

Digital Tools as a Didactic Strategy to Strengthen Formative Assessment

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Abstract

The purpose of the study was to analyze the implementation of digital tools adjusted to the formative evaluation in the Educational Unit "Cardenal Carlos María de la Torre". For this purpose, some digital tools and their application in the formative evaluation were evaluated, which facilitated the optimization of time and physical materials; the most complex subjects for students were considered, the subjects of Mathematics, Physics, and English, the most important tools were identified in each of them, such as GeoGebra, Phet, and Wordwall. For the study we worked with second-year students of the evening section of the Unified General High School; parallel "A" was chosen with a population of 32 students for the experimental group and parallel "B" with a population of 30 students, which is the control group. Through the use of the statistical tools Jamovi and Excel®, the level of normality of the data obtained and the statistical significance was evidenced, which demonstrated an improvement in the effectiveness and efficiency in the application of the formative evaluation, in addition to the interest of the students in the application of the selected tool for each of the subjects. It is advisable to promote the proper use of digital tools in educational institutions, especially at the secondary level for its savings in time and resources, in addition to the students show greater interest in the teaching-learning process, as part of the development of the subjects, becoming an element of vital importance for their training.

Keywords: digital tools, formative assessment, learning, normality, digital divide.

1. Introduction

"Technology would never replace good teachers, but it has transformative potential in their hands"

George Couros

The dizzying advance of technology in contemporary society has permeated all aspects of life, including the educational sphere. Similarly, the COVID-19 pandemic has had a significant impact on education globally, becoming an opportunity for change and innovation in education systems, revolutionizing the way we access information and learn.

"The health emergency completely changed many traditional aspects of education, as Rojas and Díaz (2020) argue, the pandemic had such an influence that it expanded "new educational models covering aspects of Web 2.0, of the knowledge society, to the point of changing in some cases from a constructivist model to a connectivist model" (p. 65). It is important to state that the central idea of connectivism holds that knowledge is distributed through a network of connections and, as a result, learning is manifested in the ability to build and cross these networks (Solorzano & Gracia, 2016).

Education in Ecuador today faces challenges, from the growing diversity in students' needs to the urgency of preparing them for the digital age. Susana Araujo, director of the National Institute of Educational Evaluation (Ineval), an Ecuadorian public institution in charge of promoting quality education through an evaluation of the entire educational system and its compendiums (Ineval, n.d.), believes that the coronavirus pandemic is "a before and after" for Ecuadorian education. In addition, Araujo (2024) states that some educational institutions do not yet have computer laboratories, while in others technology is already part of learning, thus increasing digital divides.

In this sense, Posso (2022) argues that the digital divide is one of the greatest challenges, given that not all students have access to the internet, appropriate electronic devices, or online learning tools. This lack of access to technology and connectivity particularly affects students in rural and low-income areas. To this, Guerrero et al. (2023) point out that in 2020 the United Nations Children's Fund (UNICEF) confirms that, in Ecuador, 37 percent of households have access to the internet, that is, that 6 out of 10 children cannot use digital platforms and resources, on the other hand, rural areas, only 16 percent of households have internet. Limited digital resources have caused unequal and exclusionary educational trajectories in rural populations due to geographical, cultural, social, and economic conditions (Burgos et al. 2020).

However, education faced a new challenge as a result of the energy crisis that began in April 2024, specifically the afternoon and evening sections, the latter resuming the non-face-to-face modality. The afternoon section would end classes at five in the afternoon instead of six and the teachers sent academic activities to the home. On the other hand, for the night section, pedagogical worksheets planned by teachers and given to students were used so that they can continue preparing from home (Ecuavisa, 2024).

The Ministry of Education (MINEDUC) issues the 2021 Prioritized Curriculum where it proposes to develop basic digital skills that are required for reading, writing, the use of digital devices and online applications, allowing students to develop computational thinking and the responsible use of technology; in this regard, Zambrano et al. (2010) ratify that in this networked society, students must create and participate in virtual communities, handle web 2.0 tools,

analyze and interpret data, understand the context, build collaborative documents through interactive applications, among others.

Despite the fact that the 2021 Prioritized Curriculum highlights the development of digital competencies in Ecuadorian educational institutions, the subject of computer science has not been part of the national curriculum since 2015. In April 2020, computer science teachers sent letters to the Presidency and the Ministry of Education, requesting the incorporation of the subject into the curriculum, arguing the context of virtual classes (Sandoval, 2020). However, for the 2024-2025 school year, the Ministry of Education will reform the curriculum by incorporating new subjects differentiated into four groups:

- 1.- Traditional subjects: Language, Mathematics, Physics, Algebra and Physical Education.
- 2.- Transversal Subjects: Computer Science and Financial Education.
- 3.- New Flexible Subjects: Introduction to Programming and Andean Cosmivision.
- 4.- Optional subjects: Maritime Awareness.

The Undersecretary of Educational Innovation, Emilia Vallejo, pointed out that the implementation of the new curriculum is mandatory in all educational institutions nationwide, and highlighted the need to overcome the digital divide that exists, especially in rural schools (Ecuavisa, 2024).

Another challenge facing Ecuadorian education today is the way to evaluate. In this network society, the traditional roles of the teacher and the student imply a change in the way learning is assessed. Russo et al. (2023) point out that, instead of rote and repetitive assessment, assessment focused on the understanding and application of acquired knowledge should be encouraged; that is, formative and continuous, allowing students to receive constant feedback and improve their learning.

Traditional assessment is challenged by the need to adapt to the changing demands of the environment. Ponce (2021) mentions that digital tools in education have drastically transformed the traditional educational paradigm due to the frequent use of the internet.

As far as the Covid 19 pandemic is concerned, it not only caused the closure of face-to-face classes, it also demanded changes in education, including the way of evaluating. Regarding formative assessment (PE), the MINEDUC in the Educational Plan "Let's Learn Together at Home 2020-2021", states that it should be constituted as an assessment exercise, a continuous record of information and comprehensive feedback by the teacher, in order for students to achieve learning objectives. In the same way, Sifuentes et al. (2023) and Willis et al. (2024) agree that, in the field of PE, the importance of feedback is highlighted as a fundamental axis to measure the development of students' competencies. PE, when executed effectively, improves student learning and, as a consequence, academic performance has a positive effect (Tapia et al., 2023).

In 2023, María Brown Pérez, Minister of Education, issued an agreement regarding the regulations to regulate evaluation, permanence and promotion in the fiscal education system with some points to consider:

- 1.- Public educational institutions will organize academic periods by quarters, in order to promote more opportunities for PE and effective feedback in the short term.
- 2.- The types of student evaluation are diagnostic, formative, summative and socio-emotional. In addition, it proposes tools that help the teacher to observe, assess and record evidence of the students' progress. PE includes projects, disciplinary and interdisciplinary research, anecdotes, individual and group exhibitions, experiments, content development, and digital tools, among others.¹
- 3.- The inputs (grades to be averaged) can be obtained through various types of contributions that students can carry out individually or in groups, as can be seen in Figure 1, where the MINEDUC proposes a variety of activities.

Figure 1. Proposed activities that students can carry out.

| Tipos de aportes | | Ponderación |
|--|---|---|
| Aportes | Actividades Disciplinarias o Interdisciplinarias individuales: | |
| | Lecciones de revisión o retroalimentación orales y/o escritas | 10% |
| | Pruebas de base estructurada integrales abiertas y/o cerradas | 10% |
| | Tareas en clase | 10% |
| | Proyectos y/o Investigaciones | 15% |
| | Retroalimentación pedagógica (puede reemplazar a cualquier ítem en el promedio) | - |
| | TOTAL: | (45%) |
| | Actividades Disciplinarias o interdisciplinarias grupales: | |
| | Proyectos y/o Investigaciones dentro o fuera de la institución educativa | 15% |
| | Exposiciones, foros, debates, mesas redondas, | 10% |
| | Talleres | 10% |
| | Desarrollo de productos como maquetas, dioramas, presentaciones artísticas y/o científicas y/o culturales | 10% |
| | TOTAL: | (45%) |
| | Proyecto Interdisciplinario | Se aplica la metodología de aprendizaje basado en proyectos y/o problemas, se debe sistematizar cada fase del proyecto con un portafolio y/o bitácora de avances. |
| Evaluación de periodo académico | Evaluación de base estructurada | 5% |
| TOTAL: | | 100% |

Source: Prepared by the National Directorate of Curriculum, 2023. In the original language, Spanish.

- 4.- Figure 2 shows the qualitative-quantitative correspondence grading scale for Baccalaureate determined as follows:

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Figure 2. School Year Grading Scale.

| Escala cualitativa | Equivalencia |
|---|-------------------|
| Domina los aprendizajes (DA) | 9.00- 10.00 |
| Alcanza los aprendizajes (AA) | 7.00- 8.99 |
| Está próximo a alcanzar los aprendizajes (PA) | 4.01- 6.99 |
| No alcanza los aprendizajes (NA) | Menor o igual a 4 |

Source: Article 26 of the General Regulations to the Intercultural Education Act. In the original language, Spanish.

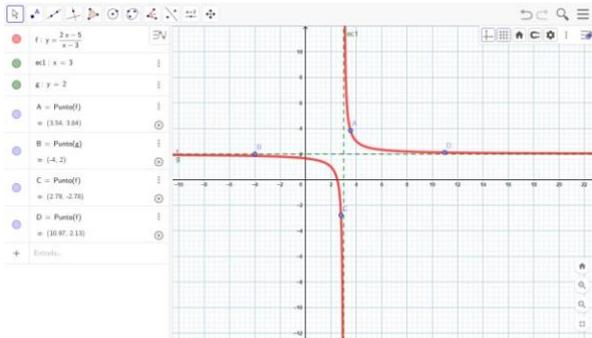
From the above, it can be deduced that PE left behind the traditional way, assessing by grade, currently it goes further as it provides greater scope where capacities, skills, and aptitudes are important indicators in education (Aranda & Álvarez, 2023). According to Bizarro et al., (2019) and Joya (2020) in relation to the student, significant learning should be promoted in them so that they are able to recognize their difficulties, needs, and strengths to face challenges and mistakes in the future.

The implementation of educational technology is a critical issue in the current context of post-pandemic education. Technology is considered a valuable tool to improve the pedagogical process, but its effective use depends on the adequate training of teachers; In this way, it is guaranteed that these tools are used effectively to improve the educational experience of students, and are adapted to the needs of the educational environment.

In this study, a didactic proposal is developed to improve the formative assessment (PE) of students from pedagogical practice. Therefore, digital resources such as GeoGebra, Phet and Wordwall are being investigated, which allow the application of strategies to strengthen PE in a satisfactory way. The incorporation of digital tools seeks to identify effective strategies within current educational demands, adapting them to the specific and individual needs and preferences of students (Medina et al., 2024).

According to the tools indicated, GeoGebra is a software of free access and easy to use in the classroom, it contributes to improving a central activity of Mathematics such as problem solving, which facilitates the development of different strategies to pose the statements, allowing the dynamic exploration of situations and providing new methods of resolution (Cotic, 2014).

Figure 3. "GeoGebra" software reflects the exercise developed during the Mathematics class.



Another tool that is taken into account is the Physics Education Technology (PhET) simulator that helps students develop scientific research skills by exploring cause and effect relationships (Diaz, 2017). Phet is considered a free multimedia teaching material that integrates technological and pedagogical elements in order to support the educational process in the subject of Physics.

Figure 4. Virtual laboratory simulator "PhET" where the practice on parabolic movement is visualized.



Likewise, the Wordwall application allows you to create a variety of teaching resources on any topic by designing interactive exercises and sharing them with students and other teachers.

Ismiyati and Saputri (2020) state that all the exercises in Wordwall are interactive and easy to learn, particularly in this study in the subject of English, through the combination and association of words and missing letters, among other useful activities to strengthen grammatical structures.

Figure 5. "Wordwall" application where interactive activity of the use of regular and irregular verbs in the simple past tense is indicated.



Zurita, et al., (2024) state that the integration of the teaching resources GeoGebra, PhET Simulators and Wordwall in the teaching of various subjects reflects a significant improvement in understanding and learning both in the theoretical and practical aspects; In the same way, these tools provide an interactive and visually stimulating learning environment in the classroom, which contributes to improving the evaluation process, leading to active, collaborative and meaningful learning

On the other hand, Ramos (2021) points out that the increasing accessibility and variety of teaching resources of technology offer teachers the unique opportunity to take advantage of digital tools and use them for PE in innovative ways. For this research, the "Cardenal Carlos María de la Torre" Educational Unit (CDLT) has been taken into consideration, which is located in the rural parish of El Quinche northeast of the city of Quito, characterized by its natural environment and the considerable distance from urban centers.

The institution's infrastructure is modest, with several buildings housing classrooms, administrative offices, and laboratories. Internet access is limited: connectivity only exists in administrative offices and laboratories, which makes it difficult to use it widely in classrooms. In addition, students come from nearby communities and most do not have personal mobile devices such as smartphones or tablets. The socioeconomic conditions of families mean that access to technology is restricted, which is reflected in the limitations to integrate digital tools uniformly into daily educational activities. Despite these challenges, the school community shows a great commitment and desire to improve the quality of education by implementing

innovative strategies that can be adapted to their realities; for example, through the records of the Samy School Management system, software created in order to guarantee greater organization and communication in the CDLT educational community, allowing to have an updated database of academic processes such as periodic grades, quarterly reports, attendance, among others, managed by the institution, it has been observed that second-year students of Unified General Baccalaureate (BGU). The afternoon section presents difficulties in the evaluation process of several subjects, including Mathematics, Physics and English.

For the reasons mentioned above, this study aims to analyze the integration of digital tools, through the application of Geogebra, Phet and Wordwall in the subjects of Mathematics, Physics and English respectively to strengthen the PE of the second year students of BGU of the CDLT Educational Unit.

As a central axis of innovation, this research seeks to contribute to social change by achieving a significant educational transformation that improves the quality of learning, equity and inclusion in access to educational opportunities. In an environment where Internet connectivity is limited and not all students have access to mobile devices, the implementation of digital tools must be creative and adapted to these circumstances so that teachers can improve PE, allowing more accurate and timely feedback that helps students identify and overcome their academic difficulties. Finally, this change will contribute to the sustainable development of the rural community of Quinche by empowering its members with the necessary skills to take advantage of the opportunities offered by the digital age.

In these circumstances, the following research question arises: To what extent do the digital tools Geogebra, Phet and Wordwall contribute to the formative assessment of second-year BGU students?

Based on the above information, the hypotheses raised in this study are:

- a) Null hypothesis (H₀): The use of Geogebra, Phet and Wordwall during the pedagogical process does not have a significant effect on the PE of students in the second BGU in the subjects of Mathematics, Physics and English.
- b) Alternative hypothesis (H₁): The use of Geogebra, Phet and Wordwall during the pedagogical process significantly strengthens the formative assessment of students in the second BGU in the subjects of Mathematics, Physics and English.

Digital tools can significantly improve PE by providing timely feedback, personalizing learning, offering a variety of assessment formats, facilitating data collection and analysis, fostering student collaboration and engagement. Each tool has different characteristics, optimizing time, increasing the student's attention levels, the distribution of efficient material and the creation of adequate learning ecosystems to strengthen PE. This educational innovation seeks to empower students with technological and critical learning skills, better preparing them for future challenges and contributing to the sustainable development and socioeconomic progress of their communities.

2. Materials and methods

The present research is of a quasi-experimental nature; therefore, it is of an applied type, where the management of an action is required to study its possible effects (Vásquez, 2010). In addition, the work groups were not randomly assigned (Bono, 2012).

The application of digital tools corresponded to the second year parallel BGU "A", while the traditional procedure fell to the second year parallel BGU "B". This process was carried out in the subjects of Mathematics, Physics and English, specifically in unit one of the third term, which deals with Rational Function, Projectile Movement and Simple Past, respectively. The research approach is quantitative because it is based on measurable processes and statistical inferences (Babatava, 2017).

The population in this study belonged to the second year of the BGU of the evening section; legally enrolled in the CDLT Educational Unit during the 2023-2024 school year. The groups were made up of 32 students who belonged to parallel "A", which corresponded to the experimental group (GE), and 30 students to parallel "B", being the control group (GE), who take the subjects of Mathematics, Physics and English and are between 15 and 17 years old.

As a first instance, an initial test (pretest) was applied in the two groups, then the Shapiro-Wilk test was performed, one of the most common tests to find the normality of the data, of this work in which a distribution of a small sample ($n \leq 50$) is used.

The statistical analysis tool used is called Jamovi, a free and open source software that allows advanced descriptive studies to be carried out without the need for specialized programming knowledge. This program offers a wide range of resources for data analysis, among the most outstanding we can mention correlation and linear regression, non-parametric tests, contingency tables, factor analysis and reliability tools, among others. In this tool, the Shapiro-Wilk test was performed to find the normality of the data, as well as the results of the statistical test "student's t" for related samples.

In the same way, the Excel® office program was used, which allows accounting and financial tasks to be carried out thanks to its functions to help create and work with spreadsheets. It features graphs, tables, calculations, and a macro programming language called Visual Basic for Applications. The statistical tables and graphs of this research were generated by this software.

To begin this study, the teacher presents the content to be studied during the week, the objective and the initial test or pre-test is applied. The initial test for each subject is designed as standardized or structured-based tests containing ten multiple-choice questions. The time allocated for the application of this test was 45 minutes. The time allocated for the execution of the didactic proposal was one week, taking into account that each subject has a certain number of hours per week that is detailed below: for Mathematics there are 5 pedagogical hours of class, while in Physics and English they have 3 pedagogical hours.

For the experimental group, after the pre-test, the development of the teaching-learning process in the classroom begins, relying on Geogebra, PhET and Worldwall for the Mathematics, Physics and English classes respectively. In the subject of Mathematics, the topic Rational Function

(FR) was worked on, during the first session a video was projected on the use of GeoGebra; in the second session, students performed (FR) exercises using the GeoGebra resource in which they can graph and analyze their characteristics; Finally, in the last session, feedback exercises were carried out in a group. In the subject of Physics, we worked with the theme of Parabolic Motion (MP), during the first session the definition, characteristics, and laws that are governed in the MP were projected in slides so that later the students can make an infographic in any digital application; in the second session, they are asked to carry out a PM laboratory practice using the PhET simulator; Finally, in the last session, application exercises are carried out with the support of video tutorials. In the subject of English, the topic of daily routines in the past simple was reviewed, in the first hour the introduction was made: basic explanation of SP and its uses, examples of regular and irregular verbs of its daily routine in SP. In the second hour, online grammar exercises were carried out with immediate feedback in the Wordwall application and in the last session an online game was played to work on the formation of the simple past tense with regular and irregular verbs by carrying out interactive activities such as roulettes, word search, drag and drop exercises among others that Worldwall has in its didactic resources.

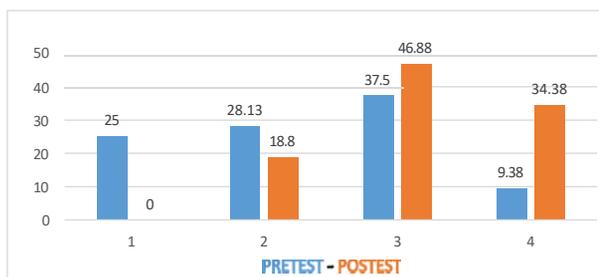
Similarly, for the control group, work was done in the subject of Mathematics with the topic Rational Function (RF). In the subject of Physics, we worked with the theme of Parabolic Motion (MP), during the week. In the English subject, the topic of daily routines in the past simple was reviewed, the introduction was made: basic explanation of SP and its uses, examples of regular and irregular verbs of its daily routine in SP. In the three subjects, work was done in the traditional way with the respective plans, using blackboards, texts, and classroom work.

To conclude the experimentation, both the GC and the EG carried out the post-test based on the initial evaluation, with the same number of questions and formats, as well as with the same time allocated for their application.

3. Results

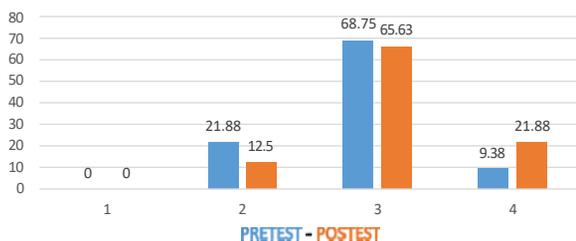
According to the analysis carried out regarding the grades obtained in the first input corresponding to the third quarter, the following percentages are reflected, which are distributed according to the grading scale that is in force in the 2023 National Curriculum for the area of Mathematics, Physics and English, respectively, which were achieved in the experimental group according to the pre-test and post-test.

Figure 6. Value of percentages corresponding to the pre-test and post-test in the area of Mathematics.



According to image 6, for the subject of Mathematics, the values of the pre-test with the grading scale show that there are 25% of students who do not achieve the required learning, while 28.13% of the students are close to achieving the required learning, in the same way 37.5% of them achieve the required learning and only 9.38% master the learning. When carrying out the post-test analysis, we can assert that there are 18.8% of students who are close to achieving learning, 46.88% who achieve the acquired learning and 34.38% who master learning. Therefore, we can state that the input of the students improved significantly after using Geogebra and it is argued that there are values of significant percentages in the levels of reach and master the learning.

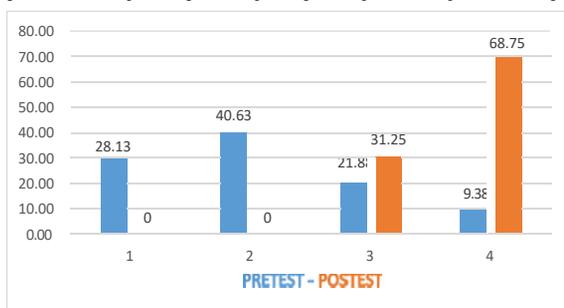
Figure 7. Value of percentages corresponding to the pre-test and post-test of Physics.



According to Figure 7, for the subject of Physics, the values of the pre-test with the grading scale show that there are 0% of students who do not achieve the required learning, while 21.88% of the students are close to achieving the required learning, in the same way 68.75% of them achieve

the required learning and only 9.38% master the learning. When carrying out the post-test analysis, we can assert that there are 12.5% of students who are close to achieving learning, 65.63% who achieve the acquired learning and 21.88% who master learning. In general, it is evident that there is a significant improvement in students' grades after the use of the Phet simulator.

Figure 8. Value of percentages corresponding to the pre-test and post-test of English.



According to Figure 8, for the subject of English, the values of the pre-test with the grading scale show that there are 28.13% of students who do not achieve the required learning, while 40.63% of the students are close to achieving the required learning, in the same way 21.88% of them achieve the required learning and only 9.38% master the learning. When carrying out the post-test analysis, we can assert that there are 0% of students who are close to achieving learning, 31.25% who achieve the learning acquired and 68.75% who master learning. It is evident that there is a significant increase in students' grades after the use of Wordwall, the percentage value is high at the level where they dominate learning.

After the analysis of the respective percentages, we proceed to perform the normality tests of the distributions and their respective arithmetic means, with the results of the pretest and post-test that belong to the GC and GE, using the Shapiro-Wilk test, this test helps us to verify the Hypotheses that were raised in the research.

Table 1. Shapiro-Wilk Test, in the subject of Mathematics of the control groups and experimental in its pre-test and post-test.

| Descriptive | Pretest GE | GE Postset | Pretest GC | Postest GC |
|----------------------|------------|------------|------------|------------|
| N | 32 | 32 | 30 | 30 |
| Stocking | 5,94 | 7,84 | 6,13 | 6,47 |
| W for Shapiro-Wilk | 0,943 | 0,936 | 0,932 | 0,938 |
| Shapiro-Wilk p-value | 0,093 | 0,057 | 0,056 | 0,081 |

In Table 1, the Shapiro-Wilk normality test is established in the study groups of the subject of Mathematics, it is essential since the "Student's t" statistic is used, in this way it will be verified that the data conform to the normal distribution. The result of the test can be interpreted through the p-value obtained for each assessment which is (0.093, 0.057, 0.056, 0.081) respectively that is greater than 0.05, therefore, the data conform to the normal distribution.

Figure 9. Arithmetic mean of the subject of Mathematics in the control and experimental groups, of the results of the pre-test and post-test. In the original language, Spanish.

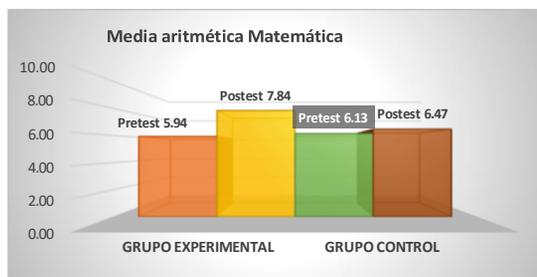


Figure 9 shows a difference in the arithmetic means for the subject of Mathematics between the pre-test and post-test tests. The arithmetic means in the pre-test are similar and only have a difference of 0.19. On the other hand, in the post-test test the difference between the GE and GC increases by 1.37. The control group and the experimental group showed an increase in post-test scores in relation to the pre-test. The EG, which used the Geogebra tool as a resource in the formative assessment, showed an increase in the average with the pre-test is 5.94 and with the post-test it is 7.84.

Table 2. Student's t-test, in the subject of Mathematics in the control groups and experimental in the post-test.

| T-Test for Paired Samples | | | | | |
|--------------------------------|------------|---------------|-------------|------|-------|
| GE Postset | Postest GC | T for Student | statistical | Gf | p |
| | | | 3,76 | 29,0 | <.001 |
| Note. $H_0: \mu_1 - \mu_2 = 0$ | | | | | |

Based on Table 2, to establish whether there is a statistically significant difference between the arithmetic mean of the EG and GC, the "Student's t-test" was used for two independent samples. The value of the statistic is 3.76; The P value is less than 0.001, therefore there is statistical significance among the tests and the alternative hypothesis is accepted.

Table 3. Shapiro-Wilk Test, in the subject of Physics of the control groups and experimental in its pre-test and post-test.

| Descriptive | | | | | | |
|----------------------|------------|-------|------------|-------|------------|--|
| | Pretest GE | | GE Postset | | Pretest GC | |
| N | 32 | 32 | 30 | 30 | | |
| Lost | 0 | 0 | 2 | 2 | | |
| Stocking | 7,53 | 8,10 | 7,43 | 6,56 | | |
| W for Shapiro-Wilk | 0,935 | 0,941 | 0,935 | 0,958 | | |
| Shapiro-Wilk p-value | 0,054 | 0,082 | 0,065 | 0,275 | | |

Table 3 establishes the Shapiro-Wilk normality test in the study groups of the subject of Physics, it is essential since the statistic of "Student's t" is used, in this way it will be verified that the data conform to the normal distribution. The result of the test can be interpreted through the p-value obtained for each assessment which is (0.054, 0.082, 0.065, 0.275) respectively that is greater than 0.05, therefore, the data conform to the normal distribution.

Figure 10. Arithmetic mean of the subject of Physics in the control and experimental groups, of the results of the pre-test and post-test. In the original language, Spanish.

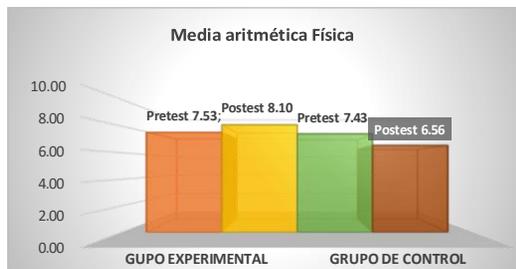


Figure 10 shows a difference in the arithmetic means for the subject of Physics between the pre-test and post-test tests. The arithmetic means in the pre-test are similar and only have a difference of 0.1. On the other hand, in the post-test test the difference between the EG and CG increases by 1.54. The control group and the experimental group showed an increase in post-test scores in relation to the pre-test. The EG, which used the Phet simulator tool as a resource in the formative assessment, showed an increase in the average with the pre-test is 7.53 and with the post-test it is 8.10.

Table 4. Student's t-test, in the subject of Physics of the control groups and experimental in the post-test.

| T-Test for Paired Samples | | | | | |
|---|------------|---------------|-------------|------|-------|
| GE Postset | Postest GC | T For Student | statistical | GI | p |
| | | | 4,92 | 29,0 | <.001 |
| Note. H ₀ : $\mu_{\text{Size 1}} - \mu_{\text{Size 2}} \neq 0$ | | | | | |

Based on Table 4, to establish whether there is a statistically significant difference between the arithmetic mean of the EG and CG, the "Student's t-test" was used for two independent samples. The value of the statistic is 4.92; The P value is less than 0.001, therefore there is statistical significance among the tests and the alternative hypothesis is accepted.

Table 5. Shapiro-Wilk Test, in the subject of English in the control groups and experimental in its pre-test and post-test.

| Descriptive | Pretest GE | GE Postset | Pretest GC | Postest GC |
|----------------------|------------|------------|------------|------------|
| N | 32 | 32 | 30 | 30 |
| Lost | 0 | 0 | 2 | 2 |
| Stocking | 5,58 | 9,11 | 4,95 | 5,23 |
| W for Shapiro-Wilk | 0,937 | 0,939 | 0,933 | 0,939 |
| Shapiro-Wilk p-value | 0,063 | 0,071 | 0,058 | 0,084 |

Table 5 establishes the Shapiro-Wilk normality test in the study groups of the subject of English, it is essential since the "Student's t" statistic is used, in this way it will be verified that the data conform to the normal distribution. The result of the test can be interpreted through the p-value obtained for each assessment which is (0.063, 0.071, 0.058, 0.084) respectively that is greater than 0.05, therefore the data conform to the normal distribution.

Figure 11. Arithmetic mean of the subject of English in the control and experimental groups, of the results of pre-test and post-test. In the original language, Spanish.

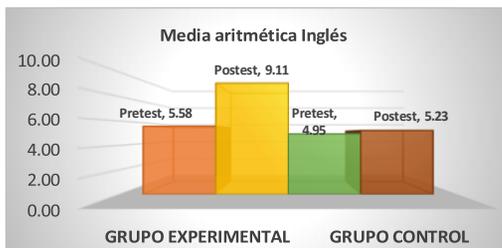


Figure 11 shows a difference in the arithmetic means for the subject of English between the pre-test and post-test tests. The arithmetic means in the pre-test are similar and only have a difference of 0.63. On the other hand, in the post-test test the difference between the EG and GC increases by 3.88. The control group and the experimental group showed an increase in post-test scores in

relation to the pre-test. The EG, which used the Wordwall tool as a resource in the PE, showed an increase in the average with the pre-test is 5.58 and with the post-test it is 9.11.

Table 6. Student's t-test, in the subject of Physics of the control groups and experimental in the post-test.

| T-Test for Paired Samples | | | | | |
|--|------------|---------------|-------------|------|-------|
| GE Postset | Postest GC | T for Student | statistical | Gl | p |
| | | | 12,5 | 29,0 | <.001 |
| Note. H ₀ : $\mu_1 - \mu_2 = 0$ | | | | | |

Based on Table 6, to establish whether there is a statistically significant difference between the arithmetic mean of the EG and CG, the "Student's t-test" was used for two independent samples. The statistical value is 12.5, the p value is less than 0.001, therefore there is a statistical significance among the tests and the alternative hypothesis is accepted.

It is therefore concluded to accept the alternative hypothesis (H1): The use of Geogebra, Phet and Wordwall during the pedagogical process significantly strengthens the PE of the students of the second BGU in the subjects of Mathematics, Physics and English. The results confirm that there is an incidence of the digital tools used in the formative assessment of the student.

Figure 12: Comparison of arithmetic means of the three subjects. In the original language, Spanish.



In image 13 we can see the comparison of average values of the pre-test and post-test between the subjects of Mathematics, Physics and English simultaneously where it is evident that in the area of English there is a greater increase in the averages of PE with the integration of Wordwall in the classes of this subject.

4. Discussion and Conclusions

Based on the results achieved, we can affirm that this work revealed that both groups, GC and GE, showed increases in their grades from the pre-test to the post-test. However, the EG, which used several digital resources such as Geogebra, PhET and Woldwall during the Mathematics, Physics and English classes respectively, showed a more considerable advance compared to the GC. This finding was corroborated by the "Student's t-test", which reflected a difference in substances between the groups, positively favoring in the EG.

In addition, based on the results obtained, it is determined that the null hypothesis, which postulates that the use of Geogebra, PhET and Wolwall during the PE process does not have a significant effect on student learning, is therefore rejected. The results of the study support the alternative hypothesis, which states that the use of Geogebra, PhET and Woldwall during the PE process significantly improves student learning. This is evidenced by the fact that the GE that used Geogebra, PhET and Woldwall during the development of the EF, obtained a superior improvement in its performance compared to the GC.

The objective of the research, which was to analyze the integration of digital tools, through the application of Geogebra, Phet and Wordwall in the subjects of Mathematics, Physics and English respectively to strengthen students' PE, is also fulfilled.

The conclusions presented below emerge after an exhaustive analysis of the results obtained during the research that not only highlight the positive impact of digital tools on PE, but also point the way towards a more inclusive, dynamic and student-centred education. With this vision of progress and change, the following conclusions are presented:

The synergy between the human experience and the potential of digital tools opens up a new landscape in education. Integrating traditional knowledge with digital possibilities not only enriches PE, but also drives a new era of collaborative and digital learning.

The implementation of the GeoGebra, Phet and Wordwall tools in the subjects of Mathematics, Physics and English respectively not only diversifies the evaluation methods, but also democratizes access to learning, allowing students to explore concepts in an interactive and personalized way and in turn enhance instant feedback. This approach not only prepares students to face the challenges of the 21st century, but also lays the foundation for a more innovative, collaborative society, network society, and digital transformation of education.

WORKS CITED

- Agreement No. MINEDUC-MINEDUC-2023-00012-A. María Brown Pérez. April 3, 2023
- Aranda, M. R., & Álvarez, C. A. V. (2023). Formative assessment: Literature review. *Horizontes Journal of Research in Education Sciences*, 7(31), 2685-2698.
- Araujo, S. (2024, February 26). Punto Noticias /Interviewed by Alexis Moncayo. https://www.youtube.com/watch?v=bmTY_jQMfIs
- Babativa Novoa, C. (2017). Quantitative research. Bogotá: Fundación Universitaria del Área Andina, 2017.
- Bizarro et al., (2019). Formative assessment within the framework of the competency-based approach. (2019). *Innova Education Journal*, 1(3), 374-390. <https://revistainnovaeducacion.com/index.php/rie/article/view/45>

- Burgos-Briones, J. G., Burgos-López, G. A., & Cedeño-Martínez, D. G. (2020). The Ecuadorian rural teacher in the twenty-first century. Challenges and Challenges. *Domain of the Sciences*, 6(4), 358-369.
- Caballero, J. E. A. P., Zuñiga, L. M. R., Zapata, C. A. V., Cruz, J. R. D. L., & Ruiz, K. F. C. D. (2022). More effective digital tools in the teaching-learning process. *Horizontes Journal of Research in Education Sciences*, 6(23), 669-678.
- Cotic, N. S. (2014). *GeoGebra as a bridge to learn mathematics*. Buenos Aires: Congreso Iberoamericano.
- Ecuavisa. (2024, April 22). The education system is once again undergoing modifications, this time due to the energy crisis. www.ecuavisa.com/noticias/ecuador/sistema-educativo-sufre-modificaciones-por-crisis-energetica-YC7206221
- Ecuavisa. (2024, January 4). New curriculum and change of schedules in schools and colleges in Ecuador in 2024. [www.ecuavisa.com/ https://www.ecuavisa.com/noticias/ecuador/horarios-clase-modifican-nueva-malla-curricular-2024-ID6566813#](https://www.ecuavisa.com/noticias/ecuador/horarios-clase-modifican-nueva-malla-curricular-2024-ID6566813#)
- Educational Evaluation-Information – Ministry of Education. (n.d.). Gob.ec. Retrieved March 22, 2024, from <https://educacion.gob.ec/evaluacion-educativa-informacion/>
- Evertson, C., & Merlin, G. (2008). Observation as inquiry and method. *Applied Quantitative Methods*, 2, 174-188.
- Fernando, S. M., & García Martínez, A. (2016). Fundamentals of network learning from connectivism and activity theory. *Cuban Journal of Higher Education*, 35(3), 98-112.
- Guerrero-Casquete, E. M., Chilliquinga-Campos, E. V., Velasco-Almachi, L. D., & Pimbo-Tibán, A. G. (2023). Education in the rural sector in times of pandemic due to Covid-19. *Scientific Journal UISRAEL*, 10(2), 143-154.
- National Institute of Educational Evaluation. (n.d.). Ineval Frequently Asked Questions. <https://www.evaluacion.gob.ec/preguntas-frecuentes-ineval-instituto-nacional-de-evaluacion-educativa/>
- Ismyati, W., & Saputri, T. (2020). Using Wordwall to improve english vocabulary mastery: systematic review. *Konstruktivisme: Jurnal Pendidikan dan Pembelajaran*, 12 (2). pp. 120-131. ISSN 2442-2355.
- Joya, Z. (2020). Formative assessment, an effective practice in teaching performance. *Revista Scientific - Refereed Article - Record No: 295-14548 - pp. BA2016000002 - Vol. 5, No. 16 - May-July 2020 - p. 179/193*. https://www.indteca.com/ojs/index.php/Revista_Scientific/article/view/438
- Medina, M., Pin, J., Chinga, R., & Lino, V. (2024). Wordwall as a support tool in the pedagogical reinforcement of Natural Sciences. *Pole of Knowledge*, 9(3), 1118–1136. <https://doi.org/10.23857/pc.v9i3.6708>
- Pinedo Villafuerte, G. (2022). Digital competencies and academic performance in students of a private higher technological institute in Cusco, 2021.
- Ponce, J. K. M. (2021). Digital educational tools and meaningful learning in students. *Domain of Sciences*, 7(1), 712-724.
- Posso Pacheco, R. J. (2022). The role of the teacher in the university context: a post-pandemic vision. *MENTOR Journal of Educational and Sports Research*, 1(2), 91–96. <https://doi.org/10.56200/mried.v1i2.3357>
- Ramos, J. (2021). Digital tools for education. *XinXii*.
- Rojas, O., & Díaz, J. (2020). The obligation to change; Transformation of education through the inclusion of technological tools for meaningful learning. *Hamut'ay*, 7(2), 64-74. doi: <http://dx.doi.org/10.21503/hamu.v7i2.2134>
- Russo, C. C., Sarobe, M., Ahmad, T., & Sinda, N. (2023). Innovative methodologies in the development and assessment of digital competencies of university teachers and students. In XXVIII Argentine Congress of Computer Science (CACIC) (La Rioja, October 3-6, 2022). <http://sedici.unlp.edu.ar/handle/10915/149484>
- Sandoval, C. (2020, September 26). Computing is not in the curriculum. *El Comercio*. <https://www.elcomercio.com/tendencias/sociedad/computacion-malla-curricular-educacion-ecuador.html>
- Sangrá, Albert and Steve Wheeler (2013): "New Forms of Informal Learning: Or Are We Formalizing the Informal?", *Universities and Knowledge Society Journal*, Vol. 10, No. 1, pp. 107-115. <http://journals.uoc.edu/index.php/rusc/article/viewFile/v10n1-sangra-wheeler/v10n1-sangra-wheeler-en-12/3/2015>
- Sifuentes, Y. T., Murga, Ó. J. O., & Oscco, F. G. (2023). Digital tools in formative assessment during the pandemic context. *Horizontes Journal of Research in Education Sciences*, 7(27), 444-453.

Correa Zarría Nancy Carolina, Guajala Sanmartín María Augusta, Veloz Jiménez Henry Vicente, Félix Agustín Bravo Faytong, Manuel Roberto Tolozano Benites

- Tapia, P. T. C., Soria, J. E. Y., Vásquez, M. C. S., Robayo, D. A. C., & Moposita, C. M. S. (2023). Formative and Summative Evaluation in the Educational Process: Review of Innovative Techniques and their Effects on Student Learning. *Ciencia Latina Revista Científica Multidisciplinar*, 7(2), 1478-1497.
- Tejedor, F. García-Valcárcel, A. 2007. Causes of the low performance of university students (in the opinion of professors and students). Proposals for improvement within the framework of the EHEA. *Journal of Education* (342). 443-473. <https://dialnet.unirioja.es/servlet/articulo?codigo=2254218>
- Vaillant, D., Zidán, E. R., & Biagas, G. B. (2020). Use of digital platforms and tools for the teaching of Mathematics. *Ensaio: Avaliação e Políticas Públicas em Educação*, 28, 718-740.
- Zambrano, W. R., García, V. H. M., & García, A. V. M. (2010). New role of the teacher and the student in virtual education. *Dialectics: Journal of Research*, (26), 51-62.
- Zurita-Delgado, M. E., Eugenio-Pilliza, C. I., & Alay-Giler, A. D. (2024). Anxiety to mathematics, a didactic proposal for its attention from pedagogical practice. *MQR Investigate*, 8(2), 656–679. <https://doi.org/10.56048/MQR20225.8.2.2024.656-679>.