%	15	41,0%
	Male	17	46,0%	22	59,0%
	Total	37	100%	37	100,0%

The distribution of age in two groups, one control and the other experimental. In the control group, 84% of the participants are 12 years old and 16% are 13 years old, in the experimental group, 92% are 12 years old and 8.0% are 13 years old. This suggests that age is balanced between the two groups, which may be important to eliminate any age bias in the study or experiment being conducted, presented in the table 4

Table 4: Sample population control group and experimental group by age

		Control Group		Experimental Group	
		f	**%**	**F**	**%**
Age	Twelve years	31	54,0%	15	41,0%
	Thirteen years	17	46,0%	22	59,0%
	Total	37	100%	37	100,0%

3. RESULTS AND DISCUSSIONS

The results derived from the statistical analysis of the data are shown, which leads to a discussion of the two variables from different mathematical competencies in their dimensions: problem solving, decision making and critical thinking before the application of the Moodle interactive model in students. The levels of the groups are shown in table 5.

Table 5. Level of mathematical competencies of the control and experimental group pretest.

PRE- TEST				
	Control Group		**Experimental Group**	
Levels	f	%	f	%
Low	15	40,5%	2	5,4%
Half	22	59,5%	35	94,6%
High	00	0,0%	0	0,0%
Total	37	100,0%	37	100,0%

It is observed that before the intervention (pre-test), both the control and experimental groups were mostly at the average level of mathematical competencies, with percentages of 59.5% and 94.6% respectively. This indicates a similar level between both groups before applying the Moodle interactive model. Regarding the results of the dimensions of mathematical competencies, they are seen in table 6.

Table 6. Level of mathematical competencies according to the dimensions in the pretest in the groups. Control and experimental.

PRE- TEST												
Levels	Problem resolution				Decision making				Critical thinking			
	Control Group		Experimental Group		Control Group		Experimental Group		Control Group		Experimental Group	
	f	%	f	%	f	%	f	%	f	%	f	%
Low	18	48,7%	6	16,2%	15	40,5%	6	16,2%	12	22,4%	9	24,5%
Half	19	51,3%	31	83,8%	22	59,5%	31	83,8%	25	77,6%	28	75,5%
High	00	0,0%	00	0,0%	00	0,0%	00	0,0%	00	0,0%	00	0,0%
Total	37	100,0%	37	100,0%	37	100,0%	37	100,0%	37	100,0%	37	100,0%

These results show the levels of the dimensions of mathematical competences (problem solving, decision making and critical thinking) in the pretest. In both groups, the majority of students were at the average level in each of these dimensions, with no significant differences between the groups. In the application of the Moodle interactive model, the results are shown in table 7.

Table 7. Level of mathematical competencies of the control and experimental group post-test.

POS TEST				
Levels	Control Group		Experimental Group	
	f	%	f	%
Low	0	0%	0	0%
Half	28	75,7%	1	2,7%
High	9	24,3%	36	97,3%
Total	37	100%	37	100%

After the application of the Moodle interactive model (posttest), the experimental group showed a significant improvement, with 97.3% of students reaching the high level in mathematical competencies. In contrast, the control group only reached 24.3% at the high level. Table 8 details the levels of the dimensions in the posttest.

Table 8. Level of mathematical competencies according to the dimensions in the post-test in the control and experimental groups.

POST- TEST												
Levels	Problem resolution				Decision making				Critical thinking			
	Control Group		Experimental Group		Control Group		Experimental Group		Control Group		Experimental Group	
	f	%	f	%	f	%	f	%	f	%	f	%
Low	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	2	5,4%
Half	19	51,4%	1	2,7%	28	75,7%	2	5,4%	22	59,5%	7	18,9%
High	18	48,6%	36	97,3%	9	24,3%	35	94,6%	15	40,5%	28	75,7%
Total	37	100%	37	100%	37	100%	37	100%	37	100%	37	100%

As can be seen in the experimental group, the percentages at the high level were 97.3% in problem solving, 94.6% in decision making and 75.7% in critical thinking, evidencing notable progress. In table 9 you can see the following comparison whose data are taken from pretest and posttest in the experimental group.

Table 9. Level of mathematical competencies according to the pretest and posttest in the experimental group

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EXPERIMENTAL GROUP				
Levels	Pre- Test		Post-Test	
	f	%	f	%
Low	2	5,4%	0	0,0%
Half	35	94,6%	1	2,7%
High	0	0,0%	36	97,3%
Total	37	100,0%	37	100.0%

Table 9 makes a comparison of the levels of the experimental group before and after the intervention. A clear improvement is observed, going from 94.6% at the medium level in the pretest to 97.3% at the high level in the posttest.

The results described clearly show that the application of the interactive Moodle model had a positive effect on strengthening the mathematical competencies of the students in the experimental group. While no significant changes were observed in the control group, the experimental group showed a notable improvement, reaching high levels in mathematical competencies and their dimensions after the intervention. These findings suggest that the interactive Moodle model, based on the mathematical model proposed by Ed Dubinsky in the 1980s, was effective in strengthening problem-solving, decision-making, and critical thinking skills in the area of mathematics. It is likely that the interactivity, theoretical approach and strategies applied in the model have contributed to more significant learning and the development of mathematical competencies in students. In this way, the results support the effectiveness of the Moodle interactive model as a pedagogical tool to improve mathematical competencies at the level of education evaluated. However, it would be more enriching to conduct more research and replicate the study in different contexts to confirm and expand these findings.

CONCLUSIONS

The research revealed the impact of using an Interactive Model in Moodle on the development of mathematical competencies in eighth-grade students. The results revealed a significant improvement in the experimental group after the application of the model compared to the control group. Initially, both groups were located at a medium level of mathematical competencies in the pre-assessment. However, after the intervention, 97.3% of the experimental group reached a high level, while the control group achieved 75.7%. Regarding the dimensions evaluated, the experimental group improved notably in problem solving and critical thinking, surpassing the control group. In this way, the use of the Interactive Model in Moodle positively influenced the development of mathematical competencies, particularly in problem solving and critical thinking, evidencing its effectiveness as a teaching tool in the mathematics teaching-learning process of the participating students.

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