THE USE OF VIRTUAL LEARNING SPACES AND ITS RELATIONSHIP WITH THE LEARNING OF ALGEBRA IN HIGHER EDUCATION

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SUMMARY

The research studied the relationship between the use of Virtual Learning Spaces (EVA) and the level of learning achieved in the subject of algebra by students at the University of the Armed Forces - ESPE, Latacunga extension. For this purpose, we worked with an intentional sample of students and teachers. The research was quasi-experimental with a mixed approach. To carry out the research, two groups were established: an experimental group, which used the EVA designed in the MOODLE platform; and a control group, which did not receive the stimulus. To establish the learning levels of the students, the grades of the first algebra partial (pre-test) were obtained; and the teachers were interviewed to determine the way they work and their position on the use of an EVA for the teaching-learning of algebra. To establish the relationship between the variables, an EVA designed for the learning of inequalities and functions was applied during the second partial period; once the application period was over, the grades of the second partial period were obtained (post-test); in addition, a satisfaction survey on the use of the EVA was applied to the students of the experimental group. Finally, frequency tables were used for data analysis; and a qualitative analysis of the interview with the teachers and of the satisfaction survey applied to the students of the experimental group on the use of the EVA was carried out. In the quantitative analysis, the tabulation of grades obtained by the students in the two mid-term exams was made; and from these data, using Fisher's ratio (F), the fulfillment of the hypothesis that determines that the use of the EVA improves the learning of algebra, a dimension measured with the academic performance of the students, was verified.

Key Words: Virtual Learning Spaces -Algebra, Higher Education, Moodle.

INTRODUCTION

In the last decade, and especially during the COVID-19 pandemic, the use of digital resources and connectivity were essential to develop teaching-learning processes; and among the most used tools perhaps after video calling platforms such as ZOOM + or Microsoft Teams, there are Virtual Learning Spaces (EVA). These learning spaces that hosted on a website, contain a series of computer tools for didactic interaction, which favor the inter-learning process synchronously, asynchronously or by combination . of these modalities. These constructivist models according to Sandí and Cruz (2016), enhance collaborative work in a learning environment, considering among its main advantages the motivation to reflect, continuous availabilityand adapt to the learning pace of students.

In the education system, small variations have been generated in its classic teaching model (Mota, et al, 2020). That is why the use of virtual learning environments (EVA) was proposed as a tool to support the teaching work making education exceed the limits of the classroom. Based on the above, it is necessary that educational establishments implement technological tools in the teaching-learning process in order to strengthen the autonomy and responsibility of the student; in addition, to overcome the space-time limitations between teacher and student, with flexibility in the use of learning times and spaces (Darling-Hammond, et al, 2020).

Herrera and Montero (2020), establish that the relationships between teachers, students and content can be mediated with the use of virtual learning environments; This is because a digital culture has emerged. Therefore, in a "digital learning society" we must take advantage of the transformation capabilities provided by information and communication technologies (ICTs). The role of the teacher has been transformed with the implementation of virtual learning spaces; this with the purpose of achieving the greatest knowledge and skills within a virtual educational community. The teacher has had to diversify and incorporate several aspects of the curriculum to their digital training such as: methodological strategies, pedagogical and didactic, communicational, technological and educational competences (Camacho et al, 2017).

Within the process of leveling students who enter the University of the Armed Forces ESPE, Latacunga extension, the use of technologies in their training is important; since the use of virtual spaces in the educational process can help enhance learning such as of algebra; This with the effective fulfillment of the methodological activities incorporated by the teachers for the synchronous and asynchronous work of the students.

For Flores (2016), deficient knowledge in mathematics prior to university entry is an issue of great concern at the university level; which is why the development of new learning skills and abilities is required. by students. Some of the deficiencies that students present when learning algebra are: the lack of ability to abstract the meaning of a quantity or a numerical value, or the difficulties in selecting an operation or calculation required to solve a specific problem (Ramos et al., 2021). Among the most important aspectsfor students to achieve learning in algebra, is to understand the basic concepts of algebra; as well as the properties of mathematical operations, the simplification of algebraic expressions, the resolution of equations, among others. In addition, to develop skills in problem solving, identify patterns and relationships to apply them in solving more complex problems; and apply algebra in real situations.

The level of training received in high school, and the fact that students do not work adequately to develop critical thinking, are other difficulties present in the teaching – learning of algebra. This is a challenge that requires Higher Education institutions to work on the incorporation of pedagogical innovations, especially to teach exact sciences such as algebra; for which, it requires constant preparation and updating by teachers in the use of new strategies. pedagogical and technological tools (The Organization for Economic Cooperation and Development [OECD], 2016).

In relation to the learning of the subject of algebra of the students of leveling of engineering of the Univ ersidad of the Armed Forces ESPE, extension Latacunga; have analyzed the tables of qualifications of the students of the previous semesters, where It is evident that about half of the students (45.65%) do not pass the subject of Algebra. This factor could be associated with the fact that training in the institution maintains a knowledge transfer approach in which individuals are notan active part of the learning process (traditional model). In a pre-study conversation with the leveling students, they mention that their algebra classes are mostly of the master type; And in relation to the use of virtual learning spaces, they stated that they do not use them in their learning process .

Several investigations have been developed in which the difficulties of learning algebra are determined (Flores, 2016; Ramos et al, 2021, Serres, 2011, Pramesti and Retnawati, 2018). These works allow to show the problem that has with the use of traditional methodologies in the process of teaching - learning of algebra at a higher level. There is also research such as those of Corrales (2021), Juan et al (2012) and Leite et al (2022), on the advantages of using virtual spaces in the teaching of mathematics. From these experiences was born the following research question: What will be the incidence of the use of Virtual Learning Spaces (EVA) in the learning of algebra in the students of leveling of the ESPE, extension Latacunga?

Faced with this problem of interlearning algebra, the general purpose of the study was proposed, which was: to *determine if the use of a virtual learning space influences the learning of algebra*. The specificobjectives were: to establish whether teachers and students use virtual spaces in the teaching-learning process of algebra; design a virtual space for learning algebra on the "moddle" platform; and, experimentally with the use of this virtual space determine if it influences the learning of algebra.

The justification of the study is due to the high rate of repetition in the subject of algebra in the leveling of the ESPE in Latacunga (about 50%), whose causes may be the low level of preparation in algebra received by students in secondary school; the use of traditional methodologies used by teachers in the teaching of this subject; or the low use of technological tools in the teaching-learning process of algebra, as is the case of EVA's.

The development of theresearch sought to establish whether the use of technological tools in the teaching of algebra, improved the performance and academic performance of engineering leveling students of the ESPE-Latacunga, base subject for Other subjects, especially in the area of mathematics of the career. In addition, the use of virtual learning spaces was for many students a new learning experience, and their management is considered to be very useful for theirlearning during the COVID-19 pandemic, since in this experimentation a series of synchronous and asynchronous activities were incorporated into the EVA such as: workshops, Forums and teamwork to strengthen autonomous and collaborative learning. For teachers, the use of this technological resource allowed them to have a new vision of how to develop the teaching-learning process of algebra, in order to achieve better performance in the training of their students and reduce the rates of repetition in the subject.

BACKGROUND TO THE RESEARCH

In the work carried out by Espeleta et al (2016), it is emphasized that a problem in the teaching - learning of mathematics, is the use of incorrect strategies and little In addition, they remember that mathematics is among others: the abstraction of the nature of numbers or quantities, and that their calculations must be used in daily life; problems that are evidenced by the little usefulness and application of the theoretical-practical foundations learned in class. According to González-García et al (2018: 257) students present "errors when operating and simplifying algebraic expressions. For example, operating with a negative sign as if it were positive." The results of the study by Pramesti, and Retnawati (2018) determine that the difficulties of students in learning algebra are: understanding the problem and meaning of the variables, and the resolution of the algebra exercises . Therefore, the strategy of teachers to teach this subject has to minimize these difficulties of students in learning algebra.

Flores (2016) menciona that low performance in algebra is generated by the type of activities, methodologies or strategies used by teachers; and, points out that students must also work on cognitive and integral development in order to generate meaningful learning in students, who have different learning needs and expectations. Leite et al (2022), notes that after the closure of schools and universities worldwide due to COVID-19, virtual learning environments (EVAs) have seen a huge increase in their use. His study on the use of virtual spaces in algebra determines that teachers have changed in the use of didactic strategies, and that the use of this technological tool was positively related to student performance. These studies reinforce the importance of algebra as a necessary domain in engineering careers.

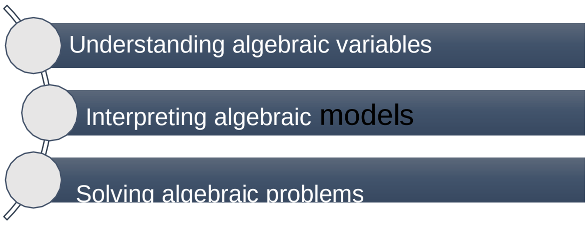
THE TEACHING OF ALGEBRA AT THE HIGHEST LEVEL

Often, mathematics does not show the authentic usefulness of these in real life. In some tasks, authentic aspects are combined with inauthentic ones; for example, the context is authentic, but the question is artificial and different from what people would ask in that context. Studies show that students are more motivated by authentic questions than by authentic contexts. As an alternative, Vos (2018) proposes for the teaching of mathematics, to use authenticity as an objective construction and not as a subjective perception.

In the last decade,the learning of algebra has undergone a constant evolution due to its application in computer science, electronics and others related to the solution of multidimensional problems. Computing requires the conceptualization and management of algebraic processes of varying complexity; which is why mathematics teaching trends have been developing as thinking styles oriented by cognitive parameters (Karadag, 2009). According to Ridgway et al (2011), thinking mathematically is developing mental habits to solve a problem when you need it , and it is not turning to a book to do it. This meaning establishes that in algebra it is necessary to construct a planthat reconstructs the algebraic notions in the mind, for the solution of problems of the multi-problematic environment. Algebraic models have as their main objective to interpret real problems in algebraic variables expressed in calculation routines (Serres, 2011; Sanjosé, et al, 2007). To achieve an effective interpretation, the developmentof cognitive processes is required in which critical thinking, reasoning, argumentation are prioritized to represent, evaluate and solve problems translated into an algebraic language (Niss and Højgaard, 2011; Ramos et al, 2021).

Cognitive and methodological inconveniences are generators of constant errors in mathematical calculation routines (Brousseau, 1971); aspects that must be mastered with the help of new learning strategies . According to Palarea and Socas (1994), there are certain factors Typical algebraics, which are caused by the lack of knowledge and by the peculiarities of the algebraic language. They also point out the presence of epistemological difficulties, the lack of understanding in the representation of algebraic expressions; and skills in algebraic calculus. Serres (2011) states that some of the aspects that should be worked on in the teaching of algebra are: improving the understanding of algebraic variables and the relationship between quantities; the interpretation of algebraic models, and the resolution of problems (Fig. 1). Theseparticularities generate difficulties in the teaching process in many students.

Figure 1. Problems associated with algebraic learning.



Source: Serres (2011)

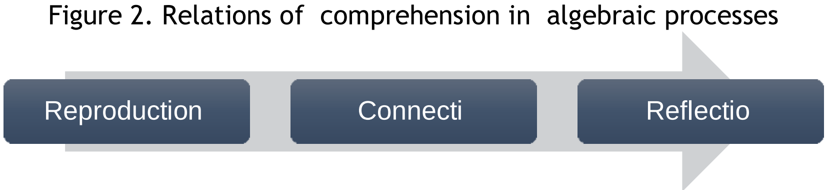
Understanding the environment is directly involved with processes that algebraically model problem solving ; Therefore, students must conceptualize and create the necessary conditions to identify and use the algebraic routines of each situation. Flores (2016), associates certain factors to take into account in the teaching of algebra that are related to the understanding of algebraic processes (fig. 2); These are:

– Reproduction: which focuses on the use of common algebraic operations, along with simple calculation routines on problems of the near environment.

– Connection: determined by the generation of notions and applications in algebraic processes, to solve problems not defined as frequent, and that also involve known environments.

– Reflection: involves complex models and develops them with mathematical approximations with certain algebraic operations.

Figure 2. Relations of comprehension in algebraic processes



Source: Flores (2016)

USE OF TECHNOLOGICAL TOOLS IN HIGHER EDUCATION TEACHING

In the last decade the joint development of technology and education have had a great impactoby the innovation of technological resources, which are increasingly accessible and varied. Among these we have the use of virtual platforms such as MOODLE. It is also important to note that the use of technology is not a panacea for education; it is for this reason that educational and training objectives should be the main reasons why the various resources are selected. technological technologies (Molinero and Chávez, 2020).

Virtual education can be considered complex due to the lack of interaction, adaptation to the virtual environment, or clarity in the theory-practice relationship; but, due to the different applications that support and dynamize it, it is analmost indispensable dynamic resource in any educational process. In this context, it is understood that virtual pedagogical processes have characteristics of remarkable complexity and difference with face-to-face educational activity (Corrales, 2021). The differences lie in the way in which the actors interact within a virtual activity, which is closely related to the rhythms of learning; reason by which; It will be the teachers and students who establish the most usefuland appropriate resources for the teaching-virtual learning process.

THE DESIGN OF A VIRTUAL ALGEBRA LEARNING SPACE

Most authors agree that the main components of an EVA are: space, students, teachers, materials and the didactic strategy for the development of the teaching-learning process (Molinero and Chávez, 2020; Mota et al, 2020; Corrales, 2021). The operational conception of algebra refers to conceiving concepts as processes, as algorithms, or a sequence of mental and physical operations. In the case of the teaching of equations, the emphasis is not placed onalgebraic structuring, but must resort to other methods of arithmetic or basic geometry. The operational conception implies an interpretation of a process as a potential entity, that is, a dynamic, sequential and detalled entity (Maldonado, 2013).

The selection of a technological tool must be based on its versatility to be able to learn; that is, these must become a support and not an obstacle to the interlearning process. Based on the criteria, Camacho et al (2017), Corrales (2021), Juan et al (2012), and Leite et al (2022) consider that some of the pedagogical characteristics for the virtual teaching of algebra are related to: the stimulation of communication, the use of interactive methodologies for teaching, the improvement in feedback processes, increased motivation foralgebra proficiency, and relevant content selection (Fig. 3).

Figure 3. Features of virtual tools

Source: Camacho et al (2017), Corrales (2021), Juan et al (2012), and Leite et al (2022)

Education shows a variety of scenarios for its work, and among these are those that are generated with the use of technological tools and applications . When comparing between a traditional and a virtual education environment, some benefits are established when using the latter, such as: you have a greater possibility of working collaboratively, access is to a greater amount of information, the process of education revolves around the student, a variety of tools can be used, among others (Table 1).

Table 1: Contrast traditional and virtual education

Traditional education environment	Virtual Education Environment
• Development of individual tasks	• Task development with collaboration
• Inclusion of timely information	• Free access to information
• Unique means of communication	• Variety of media
• Direct knowledge of the teacher	• Student-oriented learning

Source: Vega et al (2015).

Taking into account these aspects, Vega et al (2015) point out that the use of virtual environments in educational processes is very useful , provided that their effectiveness is taken into account. The organization of a teaching-learning process with the use of virtual environments is a pedagogical process that aims to develop the ability to learn, from the creation of specific conditions that favor it, apoyado in the use of technology.

The structural conception of algebra refers to the ability to mentally "see" mathematical objects that are abstract mental organizations, such as real objects, with defined characteristics and functions (Vilchez, 2015). This conception determines that to teach algebra, it is required to work with rules, properties and procedures of this. Vega et al (2015), points out that the development of mathematics goes hand in hand with needs of society; And in education, it mentions that the use of technological tools is a function of the pedagogical, disciplinary, technological and contextual objectives of learning (Fig. 4).

Figure 4. Educational references for virtual teaching

Source: Vega et al (2015)

The pedagogical model determines the virtual learning objects. The disciplinary referent: determines the contents with which the technical tools will be selected. The technological reference is related to the relevance of the selected educational software; which should stimulate learning with its use in virtual learning spaces. And the contextual reference: it takes into account educational environments to create new learning experiences. In relation to educational software, there are several options that support the teaching work in the different fields of mathematics, such as: basic mathematical operations, mathematical logic exercises, the field of data analysis, work with spatial properties applied to geometric objects. Some of these programs are: GeoGebra, Derive, Descartes applet, Cabri-Géometre, or CaR Regla y Compass, among others (Fernández et al, 2017).

METHODOLOGY

This research was developed at the University of the Armed Forces ESPE, Latacunga extension, which is located in the Belisario Quevedo sector of the city of Latacunga, Provincia de Cotopaxi, Ecuador. The research had a descriptive and explanatory scope of what happens with the level of learning of algebra when using virtual spaces in teaching students of ESPE leveling. The research approach was mixed concurrently (Hernández-Sampieri et al, 2016); qualitative, because the problem of teaching algebra was understood through the teachers' opinions; and quantitative, because with the numerical data of the research questionsit was possible to verify the established hypotheses.

The research carried out was of the correlational type, since the degree of relationship between the two variables was determined: level of learning (measured by academic performance), and the use of virtual learning spaces (EVA). For Bernal (2010), this type of research establishes the degree of relationship between two or more variables, for which the first step to be carried out is the measurement of variables, to then validate the hypothesis with the support of statistical techniques, and determine the existence or not of a correlation.

The research design was quasi-experimental, including a pretest and posttest with two control groups. The advantage of this design is that you have an initial reference point to see the changes in learning algebra after using an EVA (Gutiérrez and De La Vara, 2012). According to White and Sabarwal (2014) the quasi-experimental method is used more frequently when it is not feasible to randomly select the study objectives.

The research population was composed of students and teachers who studied and taught respectively the subject of algebra in the leveling course taught at the University of theArmed Forces ESPE, Latacunga extension during the period June – September 2019. The population size was 87 students and two teachers of the subject. Since it worked with the entire population, the sample was intentional non-probabilistic.

For the qualitative research, the interview with teachers was used as a technique, and an open questionnaire was used as an instrument with which the information was collected that allowed to fulfill the second objective of the research ; that is, to establish the level of knowledge and skills in teaching algebra using EVA's; as well as, their weaknesses to be able to guide them in the use of this platform. In summary, the interview consulted about: the usual activities developed in classes, the opinion of teachers on the use of virtual spaces, and knowledge of tools or resources technology for teaching algebra; the instrument was validated with experts before its application

For the quantitative part, a questionnaire was used as a technique to obtain information to the survey, which in the opinion of Bernal (2010) is useful to obtain Direct information from study individuals that cannot be obtained by other means. The questionnaire that was applied to the students, consisted of 12 closed questions with answer options on the Likert scale. The information collected was related to the knowledge, development of activities and results of the use of the Virtual Learning Space designed for the learning of algebra. The questionnaire was validated by experts, and the level of reliability was carried outwith a pilot test, and the calculation of Cronbach's alpha, whose value was 0.6657, which establishes that the results obtained are consistent and coherent.

The collection of information was done through fieldwork in twophases: in the first, the instruments were applied to obtain data from students (survey) and teachers (; and in the second, to obtain data from the academic base of the university. Data was collected from the pretest and posttest, for the verification of the hypotheses: the *use of a Virtual Learning Space* (*EVA*) *does not allow to improve* the *learning (measured* by *the performance) of the subject of algebra by part* of the *leveling students of* the *University of the Armed Forces ESPE, Latacunga* extension *in the period June – September 2019.*

The experimentation was carried out in the second partial of the academic period June – September 2019; the phases that were carried out within the design were: 1) selection of the experimental groups, group 1 (parallels A and B), composed of 44 students, which used EVA to learn algebra; and the control group (parallels C and D), composed of 43 leveling students, 2) coordinated with the teachers who teach the subject of algebra, to establish the mastery of the contents to be implemented in the virtual learning space designed in the Moodle platform; These were: inequalities, exponential and logarithmic functions, linear equations, considered the topics of Mayrdifficulty. And, 3) the teachers and students of the experimental group were instructed on the contents and use of the activities and tools included in the EVA; and the control of the activities was in charge of the teachers of the algebra assignment (Table 2).

Table 2: Algebra contents selected for your EVA application

Theme	Subtopic
Inequalities	Intervals
	Linear inequation
	Quadratic inequation
	Polynomial inequation
Functions	Domain and Rank
	Linear and quadratic function
	Polynomial function
	Monotony and parity of functions

Source: Syllable of the ESPE algebra subject (2019)

During the experimentation, the contents were worked on simultaneously in class; and the autonomous activities programmed in the virtual classroom, which had the due accompaniment and tutoring by the teachers. In addition, the students of the experimental and control group studied the same contents: Inequities and functions. 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 studied the materialsand carried out the activities proposed in the EVA.

In the virtual classroom, a file was placed with organized information on each topic; as well as, solved exercises with a medium and high level of complexity; In addition, a video was shared in which the topics to be studied were explained. Also, a chat was enabled for synchronous communication, whose objective was to help students with their doubts or inconveniences of the study content. Finally, the tasks to be developed by the students were proposed; which were part of a workshop, and whose objective was to carry out collaborative work among peers. The estimated time for the development of the activities assigned in EVA for each topic was 2 hours. In addition, the GeoGebra tool was incorporated for the study of the subject of function analysis, considering that it is complex for students to make graphs that facilitate their understanding.

Once the treatment of the themes was completed, and the phase of the application of the EVA with the students of the experimental group, and the conventional work was carried out with the individuals of the control group; a posttest was applied, which evaluated with a questionnaire similar to the structure of the pretest, the knowledge acquired by the two groups on inequalities and functions. The data treatment culminated with the comparison of the results of the response variable that was the academic performance obtained in the pre and posttest. To measure academic performance, algebra scores corresponding to the first partial (pretest), and the questionnaire applied as a post-test, were used. To conclude the research, a satisfaction survey was applied to the students of the experimental group who used the EVA; This, to know their opinion and experiences of the use of the virtual classroom, and the activities developed that were included in the work platform for the learning of this subject.

RESULTS

The purpose of the research was to establish the relationship between the use of Virtual Learning Spaces with the level of algebra learning of leveling students. In the interview that was carried out with the teachers of the subject, previously trained in the application of the EVA, qualitative information was obtained related to: the development of the training process in the Algebra subject using the virtual classroom, his opinion on the use of virtual space, and the influence that this technological tool could generate in the performance and knowledge of students.

Information obtained from teachers; In the first place, related to the teaching-learning process, it highlights that initially they capture the attention of the student; for which, they usually carry out a dynamic of introduction of the subject with the participation of all students, and of this They attract their interest and generate motivation for learning. Then they continue with a preliminary vision of the subject and the contents to be treated, to relate them to the previous knowledge obtained, this is done with examples and exercises with different levels of difficulty. To evaluate the abstraction capacity of the subject, they ask for the participation of students in activities that take place in the classroom, usually it is a series of exercises. Finally, they assign autonomous tasks to demonstrate what they have learned. In case of problems or difficulties with the assigned activities, they give feedback in the next class session .

The second topic analyzed was the opinion on the application of virtual spaces to teach algebra. In this regard, they state that these environments can help improve training, facilitate learning, since there is more time for interaction with students.

Also, they develop greater responsibility in the student in front of their learning; since the student can maintain his own pace and style of learning, and strengthens his autonomous learning. Teachers point out that the use of a virtual space provides the opportunity for a pedagogical change for both the teacher and the student. They point out that the teacher must be strategic in the use of an EVA, and that for its use they must have a proactive, planning, interactive and evaluative thinking. In addition, they say they must be prepared to make decisions; and that it is essential to be very clear about the purpose and objectives of virtual education; as well as, his new role; and that the activities and the type of evaluation have to be related to the subject matter treated.

On the influence of a virtual learning space on the performance and improvement of students' knowledge in the subject of algebra, the teachers mentioned that these technological tools can help reinforce the Knowledge that students often cannot assimilate in class; such as, for example, in the simulation and analysis of function graphs . In addition, they say that EVAs can help increase students' academic performance. Teachers consider that the use of a virtual environment would improve the teaching-learning process, since it manages to awaken the interest of students in learning algebra; but, they require technological knowledge for effective use. They emphasize that virtual environments allow the development of new skills and knowledge through the construction of knowledge among the members of the educational process.

Finally, on the subject, they mentioned some of the virtual platforms they know as: Claroline, Sakai LMS, Moodle, Dokeos-Compliance LMS , e-ducativa. In ESPE the institutional platform used is the Moddle, and among the most used activities are : files, tasks, workshops, forums and chats , and wikis. Other tools that they say can be incorporated into virtual classrooms for teaching algebra are: edublogs, Blackboard, GeoGebra, the Desmos graphing calculator, Classroom, Kahoot, Matlab, Schoology, Quizizz.

Regarding the quantitative results, initially those obtained at the end of the first partial were analyzed, which were considered as the pretest. In the case of the experimental group, it was identified that the majority of students (61%) obtained a grade of 11.53 to 15.72 points. The second group of importance (20%), obtained a score in the range of 8.22 to 11.53 points; the third group of students (16%) achieved a grade of 15.72 to 19.91. A single student (2%) obtained the grade between 7.35-8.22, being the score with the lowest percentage (table 3).

As for the control group, the ratings are very similar to that of the experimental. 57% of students (61%) scored from 11.53 to 15.72 points, and 36% in the range of
8.22 to 11.53 points. A third group of students (5%) reached themaximum grade ranging from 15.72 to 20.00. Like the experimental group, a single student (2%) obtained a score located in the range of 7.35 to 8.22 (Table 3). Performed an F test of variances with the values of the qualifications of the groups, a value of p equal to 0.495 was obtained, establishing that there is no significant difference in the scores of the control and experimental group for a level of significance 95%.

Table 3: Pretest evaluation data in experimental and control groups

	PRE-TEST				
Range of qualifications	Equivalences	Frequency	Experimental	Frequency	Control
7.35-8.22	Casualty	1	2%	1	2%
8.22-11.53	Medium Low	9	20%	15	36%
11.53-15.72	Medium High	27	61%	24	57%
15.72-20.00	Loud	7	16%	2	5%
		44	100%	42	100%

Source: Academic Secretary of Leveling of the ESPE (2019)

In the posttest results of the experimental group, it was identified that the largest group of leveling students (68%), obtained a high score in the range of 15.72-2 0.00; followed by 27% that reached a score between 11.53 to 15.72 qualified as medium high. Finally, only two students (4%) had grades below 11.53, considered as medium low and low (table 4). On the side of the results of the posttest of the control group, results similar to those achieved by the experimental group were obtained. The highest percentage of students (48%), reached a high score on the scale of 15.72 to 20.00; followed by 31% who reached the grade between 11.53 to 15.72 considered as high average. Nine students out of 42 (21%) had grades assessed as low and middle (Table 4).

Table 4: Post-test evaluation data for experimental and control groups

Post Range of qualifications	Equivalences	Frequency	Experimental	Frequency	Control
7.35-8.22	Casualty	1	2%	3	7%
8.22-11.53	Medium Low	1	2%	6	14%
11.53-15.72	Medium High	12	28%	13	31%
15.72-20.00	Loud	30	68%	20	48%
		44	100%	42	100%

Source: Algebra Teacher Grade Register, ESPE-SL (2019-2020)

Based on these values, it is determined that 95% of the students in the experimentation group, and 79% in the control group , obtain high grades. In the case of students in the experimental group, in the pretest, 77% of students obtained high grades; that is, they have improved their score by 18%. In the case of the control group, in the pretest, 64% achieved a high grade; that is, 13% of students in this group haveimproved their grade. This relative analysis determines that there was a higher academic performance in the group that used the virtual space; this can demonstrate that there was a greater understanding of the contents of algebra by the groups, and that the use of virtual aul in the experimental group, had a certain impact to strengthen the new knowledge of algebra in the students who used it; Despite the increase in ratings in both groups. The increase in grades in the experimentaland control group is considered to have occurred due to a factor external to the use of virtual space in the teaching – learning of algebra; This is the need for students to pass the semester of leveling; which is why the grades obtained during the second partial were higher.

In relation to the experimental group, it is that 52% had a low performance before receiving the stimulus to use the EVA, and after it, the percentage was reduces to 22%; That is, one in three (30%) grade students improved their learning of algebra. On the control side, the pretest determined that 62% of students had a low performance. The subsequent result of the posttest, established that 37% of students presented a low performance; that is, the values are similar to the experimental group; that is, 25% of students in the control group improved their academic performance.

HYPOTHESIS TESTING

To establish the relationship of the variables: use of virtual learning spaces vs. learning measured by the academic performance of leveling students in the subject of algebra, the *exact Fisher test* was used to determine whether or not there is a significant association between two categorical variables; This is an alternative to the Chi-square independence test. For its calculation, a 2x2 cross table was used to test the hypothesis (Table 5). Posttest records were used as data. both the experimental group and the control group. Grades less than a score of 14 out of 20 were considered to be underperforming.

The null hypothesis (Ho) that was raised in the research was: The use of a Virtual Learning Space (EVA) does not allow to improve the learning (performance) of the subject of algebra

by the leveling students of the University of the Armed Forces ESPE, Latacunga extension of the period June – September 2019. And, the alternative hypothesis (Ha): The use of a Virtual Learning Space (EVA) allows to improve the learningwith academic performance of the subject of algebra by the students of leveling of the University of the Armed Forces ESPE, Latacunga extension of the period June – September 2019.

. Table 5: Post-test notes of the experimental group

Post-test ratings		
Experimental group		Control group
Number of low-performing students	8	16
Number of students with acceptable performance	36	26

Source: Academic Secretary of Leveling of the ESPE (2019) - Register of qualifications of algebra teachers, ESPE-SL (2019-2020)

A significance level of 0.05 was used to test the hypothesis. The p-value obtained for a unilateral test was 0.03, a value lower than the significance level, therefore, the null hypothesis (Ho) is rejected and the alternative hypothesis (H1) is accepted, that is: *The use of a Virtual Learning Space* (EVA) *allows to improve* the *level of learning (performance) of the subject* of *algebra by* the *students of leveling* of *the University of the* Armed *Forces ESPE.*

To verify the degree of satisfaction of the students when using the Virtual Learning Space (EVA) of algebra designed, a survey was applied to the members of the experimental group . The questionnaire consisted of 11 closed questions on the dimensions of the variable: use of Virtual Learning Spaces. The results in the learning dimension of algebra were as follows: more than half of the students (52%) who used the learning space believe that the planned tasks were very useful to reinforce the knowledge of the topics studied in the algebra class; 45% thought that the proposed activities were useful for their learning of the ASIGNATURA; and only 3% considered that they were neither useful nor useless (Table 6). That is, most of the students in the experimental group have a positive position that the tasks planned on the platform gave them the opportunity to reinforce their knowledge of the topics of algebra inequalities. and functions) studied in class.

Table 6: Learning Algebra with EVA Use

	Very useful	Useful	Neither useful nor useless	Not very useful	Nothing useful
How to rate the activities planned in The virtual platform to reinforce your knowledge of algebra.	52%	45%	3%	0%	0%
	A lot	Pretty much	Something	Little	Nothing
The use of virtual space motivated him to Learning Algebra	41%	32%	18%	9%	0%
The use of virtual spaces improved their academic performance in algebra	57%	32%	11%	0%	0%
	Very useful	Useful	Neither useful nor useless	Not very useful	Nothing useful
How he qualifies the virtual space to learn algebra.	68%	23%	9%	0%	0%

Source: Post-test survey of the experimental research group (2020)

To the question: Does the use of *virtual space motivate you to learn* algebra ?, a little more than four out of ten students (41%) think that the use of EVA's led motivated a lot in learning algebra; 32% (more than three out of ten students) thought that their motivation to learn algebra increased considerably with the use of a virtual space (Table 6). 18% of participants in the experimental group said their motivation increased somewhat; and 9% only slightly increased. Nearly three-quarters of students (73%) who usedthe EVA have a positive view of using virtual learning spaces to improve their motivation for learning algebra.

Another question of this dimension of learning was if: Did the use of virtual space improve their academic performance in algebra?, more than half of the students in the experimental group (57%) indicated that the use of virtual space in algebra allowed them to greatly improve their *academic performance*. 32% (more than three out of ten students) responded that their grades improved a lot. That is, 89% of students have a positive view of the use of a virtual space to improve their academic performance in the subject of algebra (table 6). 11% of students thought that the EVA lis somewhat helpful to improve their scores in this subject.

The fourth question of this dimension was whether: Was *the application of virtual space* *adequate for learning algebra*?; In this regard, most students in the experimental group (68%) considered that it was very useful; while, 23% point out that this virtual space was useful to learn algebra. These results establish that more than nine out of ten respondents see the usefulness of an EVA to learn the subject. Only 9% stated that the virtual environment used to learn algebra was neither useful nor useless (Table 6).

A second dimension consulted was the usefulness and ease of management of the designed virtual space. To the query, if the contents or the programmed activities were related to the classes taught by their teachers, the majority of the students who used the virtual space, answered to be in total agreement with this query (45%); while half (50%), answeredthat the activities and contents of the EVA had Relationship with the topics covered in the classes (Table 7). Based on these percentages, it is established that more than nine out of ten students consulted (95%), have a positive point of view on the existence of the relationship class topics and resources included in the virtual space. On the other hand, 18% think they do not agree or disagree with this relationship.

Table 7: EVA facilities for learning algebra

	Totally agree	Agree	Neither agree nor agree disagreement	Disagree	Strongly disagree
The activities or contents of the EVA were related to the topics covered in classes	45%	32%	18%	5%	0%
The interface (communication zone) of the EVA was organized for easy handling	41%	50%	9%	0%	0%
He had no problems in accessing the virtual classroom and the activities of the algebra subject	66%	27%	7%	0%	0%
	Very appropriate	Appropriate	Normal	Limited	Very limited
The time you had to carry out the activities programmed in the EVA	27%	57%	11%	5%	0%

On the ease of handling the interface (communication zone) of the EVA for the development of activities; four out of ten students who used it, say they totally agree that the interface was well organized for easy managementand mastery. To this position, we can add the 50% of students who mention agreeing with the ease of working with EVA resources. (Table 7); that is, there is a criterion of more than nine out of ten EVA users that its handling and mastery was easy. 9% said they neither agreed nor disagreed with this precision.

Another question of the dimension: usefulness of the activities and ease of management of the virtual space, referred to the problems of access to the EVA and its activities; More than six out of ten users (66%) say they are totally agreedthat there was no problem accessing the virtual space. Similar opinion was expressed by 27 students in the experimental group, who mentioned agreeing with the ease of access to EVA and its programmed activities (Table 7). These resultsdetermine that 93% of users of the virtual environment for learning algebra had no difficulties in handling EVA. 7% think they do not agree or disagree with this ease of access to the virtual classroom.

The last question about the facilities in the development of the activities programmed to learn algebra in virtual space, was about the time to perform these. The answer of the majority of students (57%) was that the time was appropriate ; 27% had a more favorable criterion, noting that the time they were given to perform algebra learning activities was very appropriate (Table 7). Overall, more than 8 out of ten students mentioned that the time scheduled to develop their activities was adequate. On the other hand, 11% thought that the time allocated to perform the tasks was normal; and, 5% that this was limited.

A third dimension analyzed was related to the need fortutoring of their teacher to carry out the algebra work proposed in the virtual classroom, and the development of skills to perform autonomous activities and teamwork. The first question of this dimension referred to the students' need for accompaniment or teacher guidance to carry out the learning activities planned in the EVA of algebra; the answers of the majority (34%) was that they only sometimes required the help of their teacher to perform thetasks (Table 8). On the other hand, four out of ten users of the platform (39%) required help most of the time or throughout the experiment (always) to perform the tasks. On the other hand, 27% say they have never or almost never required the tutoring of their teacher to develop the activities proposed in the EVA. These answers establish that most users of the virtual space work autonomously in performing their algebra tasks.

Table 8: Counseling and skills developed

	Always	Most of the time	Sometimes	Almost never	Never
I need the accompaniment or guidance of the teacher to perform algebra tasks in the EVA	17%	22%	34%	21%	6%
	A lot	Pretty much	Something	Little	Nothing
The activities programmed in the EVA allowed him to develop teamwork skills	30%	40%	15%	10%	5%
The activities programmed in the EVA allowed him to develop self-learning skills or autonomy	62%	26%	10%	2%	0%

Regarding the development of skills to perform team activities, the responses of the students of the experimental group were mostly (40%) that they developed this collaborative work skill (Table 8). Ifone in ten students (70%) have a positive opinion about the development of this collaborative skill; On the other hand, 30% of users say that they have developed some, little or nothing collaborative work when working with the activities programmed in the virtual classroom designed to learning algebra.

The final question asked to EVA users to learn algebra was related to the development of skills to perform autonomous or self-learning activities. In this regard, the answers of 62% of the students were that they developed a lot of the ability to work autonomously (Table 8). From the positive point of view, more than eight out of ten users of the virtual classroom of algebra, say they have developedthis self-learning skill. On the other hand, about 10% mentioned that they did not develop this skill using virtual space.

CONCLUSIONS

Theoretically, researchers and theorists of Virtual Learning Spaces establish and agree that it is pertinent and relevant to use these virtual technological environments in teaching-learning in all subjects, including algebra. Its use would generate interest and motivation in students; In addition, it allows them to manage their time, achieve autonomy in their learning, acquire new knowledge, and actively and participatively develop new procedural and attitudinal skills. To be academically successful with an EVA, it is necessary that the activities are selected according to the learning objectives, and planned according to the type of content, level of difficulty of the subject and characteristics of the students to be taught.

Leveling algebra teachers at the University of the Armed Forces ESPE, Latacunga extension, work most of the time with traditional methods. But, if they use various technological tools in the development of their courses. The teacher's knowledge about the relevance, functionality and benefits of using virtual spaces in the teaching of algebra is limited; likewise, their skills and abilities for the use of this technological platform in the teaching - learning of the subject.

52% of students in the experimental group had a low performance before receiving the stimulus to use the EVA, and after it, the percentage was reduced to 22%; That is, one in three leveling students in this group improved their learning of algebra. On the control side, the pretest determined that 62% of students had a low performance. The subsequent result of the posttest established that 37% of students presented a low performance; values very similar to the experimental group. That is, 25% of students in the control group also improved their academic performance. The increase in grades in the two groups, it is considered that it could also be given to a factor external to the use of virtual space in the teaching – learning of algebra; this is, the need or motivation of the students to pass the semester of leveling; reason why, the grades obtained especially in the group of control were higher.

The calculated p-value of 0.03, lower than the significance level 0.05, determined that statistically there is a relationship between the use of the Virtual Learning Space (EVA) designed with resources, activities and tools for learning algebra, and the improvement of learning as a response variable, which was measured by the academic performance of the students of leveling of the ArmedForces ESPE, Latacunga extension.

The design and application of a virtual classroom with contents and activities to learn inequalities and functions, which was used by an intentional experimental group, at the discretion of most of the students, was a technological tool that It allowed to improve their academic performance and develop certain skills for learning ALGEBRA. In addition, the acceptance of leveling students to the use of EVA as a complement to their Face-to-face studies. According to their criteria, it allowed them to reinforce the knowledge of the subject, feedback the contents, awaken interest in the subject, develop autonomous and collaborative work skills, being an active and fundamental partin the construction of their own knowledge.

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