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Curso de nivelación algebraica para incrementar el rendimiento académico en estudiantes de ingeniería en un ambiente virtual de aprendizaje

Algebraic Leveling Course to Increase Academic Performance in Engineering Students in a Virtual Learning Environment

Curso de nivelamento algébrico para aumentar o desempenho acadêmico de estudantes de engenharia em um ambiente virtual de aprendizagem

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Resumen

El propósito de este estudio fue determinar la influencia que tuvo el desarrollo de un entorno virtual de aprendizaje con contenidos básicos de álgebra en estudiantes de la materia de Matemáticas II en el tema de diferenciación. La investigación fue cuasi experimental con pretest y postest; la muestra se integró de estudiantes de primer semestre de la carrera de Ingeniería Petrolera de la Universidad Autónoma del Carmen en el periodo de agosto-diciembre del 2017. Esta muestra fue subdividida en dos grupos: el primero con 24 estudiantes correspondientes al grupo experimental y el segundo con 41 estudiantes para el grupo control. La realización del pretest consistió en una prueba objetiva de opción múltiple, con la cual se determinó que ambos grupos fueron homogéneos al inicio del experimento. Se desarrolló un entorno virtual de aprendizaje tomando como modelo de diseño instruccional la estructura Análisis, Diseño, Desarrollo, Implantación y Evaluación (ADDIE). Tras la implementación del entorno virtual se aplicó una prueba postest, con reactivos similares a los establecidos en la primera prueba.

Como parte de los resultados se registró que ambos grupos dejaron de ser homogéneos; el grupo experimental resultó favorecido. Además, se aplicó una prueba departamental correspondiente al tema de diferenciación en ambos grupos, se correlacionaron los resultados de la prueba con los obtenidos en el curso virtual y se obtuvo una correlación positiva moderada. De igual forma, al realizar la comparación de ambos grupos, se pudo establecer que el grupo experimental tuvo un mejor rendimiento académico que el grupo control. En relación con la apreciación que los estudiantes tuvieron con respecto al uso de los entornos virtuales de aprendizaje, manifestaron una apreciación positiva e indicaron que el entorno virtual había apoyado su aprendizaje.

Palabras clave: entorno virtual de aprendizaje, nivelación en álgebra, rendimiento académico.

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Abstract

The purpose of this study was to determine the influence of the development of a virtual learning environment, with basic contents of algebra in students of Mathematics II in the subject of differentiation. The research was quasi-experimental with pre-test and post-test; the sample was integrated with students of the first semester of the Petroleum Engineering career of the Universidad Autónoma del Carmen in the period August-December 2017. This sample was subdivided into two groups, the first with 24 students corresponding to the experimental group and the second with 41 students for the control group. The realization of the pre-test consisted in an objective multiple choice test, with which it was determined that both groups were homogeneous at the beginning of the experiment. A virtual learning environment was developed using the ADDIE structure (Analysis, Design, Development, Implementation and Evaluation) as an instructional design model. After the implementation of the virtual environment a posttest test was applied, with reagents similar to those established in the first test.

As part of the results both groups were no longer homogeneous; the experimental group was favored. In addition, a departmental test was applied corresponding to the subject of differentiation in both groups, the results of the test were correlated with those obtained in the virtual course and it was obtained a moderate positive correlation. In the same way, when comparing both groups, it was possible to establish that the experimental group had a better academic performance than the control group. In relation to the appreciation that students had regarding the use of virtual learning environments, they expressed a positive appreciation indicating that the virtual environment had supported their learning.

Keywords: virtual learning environment, leveling in algebra, academic performance.

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Resumo

O objetivo deste estudo foi determinar a influência que teve o desenvolvimento de um ambiente virtual de aprendizagem com conteúdos básicos de estudantes de álgebra da disciplina de Matemática II sobre a questão da diferenciação. A pesquisa foi quase experimental com pré-teste e pós-teste; A amostra foi composta de carreira calouros de Engenharia de Petróleo pela Universidade Autonoma del Carmen, no período de agosto a dezembro de 2017. Esta amostra foi dividida em dois grupos: o primeiro com 24 alunos para o grupo experimental eo segundo com 41 alunos para o grupo controle. Executando o pré-teste consistiu de um teste de escolha múltipla objectivo, com o que foi determinado que ambos os grupos eram similares no início da experiência. um ambiente virtual de aprendizagem foi desenvolvido no modelo de design instrucional a análise, concepção, desenvolvimento, implementação e avaliação (ADDIE) estrutura. Após a implementação do ambiente virtual, foi aplicado um pós-teste, com reagentes similares aos estabelecidos no primeiro teste.

Como parte dos resultados, registrou-se que ambos os grupos deixaram de ser homogêneos; o grupo experimental foi favorecido. Além disso, um teste departamentais correspondente foi aplicada ao objecto de diferenciação em ambos os grupos, os resultados dos testes com os obtidos no decurso virtual e uma correlação positiva moderada foi obtido correlacionados. Da mesma forma, ao comparar os dois grupos, estabeleceu-se que o grupo experimental apresentou melhor desempenho acadêmico que o grupo controle. Em relação à avaliação que os estudantes tinham a respeito do uso de ambientes virtuais de aprendizagem, eles expressaram uma apreciação positiva e indicou que o ambiente virtual tinha apoiado a sua aprendizagem.

Palavras-chave: ambiente virtual de aprendizagem, nivelamento em álgebra, desempenho acadêmico.

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Introduction

At the beginning of each school year, university-level professors who teach common core subjects related to mathematics face the unequal levels of algebraic knowledge acquired by the different levels of the previous level. Even more, as Gonzalez (2013), Gómez (2011) and Petriz, Barona, López, and Quiroz (2010) put it in the studies they have done on this phenomenon, this knowledge is decreasing, which contributes to the increase of the failure rates, a statistic that is also on the rise in each generation of new admission to the university.

In view of this situation, various higher education institutions (HEIs) have developed different strategies with a view to solving this academic trend. One of them has been the leveling courses in the area, whether propaedeutic, virtual or tutoring programs. Examples of the above are the courses developed by the Technological Institute of Saltillo, the Technological Institute of Chetumal, the Autonomous University of Carmen (Unacar), the National University of La Plata, the Colombian School of Engineering, among others.

The low academic performance is a generalized problem faced by teachers in the area of mathematics who teach classes in the first semesters of higher education. This situation occurs not only at a national level but also at an international level and is addressed by various authors. Gómez (2011), for example, who studies the subject of high dropout rates, absenteeism and low academic performance of the National University of Colombia, conducted a study in which leveling courses were implemented aimed at students to try to attend this problem.

Similarly, the study conducted by Petriz et al. (2010) addresses the problem from different educational levels, starting from the results obtained at a basic level to those obtained in postgraduate admission exams, and evidence the problem in question. On the other hand, González (2013) carried out an investigation at the Central University of Venezuela where the same circumstance of low academic performance is faced, together with the problem of teacher deficiency and the use of technologies as participants in this problem.

For Cabero (2007), the evolution and use of information and communication technologies (ICT) in education must generate changes at all levels: through adaptation to the demands that the knowledge society demands, the modification of the traditional curricula and ways of teaching in response to the challenges of society and the understanding that

informal information has become important in society, so that educational institutions must incorporate and mediate it. In this sense, there have been many and very diverse efforts that have been developed to try to reduce the growth of the lag at the higher level, implementing strategies ranging from face-to-face leveling courses created by various educational institutions to the generation of tutoring programs for support students to pay for their deficiencies in the initial courses of the different faculties.

On the other hand, Díaz, Lagunes, López and Recio (2012) include the use of video as an auxiliary in the teaching of mathematics at a higher level to contribute positively to the academic performance of students. Or the research carried out in Argentina by Almirón et al. (2014), in which they developed a leveling course in algebra in mixed modality. In both cases the acceptance of the use of technology for the learning of mathematics is shown as favorable and well accepted by the students.

Unacar is not exempt from the aforementioned problems and has been affected by the high failure rates in the area of exact sciences. This institution has made various efforts to try to address this situation with little significant results. The present work aimed to resume this problem and try to provide a solution alternative through the design and implementation of a leveling course with basic algebra contents. And to provide, in this way, a strategy to help students to have a successful start in their careers, with the generation of sufficient foundations to be able to face it. This intervention was carried out in the August-December 2017 period with the students of the first semester of the Petroleum Engineering career at Unacar.

At present, many researchers of educational technology have studied constructivist learning through ICT. And it has been shown that technologies "provide an appropriate creative means for students to express themselves and demonstrate that they have acquired new knowledge" (Hernández, 2008, p.29). In this sense, the didactic of mathematics seeks with the binomial constructivism / ICT to promote the use of technologies for the development of students' school tasks and to promote autonomy, creativity and collaborative work.

The learning environments supported by ICT from the constructivist theory are defined as follows:

> A place where students should work together, helping each other, using a variety of computer tools and resources that allow for the pursuit of learning objectives and problem solving activities. Learning under the distance modality allows the individual to receive feedback and know their own rhythm and learning style; this facilitates the application of meta-cognitive strategies to regulate performance and optimize performance (González y Chaires, 2011, p. 86)

Thus, mediation with technology in the learning process represents an important challenge for the area of mathematics in universities, since it is not only about innovating with technology in the learning processes, but also in the change of beliefs and pedagogical practices. Of course, the new teaching role requires transformations regarding some skills in fundamental areas, such as pedagogical, social, organizational and technical (Manjarrés, 2010). Likewise, the student must change the way to access knowledge and study techniques.

On this line of virtual learning environments as mediators of the learning process, Adell, Catellet and Pascual (2004) point out that they are computer applications designed "to facilitate pedagogical communication among the participants in an educational process, be it completely at a distance, face-to-face, or of a mixed nature that combines both modalities in different proportions "(p.4). Likewise, Ogalde and González (2008) define them as computer tools used by students jointly with other media or didactic activities for the achievement of academic objectives. In addition, they are considered open, flexible and can be inserted into any learning process. Depending on the use they are given, they can rely on various constructivist, behavioral or cognitive scenarios, which favor autonomous and collaborative learning.

There are three major training models belonging to electronic learning (e-Learning). Taking as a reference the degree of presence or distance in the interaction between teachers and students, Area and Adell (2009) classify them as follows:

a) Face-to-face teaching model with Internet support. They are used as a complement to the face-to-face learning process or also considered as a virtual environment to consult from home.

b) blended learning or blended learning model. Integrate face-to-face classes and virtual activities within the same learning process; innovates the face-to-face model of teaching.

c) Distance model or online education. Almost all the educational process is remote and the most important is the social interaction between students and teachers through the use of virtual resources.

Teaching models in virtual learning environments allow to guide the learning activities according to the educational needs that are required through the digital resources guided by the didactic planning of the teachers. Likewise, it seeks to access and carry out learning activities similar to those developed in the face-to-face learning process.

The leveling course contemplated basic contents of algebra in b-learning mode. Since, following here Blumschein and Fischer (2007), represents a modality that focuses its learning process on the combination of pedagogical approaches of face-to-face education and training models in e-learning. In addition, once again with these same authors, the training models in e-learning only emphasize the forms of teaching-learning supported by technological tools (Blumschein and Fischer, 2007).

In short, this modality was selected for the leveling course since it includes both online learning and face-to-face learning, and allows the benefits of both modalities to be obtained.

The selection of a Learning Management System (LMS) was also necessary for the creation of the course. Clarenc, Castro, Lenz, Moreno and Tosco (2013) conceptualize it as software installed on a server that is used to create, approve, store, distribute and manage online learning activities. These same authors analyzed 19 LMS, also known as learning platforms, and classified them into three types: 1) those for commercial use or licenses, such as eCollege, Fronter, SidWeb; 2) those of free software, commonly developed by educational institutions such as Dokeos, Claroline, dotLRN, Moodle, and 3) those found in the cloud, for example, Ecaths, Wiziq and Edmodo.

In this sense, the innovation of the scenarios in which the teaching-learning processes are developed at the higher level are the result of the transformation of the universities that move from classroom to virtual teaching practice. The above rethinks didactics with new

processes that incorporate flexible methodologies and focused on student learning (Salinas y Marín, 2017).

Now, the Object-Oriented Modular Dynamic Learning Environment (Moodle) is a free software LMS and its development is done under a GPL license. This means that it is distributed free of charge and that it is allowed to use, copy, and modify the environment whenever it is accepted to share the source code to other users. This LMS is available in more than 40 languages and has regular updates (Dougiamas, 2007).

On the other hand, Moodle has a very ambitious philosophy, since it was designed and developed under a social constructivist pedagogy. Likewise, the use of Moodle from a constructivist approach can allow the development of mathematical abilities, skills and knowledge of students through the variety of digital resources (forums, self-assessments, wikis, blogs, didactic materials, interactive activities, among others) It actively promotes new knowledge as it interacts with the virtual environment.

For the present study, the Moodle platform was used. The selection was due to the ease of access and the great versatility and advantages presented by the use of it in the development of virtual learning courses: the control that the platform allows the teacher on the contents and the management of delivery deadlines. assignments, the facility to monitor the progress of students, the possibility of placing content and digital files, the creation of various types of evaluations with immediate feedback, to name a few.

In this regard, Marín, Begoña, Sampedro and Vega (2017) explain that the ease of access and use of the Moodle platform represents a transformation in the users of their training instruction, as well as in their learning processes, demanding the acceptance and development of a new role in the framework of technology-mediated education.

Consequently, being an online course, it is necessary that students are able to regulate their own learning and self-assessment. Both concepts require that the student learn to learn, and are key to the success of online learning. On the other hand, not only is it enough to have a versatile platform for the development of an online course, it is also necessary that this course clearly has the objective for which it was developed, as well as a structure and defined contents and the selection of an adequate instructional design to guarantee the quality of the course.

Yukavetsky (2003) defines instructional design as the "process based on theories of academic disciplines, especially in the disciplines related to human learning, which has the effect of maximizing the understanding, use and application of information, through systematic, methodological and pedagogical structures" (p.6) The author mentions that one of the most used instructional designs is the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model, where Analysis refers to the stage where the needs and characteristics of the recipients of the course are determined; Design to the selection of the environment to develop, from the establishment of the objectives and the units of the course content; Development to the own creation of the course, it is the moment where the activities are planned; Implementation is the start-up of the course, here the technical problems that can be generated are solved, and evaluation to the implementation of tests, evaluations and self-evaluations to measure the performance of the group, is made up of both formative and summative evaluations.

Within the creation of the didactic proposal, the formative evaluation was considered of great importance in the figure of the self-evaluation, which, for Aranda (2010), is considered as "the evaluation that a person makes about himself or about a process and / or personal result "(page 7). The use of this tool within virtual environments allows the student to self-regulate and become the protagonist of their own learning.

Having said all the above, it is worth remembering that the present work aimed to contribute to the leveling in algebra in the first semester students of the Petroleum Engineering career at Unacar. And in this way reduce the failure rates in the initial subjects of the race, avoid lag and predict the dropout in the students who pursue this career.

Methodology

The research was developed through a quantitative approach that, according to Hernández, Fernández and Baptista (2010), allows to show the level of relationship between two or more variables. It also allows testing hypotheses using statistical analysis. What gave the possibility of testing the hypothesis of this research: "The virtual learning environment with basic contents of algebra has a significant influence on the academic performance of the first semester students of the Petroleum Engineering degree who are studying Mathematics,

specifically the issue of differentiation, with respect to those who do not use it ". Hence the choice of the correlation type, since it was necessary to establish the relationship that exists between the study variable and the results after the use of the virtual learning environment.

Study design

The design used in the research was quasi-experimental with a control group and an experimental group; a pretest and a posttest were applied to both groups. It should be specified that we worked with the entire population of students who entered the careers of Chemical Engineering (control group) and Petroleum Engineering (experimental group). In order to address this type of research it was also necessary to establish a starting point and determine the conditions in which the students are before starting the experiment.

More specifically, the population was made up of students who entered the Faculty of Chemical and Petroleum Engineering in the August-December 2017 semester: 105 students, 61 males and 44 females, whose ages were between 17 and 25 years old. from 9 states of Mexico. The sample taken for the study was, in the control group, 41 students who entered in this period; The experimental group was made up of 24 students from one race and another.

In order to determine the initial conditions of the group, an evaluation instrument was developed that included 20 items, which included the topics that would be addressed in the leveling course. The test was designed objectively: each item contained four possible answers. This instrument was validated by three experts related to the subject and a pilot test was conducted with a group that had conditions similar to those of the experimental groups. The pilot test showed a reliability of 0.771362354 that, according to March and Martínez (2015, p.120), "find a result of 0.75 or higher to consider that the reliability of the instrument is acceptable, as long as it was designed by the researcher with specific purposes ".

At the end of the course in the virtual learning environment, a post-test was applied to both groups with reagents similar to those proposed in the pretest. The previous thing to determine if the strategy of the course impacted in the academic performance of the students of the experimental group, and of specific form in the matter of Mathematics II, as already mentioned before, in the subject of differentiation. Subsequently, a departmental test was

conducted for both groups to determine if there was a difference in the academic performance of the students after using the virtual learning environment.

Didactic proposal

With the objective of determining the influence of a virtual learning environment with basic algebra contents in the academic performance of the students who studied Mathematics II at the UNACAR in the career of Petroleum Engineering in the period of August-December 2017 , an extracurricular and virtual course with basic contents of algebra was developed. This was carried out simultaneously with the aforementioned subject with the aim of achieving the homogenization of knowledge in this group and achieve a better academic performance in the subject. The course was developed in b-learning mode, on the Moodle platform, which was selected for the great versatility of the tools it has and its ease of access, and the ADDIE instructional design model was adopted.

For the design phase, similar courses offered by different universities at a national and international level were investigated. For example, the course of the Technological Institute of Saltillo in 2013; another course of the Technological Institute of Chetumal in 2014, and the one of the Colombian School of Engineering in 2015. It is important to mention that for the design of the course, preference was given to the contents of the universities at the national level (see table 1) . The course therefore consisted of five thematic units: 1) powers and radicals, 2) remarkable products, 3) factorization 4) algebraic fractions 5) algebraic radicals; units that were addressed in a span of six weeks.

Tabla 1. Comparación de contenidos temáticos para cursos de nivelación en álgebra a nivel nacional

Instituto Tecnológico de Saltillo	**Instituto Tecnológico de Chetumal**	**Curso de nivelación del estudio**
- Números reales - Productos notables - Factorización - Fracciones - Solución de ecuaciones	- Exponentes - Productos notables - Factorización - Fracciones algebraicas - Radicales - Graficación de rectas u solucione de sistemas de ecuaciones - Despeje de fórmulas y regla de tres simple	- Potencias y radicales - Productos notables - Factorización - Fracciones algebraicas - Radicales algebraicos

Fuente: Elaboración propia de la comparación de contenidos de cursos de nivelación de álgebra de otras Universidades

Once the study population was defined, both an objective and the performance indicators were established in each of the selected subjects (see table 2). The materials were elaborated according to these criteria, following in each one of the thematic units a uniform distribution.

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Tabla 2. Especificación de objetivos e indicadores por tema abordado en el curso

Tema	Objetivo	Indicadores
1. Potencias y radicales	Ser capaz de realizar correctamente operaciones que involucren potencias y radicales.	• Distingue y selecciona correctamente las propiedades de las potencias y radicales. • Asocia las propiedades a utilizar dentro de un ejercicio de potencias y radicales. • Resuelve ejercicios utilizando las propiedades de las potencias y radicales.
2. Productos notables	Será capaz de realizar el desarrollo de los productos notables sin necesidad de realizar multiplicaciones.	• Reproduce los productos notables • Desarrolla los productos notables aplicados a ejercicios sin necesidad de hacer multiplicaciones. • Utiliza correctamente los productos notables aplicados en ejercicios.
3. Factorización	Identificar cada uno de los tipos de factorización existentes y los aplica.	• Identifica los principales tipos de factorización. • Asocia los tipos de factorización con ejercicios de diferentes clases. • Obtiene los factores de forma correcta.
4. Fracciones algebraicas	Ser capaz de realizar correctamente las operaciones que implican el uso de fracciones y métodos algebraicos para solucionarlos.	• Reconoce cuando una fracción algebraica se puede simplificar. • Distingue el procedimiento a seguir según la situación de fracciones algebraicas presentada. • Resuelve de forma correcta las operaciones que implican y uso del MCM* y del MCD**. • Resuelve en forma correcta las operaciones de fracciones algebraicas
5. Radicales	Identificara y simplificara las operaciones en donde intervienen los radicales.	• Simplifica operaciones en donde intervienen los radicales. • resuelve correctamente las racionalizaciones de radicales. • Realiza correctamente la conjugación de operaciones con radicales.

Nota: *MCM: mínimo común múltiplo; **MCD: máximo común divisor.

Fuente: Elaboración propia a partir del análisis de objetivos e indicadores de los contenidos del curso

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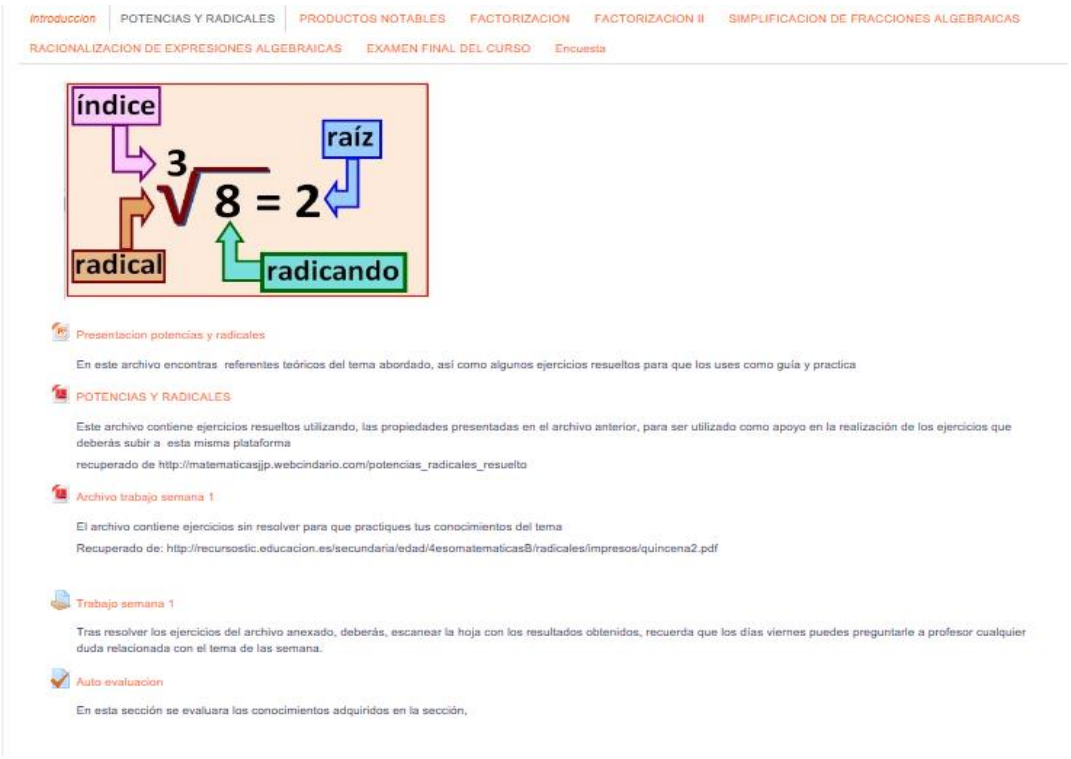
For the development stage, materials were generated for each of the thematic units; in each of them the same structure was followed. Each unit began with an electronic file with theoretical content and solved exercises, materials were generated with practice exercises to be developed by the students, then video tutorials were selected with exercises similar to those exposed in the exercises and finally for each of the topics a self-evaluation was developed.

The implementation phase began on September 15, 2017 with the first face-to-face session of the course, in which students were given training on the use and content they would find on the platform. On September 18, access was given to the contents of the first topic, corresponding to the topic of powers and radicals, and a new topic was opened every week from that date (see figure 1).

Figura 1. Presentación general del material correspondiente a la semana uno del curso de nivelación en álgebra



Fuente: Elaboración propia tomada del curso de nivelación en el aula virtual

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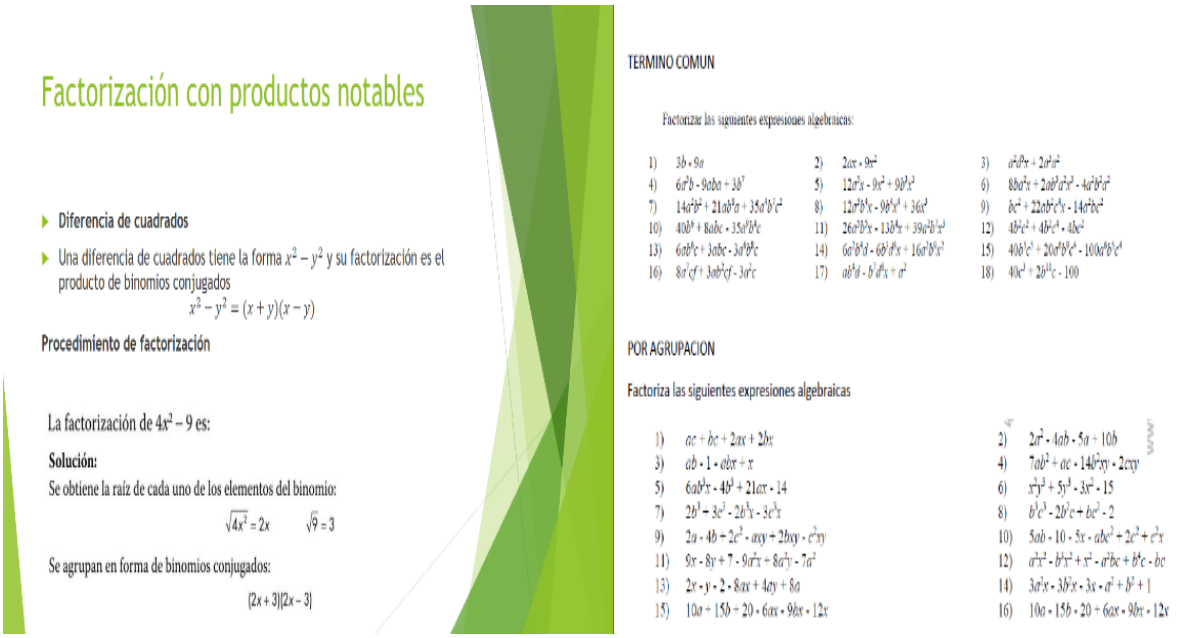
For each thematic unit, materials with theoretical PowerPoint content and electronic files were developed with exercises to be developed by the students, who had to upload them to the platform on a specified date, which was after the advisory session that was held on Fridays. of each week (see figure 2).

Figura 2. Ejemplo de materiales desarrollados para la plataforma



Fuente: Elaboración propia tomada de la plataforma educativa

Tutorials with the contents of each thematic unit were selected from the Network. The selected videos contained explanations of exercises in a detailed manner according to the contents seen in the materials to be used by the students as reinforcement (see figure 3).

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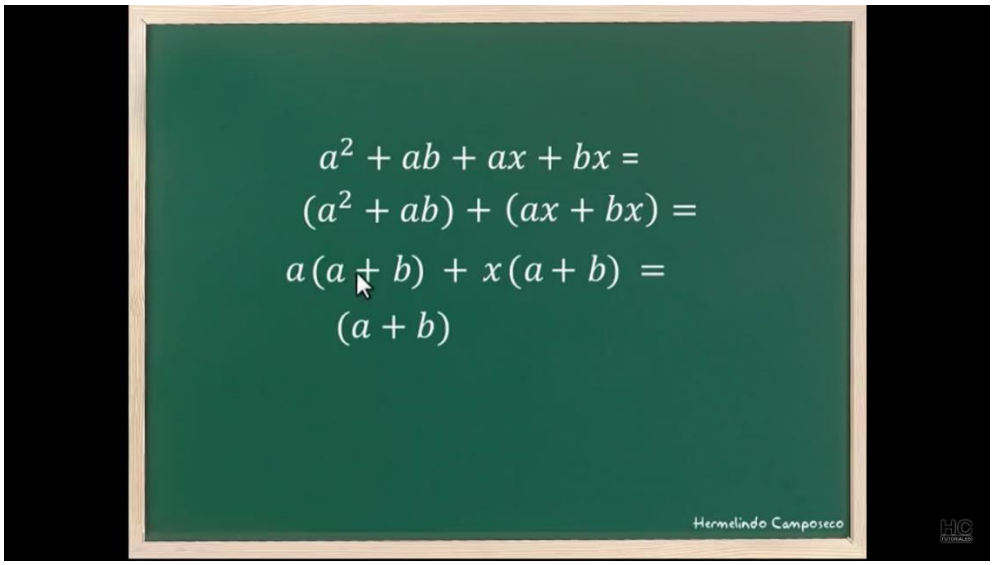
Figura 3. Ejemplo de video tutorial utilizado en el entorno virtual



Fuente: Video del álgebra tomado de https://youtu.be/Rhttf8bA3v8

One of the points considered as basic in the realization of the course was the formative evaluations presented to the students in the form of self-evaluations. The students had the opportunity to perform each of them in two attempts with immediate feedback -which were generated automatically using the option that the Moodle platform includes. The questions were taken from a repository, and it was guaranteed not only that the students could not copy, but also in case they needed a second attempt they would answer a different test to ensure that they answered with knowledge. On the other hand, a summative evaluation was also included at the end of the leveling course with the contents of the whole course, together with the self-evaluations that this exam randomly generated by the platform, and the contents of the entire repository were used. of questions (see figure 4).

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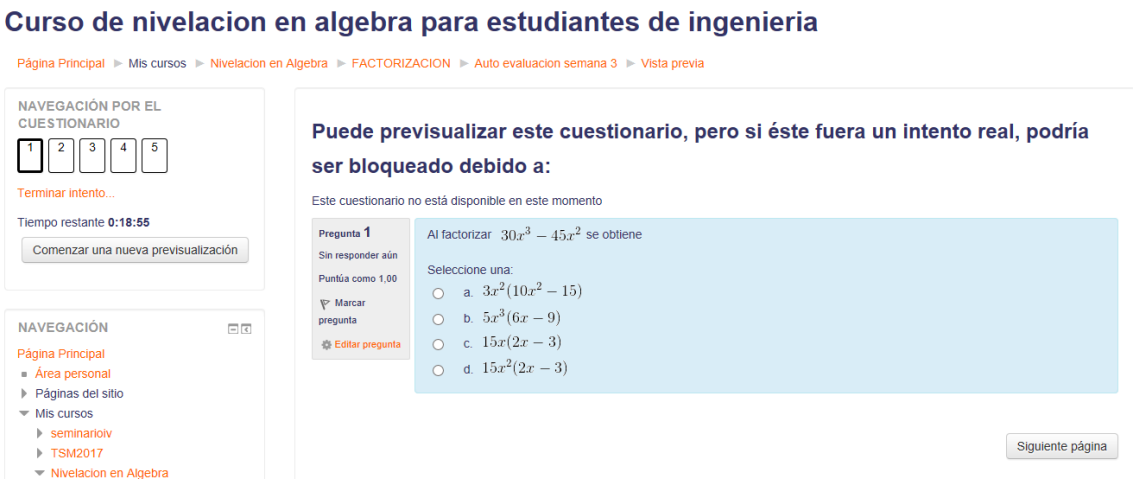
Figura 4. Ejemplo de presentación de autoevaluaciones



Fuente: Elaboración propia a partir de un cuestionario de álgebra en el aula virtual

Results

The results obtained from the study were determined in two stages: the first was the actions related to the pretest, the application of the virtual learning environment with basic contents of algebra and the application of the posttest and feedback from the participants of the experiment; the second moment was related to the impact of the virtual learning environment in Mathematics II on the subject of differentiation.

Before starting the experiment it was necessary to establish homogeneity in both groups. To do this, the pretest was used and the results of this were analyzed with the specialized software SPSS Statistics 20 (see table 3).

Tabla 3. Estadísticos pretest

Estadísticas de grupo					
	Grupo	N	Media	Desviación estándar	Media de error estándar
Pretest	Experimental	19	42.0000	15.58846	3.57624
	Control	30	42.4000	15.95597	2.91315

Fuente: Elaboración propia obtenido del análisis descriptivo del pretest

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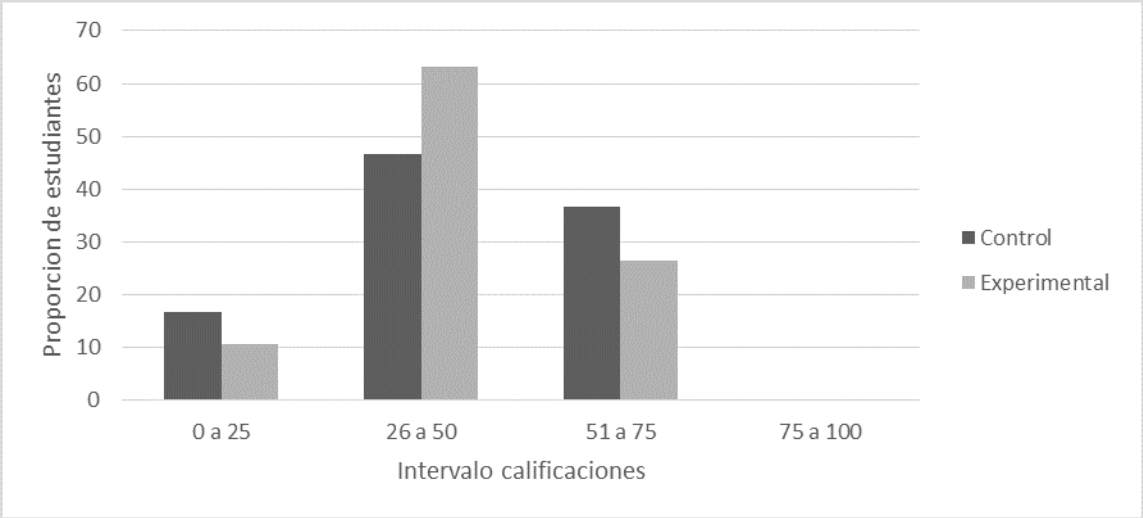
Table 3 shows the means and standard deviations of both the experimental group and the control group. Both measurements are very similar both in the group averages and in their standard deviations. Comparing graphically the behaviors of both groups, in figure 5 the ratings were divided into intervals of 25 points each.

Figura 5. Calificaciones obtenidas por el grupo experimental y de control en el pretest



Fuente: Elaboración propia a partir del análisis descriptivo del pretest

After the analysis of the descriptive statistics and the graphic visualization of the behavior of both groups, the group homogeneity test was performed by means of an independent mean difference test in the SPSS 20 software. This software showed a null hypothesis, which indicates that both groups are equal with a level of significance of 0.05. The results are presented in Table 4: the null hypothesis is maintained, the groups are homogeneous.

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Tabla 4. Prueba de medias independientes con SPSS

		Prueba de Levene de calidad de varianzas		Prueba *t* para la igualdad de medias						
									95 % de intervalo de confianza de la diferencia	
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	Inferior	Superior
Pretest	Se asumen varianzas iguales.	.396	.532	-.086	47	.932	-.40000	4.63728	-9.72901	8.92901
	No se asumen varianzas iguales.			-.087	39.122	.931	-.40000	4.61258	-9.72890	8.92890

Fuente: Elaboración propia a partir de la prueba t del pretest

At the end of the leveling course, both groups were given a posttest with reagents similar to those solved in the first evaluation, using the same indicators and with equivalent levels of difficulty. Table 5 presents the information using the same format as in the pretest.

Tabla 5. Estadísticos postest

Estadísticas de grupo					
	Grupos	N	Media	Desviación estándar	Media de error estándar
Postest	Experimental	19	61.2105	15.31005	3.51237
	Control	30	45.4667	15.56241	2.84129

Fuente: Elaboración propia a partir del análisis estadístico del postest

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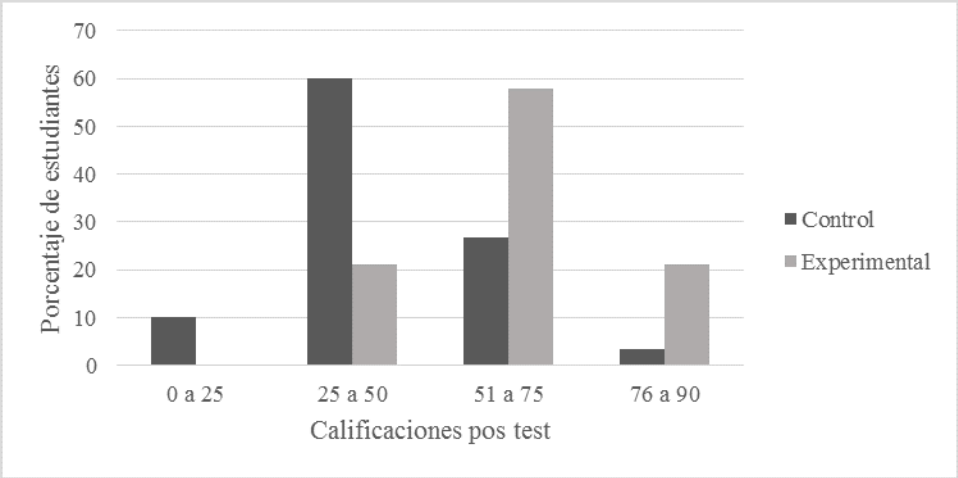
Table 5 shows a marked difference in the group averages of both groups: the results favor the experimental group. However, the standard deviations in both groups are similar, although a better overall performance is evident in the study group.

Figura 6. Representación gráfica de la comparación de los resultados del postest



Fuente: Elaboración propia a partir del análisis descriptivo del postest

In figure 6 the results obtained in the posttest were divided into intervals of 25 points each. The highest point of notes obtained by the control group was identified in the range of 25 to 50 points with 60% of the students, while in the experimental group this point is in the range of 51 to 57 with 57.9% of the students. group members.

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Tabla 6. Prueba *t* para diferencia de medias independientes del postest

Prueba de muestras independientes										
		Prueba de Levene de calidad de varianzas		Prueba *t* para la igualdad de medias						
									95% de intervalo de confianza de la diferencia	
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	Inferior	Superior
Postest	Se asumen varianzas iguales.	.004	.947	3.472	47	.001	15.74386	4.53467	6.62128	24.86644
	No se asumen varianzas iguales.			3.485	38.921	.001	15.74386	4.51771	6.60534	24.88238

Fuente: Elaboración propia a partir de la prueba t del postest

An independent mean difference test t was elaborated, based on the null hypothesis, which states that the means of both groups are equal. For this, once again the SPSS 20 software was used, and a confidence level of 0.05 was obtained. The results presented in Table 6 clearly indicate that the groups ceased to be homogeneous and that the experimental group performed better in the presented test than the control group.

Among the analyzes performed in the first part of the experiment is the analysis of the appreciation of the learning environment by students. In order to comply with this point, a survey was conducted that allowed knowing the impressions that the students had when using the virtual learning environment. The aforementioned test was qualified according to five sections of information: 1) interactivity of the students with the platform, 2) appreciation of the students for the planning and presentation of the information, 3) students' own appreciation of the use and the platform, 4) self-assessment of the students about their use of the platform and 5) appreciation by the students towards the tutor.

And following the order and the results obtained in each section of the survey, the following information was obtained: 1) the students indicated that they had no problems using the platform and that the use of the platform seemed accessible and easy to use; 2) the students indicated that the times and activities destined for the fulfillment of the activities within the platform were adequate; 3) the students indicated that the materials and activities developed in the environment supported their learning; 4) at this point it was where there was greater variability in the results of the survey: although the results in this section were positive, there were cases where the students acknowledged not having put enough effort into carrying out the activities, 5) the students indicated that the work of the tutor was adequate and they were in agreement with the work developed by the teacher.

At the beginning of the analysis of the second part of the experiment, which assesses the impact that the virtual learning environment had directly on Mathematics II in the subject of differentiation, a Pearson correlation test was performed on results obtained in the leveling course and those obtained in the departmental evaluation of the established sequence. Figure 7 shows the dispersion diagram of the results obtained from the leveling course.

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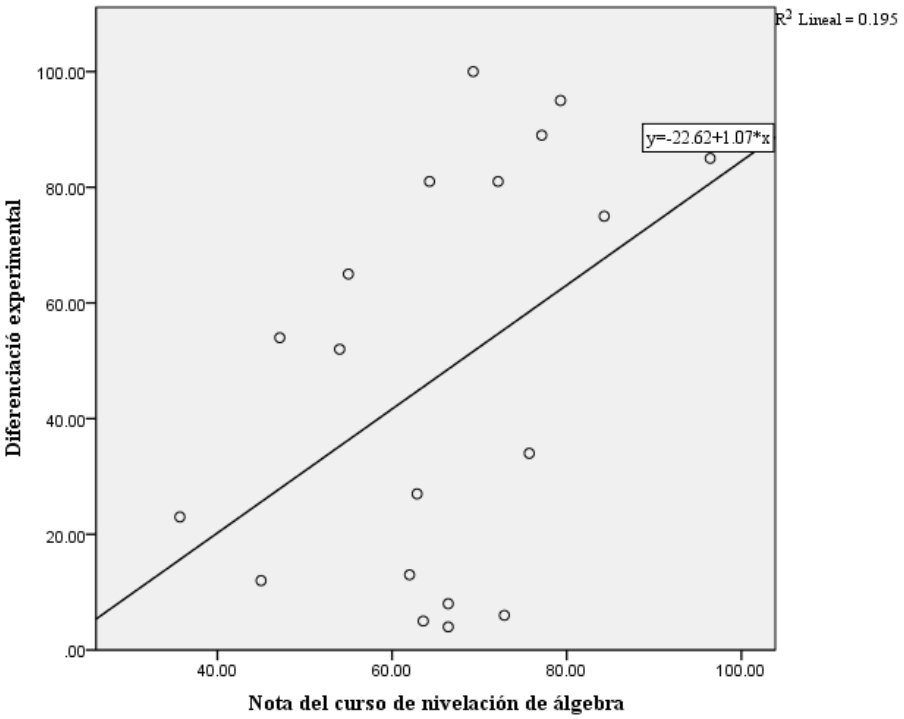
Figura 7. Diagrama de dispersión de los resultados obtenidos el curso de nivelación y los de la evaluación de la secuencia de diferenciación.



Fuente: Elaboración propia a partir de los datos del curso de nivelación

The Pearson correlation obtained through the SPSS 20 software was 0.442, which, according to Mcmillan and Schumacher (2005), is a moderate positive relationship between both variables.

After having established that there is a relationship between both variables and that the virtual environment had a positive influence on the results of the differentiation evaluation, a mean difference test between both groups was performed using the results obtained in the evaluation of the sequence.

Tabla 7. Estadísticos de ambos grupos en relación con los resultados obtenidos en la evaluación del tema de diferenciación.

	Grupos	**N**	**Media**	**Desviación estándar**	**Media de error estándar**
Comparación diferenciación	Experimental	19	47.8421	35.07336	8.04638
	Control	30	31.4000	17.32369	3.16286

Fuente: Elaboración propia a partir de la estadística descriptiva de la evaluación de diferenciación

The group averages obtained by the students are presented in table 7 in which a difference is observed that favors the experimental group again; only that in this case, unlike the previous results, there is a greater variability in the results of the experimental group, while the variation in the notes of the control group is smaller.

Tabla 8. Prueba *t* de diferencia de medias independientes

		Prueba de Levene de calidad de varianzas		Prueba *t* para la igualdad de medias						
									95% de intervalo de confianza de la diferencia	
		F	Sig.	t	Gl	Sig. bilateral	Diferencia de medias	Diferencia de error estándar	Inferior	Superior
Comparación Examen Diferenciación	Se asumen varianzas iguales.	26.563	.000	2.189	47	.034	16.44211	7.51120	1.33152	31.55269
	No se asumen varianzas iguales.			1.902	23.642	.069	16.44211	8.64569	-1.41603	34.30024

Fuente: Elaboración propia a partir de la prueba t de la evaluación de diferenciación

On the other hand, the t comparison test for independent means in SPSS 20 established a null hypothesis: both means are equal with $\alpha = 0.05$. While in a two-tailed study the rejection of this hypothesis was obtained in the test, which indicates that the groups are not homogeneous (see table 8). It also indicates that the performance of the experimental group was better than that of the control group.

Discussion

The objective of this study was to determine the influence of a virtual learning environment with basic algebra contents on the academic performance of students who study Mathematics II at Unacar in the Petroleum Engineering career in the August-December period. of 2017. Based on the results obtained, it is established that the virtual environment of learning with basic contents of algebra had a significant influence on the academic performance of the first semester students of the race already specified.

The results obtained in the academic performance of the students who participated in this study coincide with those obtained by Rubiano and Torrijos (2013), Mena et al. (2014) and Cadavid and Gómez (2015), who expressed that the use of virtual learning environments in blended learning mode improves the academic performance of students who used it compared to those who did not. While in the research conducted by Torres (2008) no significant difference in academic performance was found among the groups of students who used or not the virtual learning environment.

Regarding the development and structure of the virtual learning environment and the creation of courses in b-learning mode, the results coincide in the main points with those developed by Almirón et al. (2014), Rubiano and Torrijos (2013) and Cadavid and Gómez (2015), who in their different structures included the use of materials with theoretical content, videotutorials as support for the explanations, developed reinforcement activities for the students and gave an follow-up in the face-to-face classes, in addition to motivating the participation of the students with the assignment of a percentage of the grade for the realization of the learning activities in the Moodle educational platform.

Other authors more like Mena et al. (2014), Cadavid and Gómez (2015), Blanco and Ginovart (2012) highlight self-assessment as an activity of utmost importance in the use of virtual environments, since it allows students to know their degree of progress and can act accordingly. -Also assigned a percentage of qualification to the realization of the activity. This coincides with the research carried out here, given that the self-evaluation activity in the study was a strategy for self-management of knowledge for the promotion of students' autonomous learning; except for what Mena et al. (2014) and Torres (2008), who pointed out that their results were not encouraging, given that not considering the assignment of a percentage of the grade to the realization of the activities within the platform did not guarantee the participation of students in the same

Regarding the appreciation of the use of virtual learning environments, in this study the evaluation given by the students was positive, which coincides with the reports obtained by Almirón et al. (2014), Cadavid and Gómez (2015) and Blanco and Ginovart (2012). This shows that the use of virtual learning environments to support the learning of mathematics is an ideal means, since, on the one hand, it fosters student autonomy and, on the other, enhances their cognitive development and ability in solving mathematical problems.

Conclusions

Throughout the investigation it was possible to confirm that the use of the virtual learning environment with basic algebra contents had a positive influence on the academic performance of the participating students. Based on the results of the posttest, it is possible to affirm that the knowledge and skills in algebra of the students who had access to the virtual learning environment were superior to those that did not. It is also possible to affirm that the assessment about the use of the platform by the students was positive and that the interaction with the platform did not represent any difficulty. It is concluded on this section that it is possible to achieve a leveling in algebra making use of virtual learning environments.

According to the analysis of the data, it is also concluded that the experimental group obtained a better academic performance in Mathematics II, specifically in the subject of differentiation, but with a standard deviation, which indicates a greater dispersion in the data of the proof. This could be due to the fact that, although the majority of the students showed

an improvement in their learning, there were elements that did not manage to acquire the desired competence. On the other hand, in the survey of appreciation of the virtual classroom, students expressed a positive assessment of the use of the virtual learning environment: an indicator that the virtual platform did not represent any difficulty in its use. What motivated and supported them in the development of their algebraic abilities, and in this way it is determined that it is feasible to achieve a leveling in the knowledge of algebra making use of virtual environments.

Regarding the resources used for learning in the educational platform, the results of the survey applied for this purpose showed that the materials used in the environment were of great help to enhance the learning of mathematics and that allowed the regularization of students who formed the study group. Likewise, it could be observed that the didactics with the use of self-evaluations in the Moodle educational platform complied with the objectives outlined in the planning of the regularization course of algebra, since it served as a tool of self-regulation during the learning process and that, being an evaluation tool, allowed the self-assessment of the students during the training action.

The use of the b-learning modality was beneficial for the study, since it allowed the students to have a more direct communication with the tutor, and in this way they expressed their doubts about the development of procedures. Thus, a continuous motivation towards the use of the environment was maintained. And finally, another of the advantages that represented the use of this modality was that the students expressed feeling better prepared to face the evaluation since their doubts were solved.

Recommendations

In relation to the course, it is recommended that the leveling course begin from the preparatory period and continue during the semester. In this way the benefits of leveling could be measured throughout the four learning sequences of the Mathematics II course. Likewise, one of the external variants that could affect the results of the study is that both the experimental group and the control group were attended by different teachers: teaching-learning styles could affect the results of the study.

The assessment of students' knowledge was classified according to Bloom's taxonomy indicators, including only knowledge, comprehension, application and analysis, of which the most significant growth was obtained in the knowledge indicators and application, while the indicators of understanding and analysis showed moderate growth. It is recommended for future studies to reinforce the learning activities for this pair of indicators in the virtual platform.

For future replicas of the study it is recommended to perform it with a more representative sample. In the same way, for the course to be taught in the same modality, it will be necessary to train the teacher in the use of the platform and assign a percentage of the grade to the leveling course to guarantee the success of the study.

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