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Beyond the Classroom: The Power of Websites for Engaging and Effective Math Education

Más allá del aula: El poder de los sitios web para una educación matemática atractiva y eficaz

Além da sala de aula: O poder dos sites para uma educação matemática envolvente e eficaz

Abstract

In current education, technology is essential for developing and optimizing teaching-learning processes. Therefore, having tools and methods that enable the implementation of these technologies is crucial for developing adequate planning and teaching resources. The objective of this research was to develop a website, utilizing the WebNode tool, that contributes to mathematics teaching at the university preparatory level. Through a bibliographic review and interviews directed at teachers, the minimum thematic contents of the subject were established. It was necessary to design and develop a website that would allow the articulation of curricular planning, pedagogical tools, and activities to support students in their learning of mathematics. This integration of ICT (Information and Communication Technology) was achieved through the incorporation of iframe codes, enabling better adaptation of digital resources on the website. The resources that provided the greatest significance were the teaching materials developed in various cloud-based tools, such as Canvas and Genially.

Keywords: Digital tools, ICT, learning, mathematics learning, teaching strategy.



Resumen

La tecnología en la educación actual es esencial para el desarrollo y optimización de los procesos de enseñanza aprendizaje, por lo que contar con herramientas y métodos que permitan la implementación de estas tecnologías, constituye un factor importante para desarrollar una adecuada planificación y herramientas didácticas. El objetivo de esta investigación fue elaborar un sitio web, utilizando la herramienta WebNode, que contribuya a la enseñanza matemática en el nivel propedéutico universitario. Mediante una revisión bibliográfica y aplicación de entrevistas dirigidas a los profesores, se establecieron los contenidos temáticos mínimos de la asignatura. Siendo necesario diseñar y elaborar un sitio web que permitiese articular la planificación curricular de la asignatura, herramientas pedagógicas y actividades para que los estudiantes posean un soporte y apoyo que facilite el aprendizaje de la asignatura de matemáticas mediante la integración de TIC, a través de la incorporación de códigos Inframe que permiten una mejor adaptación de los recursos digitales en el sitio web. Los recursos que aportaron mayor significancia fueron los materiales didácticos desarrollados en las diferentes herramientas disponibles en la nube, tales como, Canvas, Genially, entre otros.

Palabras clave: Aprendizaje, aprendizaje matemático, estrategia didáctica, herramientas digitales, TIC.

Resumo

A tecnologia na educação atual é essencial para o desenvolvimento e otimização dos processos de ensino-aprendizagem, portanto, ter ferramentas e métodos que permitam a implementação dessas tecnologias é um fator importante para desenvolver ferramentas adequadas de planejamento e ensino. O objetivo desta pesquisa foi desenvolver um site, utilizando a ferramenta WebNode, que contribua para o ensino de matemática em nível preparatório para universidade. Através de revisão bibliográfica e aplicação de entrevistas, foram estabelecidos os conteúdos temáticos mínimos da disciplina. Foi necessário conceber e desenvolver um site que permitisse articular o planejamento curricular da disciplina, ferramentas pedagógicas e atividades para que os alunos tivessem apoios que facilitassem a aprendizagem da disciplina de matemática através da integração das TIC.

Palavras-chave: Aprendizagem, estratégia de ensino, ferramentas digitais, ensino de matemática, TIC.

Introduction

The first two decades of the 21st century have witnessed significant changes in both technology and education, giving rise to numerous concerns in the field of teaching, particularly regarding the type of instruction that should be implemented for current generations of young individuals aspiring to access higher education (Córdova-Morán et al., 2019). Indeed, university educators have focused their efforts on exploring new teaching methods to foster a balanced learning environment for both teachers and students (Sánchez, 2022).

Following the mandatory lockdown during the first quarter of 2020 due to the Covid-19 pandemic, a globally employed strategy was the compulsory implementation of hybrid classes. According to Moreno and Gortázar (2020), this event served as a "natural experiment and a stress test for educational systems" (p. 168). The pandemic altered certain variables affecting human social behavior due to isolation, leading to unforeseen conditions and situations (Rujas & Feito, 2021).

To address the critical situation in education during the pandemic, a provisional hybrid education system, combining in-person and distance learning, was implemented (Ríos, 2021). Despite two years having passed since the start of the pandemic, many of these abrupt changes in online learning media and environments have contributed positively to the integration of technology in education, providing new teaching strategies and methods (Martín, 2020).

Currently, technological tools serve as significant support for education across all sectors, particularly in higher education. Hence, the use of teaching methods involving information and communication technologies is appropriate, as they offer a wide range of interactive tools that also serve as emotional support for students. Additionally, these technologies provide innovative didactic proposals from the teaching perspective, enhancing the resources available for quality education (Rojas & Díaz, 2020).

It is essential to note that digital resources during the last decade have modified the flow and access to information available in web environments, promoting collaborative work between educators around the world and facilitating the exchange of teaching strategies (Area & Rodríguez, 2017).

Indeed, educators must integrate educational didactic resources into their pedagogical model to contribute to the development of educational competencies (both general and specific) based on the curriculum (Córdova et al., 2019). The unprecedented impact of ICT (Information and Communication Technology) on education is noteworthy, bringing about significant changes in teaching-learning methodologies, especially in institutions of higher education (Córdova et al., 2019).

Among subjects posing significant challenges in both hybrid and in-person education is mathematics teaching. In this case, technology plays a mediating role in learning, requiring proper preparation for teachers and the use of multiple tools and new guidance strategies for students to solve assigned tasks, particularly in subjects like mathematics supported by ICT (Hernández et al., 2021).

According to Hernández et al. (2021), digital didactic resources provide a wide variety of tools with advantageous pedagogical strategies for mathematics teaching, especially given the current situation where in-person attendance in classrooms is decreasing, and autonomous work is gaining importance. The author emphasizes that mathematics teachers must create and use digital teaching materials as ICT not only serves as support but is fundamental for efficient mathematical learning.

In summary, drawing from various publications, it can be asserted that during this third decade of the 21st century, higher education has gleaned important lessons from hybrid and online education (Rodríguez et al., 2022), contributing to the improvement and expansion of teaching and learning methods. In this regard, although mathematics has traditionally been considered the most challenging subject to teach and learn (for both teachers and students), it is precisely where information and communication technologies constitute the most valuable resource to overcome teaching obstacles (George, 2020). Therefore, considering the outlined issues, the objective of this research was to develop a website, utilizing the WebNode tool, that contributes to mathematics teaching at the university preparatory level.

Methodological Design

The geographical scope of this investigation was limited to the Admission and Leveling area of the Manuel Félix López Agricultural Polytechnic School of Manabí (ESPAM MFL), located in the city of Calceta, Ecuador. This unit is precisely responsible for providing preparatory courses to young people who aspire to pursue higher education and obtain a degree.

The study employed a qualitative approach, necessitating the application of descriptive, bibliographic, and analytical methods. A bibliographic review was conducted based on scientific publications, indexed academic websites, digital repositories, among others. Additionally, interviews were conducted with the mathematics teachers of the ESPAM MFL preparatory course, and the students were divided into two groups (one using the website and the other not using it) to evaluate the relevance of implementing this type of resource...

An intentional non-probabilistic sampling by ranges was established, given that the study population is finite, consisting of mathematics teachers from the preparatory course of the higher education institution selected for the creation of the website. As a result of the sample selection, the study universe comprised six mathematics teachers from the technical and undergraduate courses of the ESPAM MFL.

To structure the interviews, it was necessary to define the content of the mathematics subject based on the academic micro curriculum and the levels of complexity generated. This consideration arose from the virtual delivery of the subject.

Research Process

Aligned with the study objective, a methodological procedure was established to address and provide a solution to the identified issue. Consequently, the results obtained were structured based on the following process:

a) Development of the website for the mathematics subject

In the creation of this educational resource, accessibility features were taken into account, ensuring organized navigation conditions that enable students to access resources and information in an accessible manner. The procedure for designing and implementing the website is detailed below:

1. *Identification of the minimum required content from the micro-curriculum of the mathematics subject:* Through the information requested from the Admissions and Leveling Department, which is the Academic Unit responsible for the preparatory course, access to the micro-curriculum of the subject was obtained. The levels of complexity and requirements to enhance teaching and learning processes were established through interviews conducted with the subject teachers.
2. *Establishment of ICT (Information and Communication Technology) activities and didactic materials for the website:* Once the data was established in the previous phase through an analysis of the minimum content and teacher requirements, activities contributing to the development of different topics within each thematic unit were determined. This also included the identification of ICT materials and tools incorporated into the website.
3. *Website design using the WebNode tool:* This tool is easily accessible, and its interface allows for website design. The created websites are easily accessible with an internet connection, and it is compatible with a variety of digital educational tools (such as YouTube, Genially, GeoGebra, among others), as well as multimedia content.

b) Determination of the relevance of using the website for mathematical learning.

To assess the relevance of using this educational resource, two groups of students (25 in each) were formed. One group utilized the implemented website, while the other could only access the subject content in written format. Surveys were conducted with both groups to determine their perspectives regarding the use of the provided tools.

Results

The preparatory course at the Manuel Félix López Agricultural Polytechnic School of Manabí is taught in a hybrid mode, incorporating virtual elements for both synchronous and asynchronous learning. On the other hand, the in-person components integrate critical activities essential for the approval process, such as the final exam or other practical-experimental activities. For this reason, mechanisms are required to publish the didactic content developed by the teacher, aiming to equip

students with the skills and abilities necessary for their respective learning and, consequently, course approval. The following outlines the results of the present study in line with the phases outlined in the methodological process (previous heading).

1. Development of the website for the mathematics subject:

To accomplish this task, interviews were conducted with the personnel responsible for the Admissions and Leveling process of the ESPAM MFL, as well as with the teachers who teach Mathematics. The objective was to determine which curricular contents could be considered minimum requirements, in addition to identifying the levels of complexity of teaching and areas of greatest learning difficulty for students. The results of this phase are presented below, categorizing the themes for each unit of analysis into three levels: low, medium, and high (Table 1).

Tabla 1. Minimum Contents of the Mathematics Subject and their Levels of Complexity

Unit	Topic	Complexity Level
Unit I. Arithmetic	1.1. Classification of Real Numbers.	Low
	1.2. Number Line and Law of Signs.	Low
	1.3. Addition, subtraction, multiplication, and division with integers and fractions.	Medium
	1.4. Addition, subtraction, multiplication, and division with polynomials. Exponents and Radicals.	High
	1.5. Rule of Three.	High
Unit II. Trigonometry	2.1. Angles, definition, and classification.	Low
	2.2. Triangle: Classification.	Low
	2.3. Resolution of right-angled triangles.	High
	2.4. Sine and cosine laws for oblique triangles.	High
	2.5. Resolution of triangles.	High
Unit III. Plane and Space Geometry	3.1. Introduction to plane and space geometry.	High
	3.2. Geometric resolution of elementary quadrilaterals: (square, rectangle, rhombus, parallelogram, trapezoid).	Medium
	3.3. Circumference and circle.	Medium
	3.4. Area of combined geometric figures.	High
	3.5. Volume of elementary figures (prism, spheres, cones, cylinders, and pyramids).	High

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Continued from previous page. *Tabla 1. Minimum Contents of the Mathematics Subject and their Levels of Complexity*

Unit	Topic	Complexity Level
Unit IV. Elementary Algebra	4.1. Factorization.	Medium
	4.2. Problems solved through first-degree equations.	High
	4.3. System of linear equations with two unknowns: Substitution, Equalization, and Reduction methods.	High
	4.4. Complete and incomplete quadratic equations.	High

Note. The table presents the units of analysis and minimum contents of the mathematics subject taught in the preparatory course at ESPAM MFL. Each evaluation based on the level of complexity indicates that subtopics with a high level pertain to calculations, equations, geometry, among others.

After identifying the contents to be taught in the mathematics subject and the topics with higher complexity levels, activities and didactic materials were established and implemented on the website, applying ICT to enhance content comprehension and facilitate a higher level of student engagement.

Tabla 2. Strategic and Didactic Contents to be incorporated into the website for the development of the mathematics subject

Topic	Strategic Content to be incorporated into the website
Unit I	
Classification of Real Numbers.	<ul style="list-style-type: none"> • An outline of the contents to be covered. • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Bibliography.
Number Line and Law of Signs.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Didactic material with the explanation of exercises. • Bibliography.
Addition, subtraction, multiplication, and division with integers and fractions.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Genially schematization of different operations. • Didactic material with the explanation of exercises. • Bibliography.

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Continued from previous page. Tabla 2. Strategic and Didactic Contents to be incorporated into the website for the development of the mathematics subject

Topic	Strategic Content to be incorporated into the website
Addition, subtraction, multiplication, and division with polynomials. Exponents and Radicals.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Genially schematization of different operations. • Didactic material with the explanation of exercises. • Bibliography.
Rule of Three.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Genially schematization of different operations. • Didactic material with the explanation of exercises. • Bibliography.
Unit II	
Angles, definition, and classification.	<ul style="list-style-type: none"> • An outline of the contents to be covered. • Basic and simple concept of the topic. • Representative images. • Genially schematization of different operations. • Bibliography.
Resolution of right-angled triangles.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Genially schematization of different operations. • Didactic material with the explanation of exercises. • Bibliography.
Sine and cosine laws for oblique triangles.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Explanatory video on the topic. • Genially schematization of different operations. • Didactic material with the explanation of exercises. • Bibliography.
Unit III	
Introduction to plane and space geometry.	<ul style="list-style-type: none"> • An outline of the contents to be covered. • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Explanatory video on the topic. • Bibliography.

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Continued from previous page. Tabla 2. Strategic and Didactic Contents to be incorporated into the website for the development of the mathematics subject

Topic	Strategic Content to be incorporated into the website
Geometric resolution of elementary quadrilaterals: (square, rectangle, rhombus, parallelogram, trapezoid).	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Explanatory video on the topic. • Bibliography.
Circumference and circle.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Explanatory video on the topic. • Bibliography.
Area of combined geometric figures.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Bibliography.
Volume of elementary figures (prism, spheres, cones, cylinders, and pyramids).	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Explanatory video on the topic. • Bibliography.
Unit IV	
Factorization.	<ul style="list-style-type: none"> • An outline of the contents to be covered. • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Bibliography.
Problems solved through first-degree equations.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Genially schematization of different operations. • Explanatory video on the topic. • Bibliography.
System of linear equations with two unknowns: Substitution, Equalization, and Reduction methods.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Genially schematization of different operations. • Explanatory video on the topic. • Incorporation of GeoGebra to understand problem-solving. • Bibliography.

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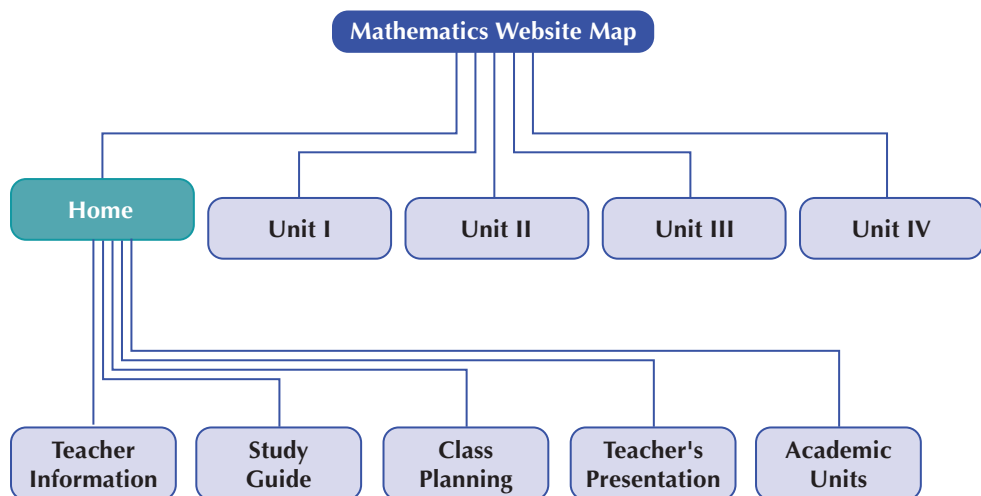
Continued from previous page. *Tabla 2. Strategic and Didactic Contents to be incorporated into the website for the development of the mathematics subject*

Topic	Strategic Content to be incorporated into the website
Complete and incomplete quadratic equations.	<ul style="list-style-type: none"> • Basic and simple concept of the topic. • Representative images. • Didactic material with the explanation of exercises. • Explanatory video on the topic. • Bibliography.

Note. Based on the conducted analysis, didactic activities are established to enhance teaching activities and make the learning process of the mathematics subject more efficient.

After defining the strategic contents, a diagram was created (Figure 1), illustrating the needs on each tab and the basic requirements for the website. Initially, it is necessary for the student to obtain information and the teacher's presentation, the study guide, class planning, as well as the link to access the contents for each unit of analysis.

Figure 1. Map of the Educational Website for the Mathematics Subject.



Note. This outline was developed based on the identification of the website's requirements.

For the creation of the subject's website, the WebNode tool was utilized. It offers an easily manipulated platform, modern design search, interactive features, free hosting storage, and content modification capabilities. Figure 2 displays the Home page developed in the application.

As illustrated in Figure 2, the site presents a simple and easily identifiable graphical interface for the students, which incorporates the necessary didactic tools to reinforce and provide feedback on the contents covered during the synchronous classes.

2. Determining the Relevance of the Website for Mathematical Learning

After conducting a survey consisting of six questions that utilize the Likert scale to determine the perspective of the 50 students regarding the use of the provided resource, the responses of the students who did not use the subject's website are shown in Table 3, while Table 4 displays the responses of those who did use it.

Figure 2. Home Page of the Mathematics Subject Website



Note. Through the following link, access is possible: <https://eddymendoza.webnode.ec/>. Access to the website is also possible through the attached QR code.



Tabla 3. Perspective of Students Who Did Not Use the Mathematics Subject Website

Question	Totally Disagree	Disagree	Indifferent	Agree	Totally Agree
Does the provided material for the mathematics subject enable frequent access?	28%	36%	32%	4%	0%
Do you believe the provided resource has improved your understanding of mathematical concepts?	24%	48%	24%	0%	4%
Does the resource help clarify doubts or reinforce your knowledge in the field of mathematics?	20%	60%	12%	4%	4%
Did you feel more motivated and interested in the mathematics subject when using the resource?	32%	44%	4%	20%	0%
How easy was it for you to navigate and find the information you needed in the provided resource?	44%	36%	4%	8%	8%
Do you consider the quantity and variety of exercises available in the educational resource to be clear for understanding the content?	20%	60%	4%	4%	12%

Note. Table 3 presents the perception of students who did not use the created educational resource, showing a high level of dissatisfaction among students with the use of written materials. This indicates the need for the implementation of creative didactic strategies.

Tabla 4. Perspective of students who used the mathematics subject website

Question	Totally Disagree	Disagree	Indifferent	Agree	Totally Agree
Does the provided material for the mathematics subject enable frequent access?	0%	0%	4%	8%	88%
Do you believe the provided resource has improved your understanding of mathematical concepts?	0%	0%	4%	4%	92%
Does the resource help clarify doubts or reinforce your knowledge in the field of mathematics?	0%	0%	4%	0%	96%
Did you feel more motivated and interested in the mathematics subject when using the resource?	0%	0%	0%	0%	100%
How easy was it for you to navigate and find the information you needed in the provided resource?	0%	0%	0%	4%	96%
Do you consider the quantity and variety of exercises available in the educational resource to be clear for understanding the content?	0%	0%	4%	8%	88%

Note. Table 4 shows a positive increase favoring the use of these educational resources. Eighty-eight percent totally agree that the website allows frequent access to information. Additionally, ninety-two percent mention that it improves the understanding of mathematical concepts, and one hundred percent felt motivated to learn the subject.

Discussion

Research on the use of websites in mathematics education has shown that the results obtained generally focus on changes related to student perception and performance (Torres et al., 2022). While these technologies have been studied mainly in industrialized countries, this research demonstrates the effectiveness of implementing a mathematics website even in regions like Latin America.

The implementation of an educational website offers several advantages. Students can access educational materials anytime, anywhere, while having a wide range of interactive resources, videos, exercises, and examples adaptable to different learning styles. This makes mathematics education more accessible, interactive, and personalized, allowing students to learn at their own pace and level of understanding, activating different areas of the brain that enhance learning. Indeed, technology has allowed for the development of integrative activities (Mora, 2023), utilizing the internet, as ICTs alone cannot drive significant changes. Therefore, it will depend on their users, in this case teachers and students, to use them efficiently.

On the other hand, the results of the research carried out by Asanza et al. (2019), entitled "The Use of ICT in University Mathematics Teaching," determine the importance of using information technologies in various academic activities. For example, incorporating mathematical applications, using augmented reality, and programming within the subject. However, all these resources should be stored in a single digital material that provides an organized and didactic framework. For this reason, meaningful learning in the mathematics subject, through the use of technological resources, such as an interactive website, must be articulated with the educational curricula, as proposed in this article. Only then will it be possible to achieve a transformation of traditional teaching methods in this area (Grisales, 2018).

Finally, the results obtained in the research on the use of ICT in mathematics learning in higher education, conducted by Morales and Cuevas (2022), showed that 93% of the total students achieved the main objective of the study. This determines that ICT enhances learning in the numerical subjects taught in the institution. It should be noted that the

study was carried out with reference to students of technology careers, which could explain the favorable results. However, it is important to consider that a group of students who are not familiar with different ICT tools could obtain different results. This highlights the need for a comprehensive resource that brings together all these educational tools. Now, more than simply innovating traditional teaching, this research has contributed to methods to improve the way mathematical knowledge is fed back through dynamic tools (Vivanco et al., 2023).

Conclusions

This research investigated the development of an interactive website as a teaching strategy to improve mathematics learning at the preparatory level at ESPAM MFL. The following conclusions were drawn:

The Need for Improved Pedagogical Strategies: The current generation of students entering higher education often lacks interest and motivation for mathematics (Landázuri et al., 2023). Traditional teaching methods, perceived as ineffective, have contributed to the demonization of mathematics as an incomprehensible subject. Consequently, many students gravitate towards careers that minimize the need for complex mathematics.

Technology as a Solution: Technology presents itself as a powerful ally in enhancing teaching methodologies. This research proposes the development of an interactive website as a means to create a more engaging and effective learning environment for mathematics education.

Effectiveness of the Interactive Website: The use of the interactive website for teaching mathematics has proven to be highly beneficial. Students in the ESPAM MFL preparatory level analyzed in this study exhibited a significant increase (almost 100%) in their interest and motivation towards mathematics. This positive outcome can be attributed to the website's user-friendly interface, ease of navigation, and the variety of interactive resources it offers. These factors facilitated access to information and provided students with a more enjoyable and enriching learning experience. Additionally, the website

promoted active participation in learning activities and fostered a deeper commitment to mathematical concepts, reaffirming its value as a teaching tool.

WebNode: A Platform for Interactive Didactic Material: WebNode, the website creation tool used in this study, is highly recommended for educators seeking to develop interactive didactic material. Its user-friendly interface and comprehensive features allow for the creation of cloud-based educational spaces. These spaces offer students accessibility, availability, and other benefits that contribute to a successful teaching and learning process. Furthermore, WebNode provides a wide range of options for integrating external didactic tools in iframe format, such as Genially, Geogebra, and YouTube, further enriching the learning experience.

The findings of this research highlight the transformative potential of interactive websites in revolutionizing mathematics education. By addressing the prevailing disinterest in mathematics and harnessing the power of technology, educators can cultivate a more engaging and effective learning environment that fosters a deeper understanding and appreciation of mathematical concepts among students. As technology continues to evolve, the integration of innovative digital tools into the educational landscape holds immense promise for shaping a future where mathematics learning is not only accessible but also stimulating and rewarding.

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