REVISTA CÁTEDRA

Measurement of the appropriation of learning achievements in physics in virtual and blended modalities

Medición de la apropiación de logros de aprehendizaje en física en modalidades virtual y semipresencial

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Abstract

The aim of this study was to evaluate the impact of the covid-19 pandemic on the acquisition of learning achievements in Physics in students of the Lev Vygotsky Educational Unit in the city of Quito-Ecuador through the statistical analysis of standardized assessments. An evaluation matrix was designed to record the learning achievement to be evaluated, together with the corresponding code for its identification, level and type of achievement. The instrument consisted of 20 multiple-choice questions with four options, covering elementary, basic and advanced levels. The questions were grouped by topic and structured to demonstrate the applicability of knowledge. Assessments were cumulative and included all content covered during the first quarter of the 2021-2022 school year. Data were collected through assessments validated by the institution's mediators and analysed to identify significant differences between virtual and blended learning modes. The results of mean comparison by means of the t-test indicated that there is no significant difference in the appropriation of learning achievements between students who attended blended and virtual classes. This study highlights the importance of effective pedagogical practices in the appropriation of students' learning achievements regardless of the mode of study.

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Keywords
Online learning, physics teaching, educational strategies, learning achievement, educational purposes, school performance.

Resumen
El objetivo de este estudio fue evaluar el impacto de la pandemia por covid-19 en la adquisición de logros de aprehendizaje en Física en estudiantes de la Unidad Educativa Lev Vygotsky de la ciudad de Quito-Ecuador a través del análisis estadístico de evaluaciones estandarizadas. Se diseñó una matriz de evaluación para registrar el logro de aprehendizaje a evaluar, junto con el código correspondiente para su identificación, el nivel y el tipo de logro. El instrumento consistió en 20 preguntas de opción múltiple con cuatro opciones, cubriendo niveles elemental, básico y avanzado. Las preguntas se agruparon por temas y se estructuraron para demostrar la aplicabilidad del conocimiento. Las evaluaciones fueron acumulativas e incluyeron todo el contenido cubierto durante el primer quimestre del año escolar 2021-2022. Los datos se recopilaron a través de evaluaciones validadas por los mediadores de la institución y se analizaron para identificar diferencias significativas entre los modos de enseñanza virtual y semipresencial. Los resultados de comparación de medias por medio de la prueba t indicaron que no existe diferencia significativa en la apropiación de los logros de aprehendizaje entre los estudiantes que asistieron a clases semipresenciales y los que asistieron a clases virtuales. Este estudio resalta la importancia de prácticas pedagógicas efectivas en la apropiación de los logros de aprehendizaje de los estudiantes sin importar la modalidad de estudio

Palabras clave
Aprendizaje en línea, enseñanza de la física, estrategias educativas, logros de aprendizaje, propósitos educativos, rendimiento escolar.

1. Introduction
The covid-19 pandemic has generated significant transformations in education around the world, forcing educational institutions to adapt to non-traditional teaching methods. One of the main adaptations has been the transition to virtual or blended learning modalities to avoid the spread of the virus. With this, the need arises to evaluate learning in these modalities, especially in high school students.

From this arises the need to investigate and contrast the appropriation of learning achievements among students who attended blended and virtual classes. The purpose of the study was to obtain valuable information for decision making in the educational field. This paper shows the results of a study that compares the learning achievements of the students of the Lev Vygotsky Educational Unit, in both modalities during the school year 2021 - 2022.

Although virtual education has gained ground in recent years, the pandemic has accelerated its massive implementation. This raises doubts about its effectiveness compared to face-to-face or blended learning. Consequently, it is necessary to evaluate learning in both modalities to determine which is more effective during the pandemic and how educational practices can be improved in this new context, leading to the following research question:

What are the effects of the covid-19 pandemic on the appropriation of learning achievements in the subject of Physics by the students of the Lev Vygotsky Educational Unit

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during the first quarter of the 2021-2022 school year? This is the central question addressed in this paper, with the aim of ensuring quality education in the post-pandemic period. For this purpose, the learning achievement assessments will be statistically analyzed in order to implement effective pedagogical practices. In order to achieve this approach, the following specific objectives have been defined:

- To design standardized instruments for the evaluation of learning achievements in the subject of Physics through a process of validation by experts.
- To measure the appropriation of learning achievements in the subject of Physics through the application of validated evaluations by experts to identify significant differences between the virtual and blended learning modalities.

The hypothesis put forward for this study suggests that academic performance in the assessment of learning achievement in the subject of Physics will be higher among students who participated in blended classes compared to those who attended virtual classes during the pandemic. It is expected that, direct interaction between students and teachers, together with access to resources and materials in the classroom, will contribute to an improvement in learning and, consequently, in academic performance, in contrast to those who participated in virtual classes and might face distractions in the home environment during virtual sessions.

In this study, we intend to demonstrate that one of the two educational modalities, either blended or virtual, is more effective for students' learning. Through the evaluation of cognitive and praxeutic[1] learning achievements in Physics of students in both modalities, we seek to determine which of them allows a greater understanding and retention of the contents, especially in the context of the pandemic and the need to adapt to new forms of teaching. This research is also expected to provide recommendations to educational authorities on the most appropriate modality to ensure effective learning in times of pandemic.

The topic of learning assessment in different educational modalities in times of pandemic and post-pandemic is of great interest due to the need to find effective solutions to guarantee student learning in a context of uncertainty and constant change. The pandemic has forced educational institutions to adapt quickly to new teaching and learning modalities, which has generated a debate about the most effective pedagogical modality and strategies for student learning. Therefore, it is essential to conduct studies to determine the best way to ensure learning in post-pandemic times.

This manuscript is organized into six main sections. In the introduction, the general context of the topic is presented and the problem addressed in this study is stated. Then, the general objective and specific objectives, the hypothesis and the idea to be defended are established. The generalities of Conceptual Pedagogy and the design of Learning Achievement are addressed, as well as the guidelines for the creation of standardized tests. In the methodology section, the sample is described, as well as the way in which data collection was carried out and the statistical analysis used. In the results section, the findings of the study are presented, accompanied by tables and figures for a better understanding of the

[1] Praxeitive system is understood as the set of skills and abilities essential to process knowledge and apply it in different contexts, therefore, it indicates what the student is able to do. Lev Vygotsky Educational Unit (2018, p. 20).

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findings. The discussion section focuses on the interpretation of the results and their comparison with previous studies in the literature. Finally, the conclusions section summarizes the main findings and offers recommendations for future research on the subject.

2. Literature review

In this research we sought to analyze the effectiveness of two educational modalities during the pandemic, so it is important to review previous studies conducted in this field and to know the relevant theories and approaches for the analysis of the results. This theoretical framework addresses the pedagogical approach governing the Lev Vygotsky Educational Unit and online and blended learning education, as well as previous studies that have evaluated the effectiveness of these educational modalities.

2.1 Conceptual Pedagogy

According to José Brito (2013), a pedagogical model is "a schematic representation of reality, which guides decision-making in the design and development of the curriculum and is an indicator of educational quality" (p. 7). Therefore, it is the set of features of an educational institution that differentiates it from others.

At the Lev Vygotsky Educational Unit, the Conceptual Pedagogy model predominates, which stems from the reflections of Miguel and Julián De Zubiría Samper on "what to teach" and "how to teach" (De Zubiría and De Zubiría, 1995) based on the contributions of Vygotsky, Piaget, Wallon, Luria, Merani, among others. The fundamental purpose of conceptual pedagogy, being an ultramodern pedagogical model, is to form symbolic, loving, ethical, talented, creative and affectively competent symbolic analysts. This model is supported by a theoretical compendium on mentefacts, exceptional minds, instruments of knowledge, intellectual operations, theory of the six readings and psychological minds (Lev Vygotsky Educational Unit [LEV], 2020, pp. 45-49).

Figure 1 shows the conceptual mentefact of Conceptual Pedagogy in which Structural Pedagogy is visualized as its supra ordinate, together with the essential characteristics that differentiate it from Active Learning and Teaching for Understanding, and the applications according to its subtheories.

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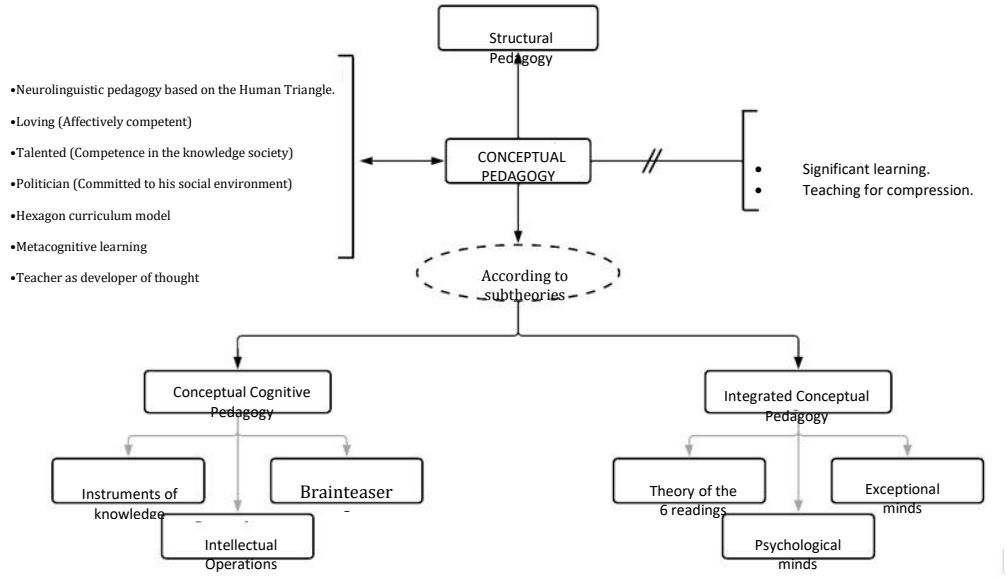

Figure 1. Mind-set [[Conceptual Pedagogy]] Adapted: De Zubiría et al., 2019, Lev Vygotsky Educational Unit, 2020

To achieve the objective of Conceptual Pedagogy, the Hexagon Model is used, which is a technology of Curricular and Didactic Design where the pedagogical elements are defined, that is, the elements that guide the educational process. The how of the process is also determined, that is, the didactic elements. In the postulate, the didactic elements are subordinated to the pedagogical ones. When referring to the pedagogical elements, it is mentioned that the learning achievements (purposes), the indicators of success in learning (evaluation) and the learning contents (teachings), become the purpose of the process, since they express in a consequential way what is sought in the student, as shown in Figure 2.

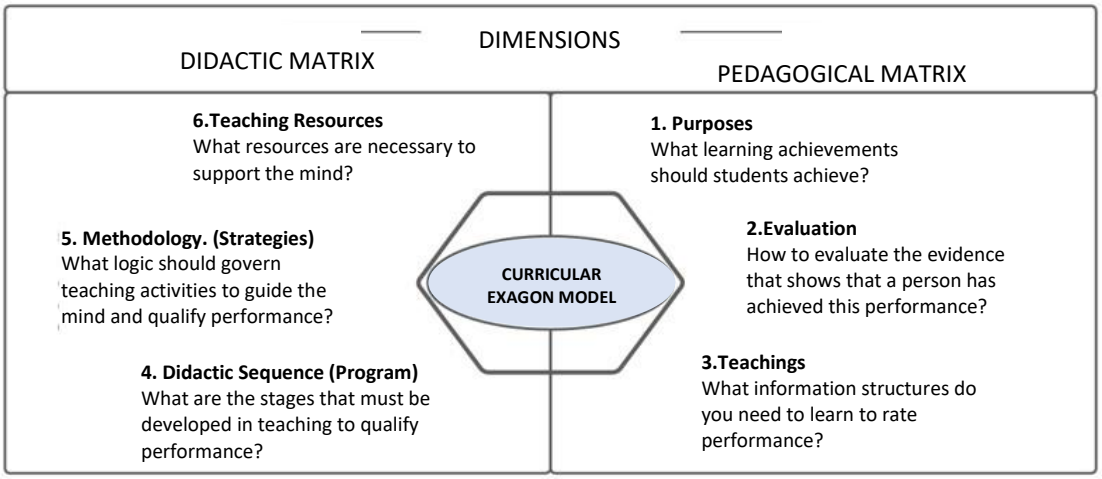

Figure 2. Model of the curricular hexagon. Adapted from Castro, 2017

Semantic memory is not designed for the processing of large amounts of data and information, "these can be memorized and retained as long as they are functional; then they are discarded as 'cortical garbage' when this memory is full, so the retention time is short"

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(Brito Albuja, 2013, pp. 7-51; De Zubiría, 2000, pp. 14-39). For such reason, learning is developed through instruments of knowledge and intellectual operations. "An instrument of knowledge is a generalized learning that allows the comprehension of the world around us; it abstracts reality into a complex mental tool that helps us to interpret situations and to apprehend" (LEV, 2020, p. 42).

Intellectual operations allow the processing, utilization, exercise and application of the instruments of knowledge. These intellectual operations are mental abilities that potentiate each of the levels of thought for the creation of new structures and semantic relations, as shown in Table 1. For this reason, it is necessary to teach simultaneously the intellectual operations together with the instrument of knowledge to be taught.

Conceptual Pedagogy offers an important contribution regarding the teaching of knowledge instruments by means of mentefacts. These focus on three fundamental areas: 1) cognitive, which allows the understanding of the world through sciences; 2) affective, which refers to the attitudes, affections and emotions necessary for human formation and motivations; and 3) praxeitive, which focuses on the skills and abilities necessary to process knowledge and apply it.

Age	Level of thinking	Instrument of knowledge	Intellectual Operations
2 - 6 years	Notional	Notion	Introjection, Projection, Nomination and De-nomination
6 – 12 years	Propositional	Proposition	Encoding, Decoding, Propositionalization and Exemplification
12 – 14 years	Formal	Chain of reasoning	Induction, Deduction, Transduction and Hypothesizing
14 – 16 years	Argumental	Argument	Tesification, Argumentation (Counterargumentation), Derivation and Definition
16 – 18 years	Conceptual	Concept	Supraordination, Exclusion, Isoordination and Infraordination

Table 1. Relationship between levels of thinking, instruments of knowledge and intellectual operations. Adapted from: (Unidad Educativa Lev Vygotsky, 2020)

Each of these areas is related to the human triangle and are hierarchized according to the level of thinking to be developed. The great advantage of mentefacts is that they allow the development of thinking from an early age, organizing and categorizing the objects and notions of the Popperian Three Worlds and transforming information into real knowledge. In addition, they are a very useful didactic tool for transcending from particular information to instruments of knowledge and generalizations that allow understanding the world. Figure 3 shows the conceptualization of the mentefact.

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2.2 Learning Achievements

According to José Brito (2019) "a learning achievement is the action (ability) and, sometimes, the operation (skill), which is manifested in its execution, realization or performance" (p. 1) as a direct consequence of a teaching-learning process for the acquisition of a competence. On the other hand, Kennedy (2007) states that "learning achievements anticipate what students will be able to do with the learning, under what conditions they will do it, and suggest evaluation criteria" (p. 19). These achievements guide the choice of the evaluation system, the selection of teaching content, teaching and learning strategies and activities, as well as the selection and use of resources.

For the Ministry of Education of Ecuador (2019) the learning achievements.

> They are those that identify the capacities associated with the areas of knowledge, practices and experiences of the area and/or subject in the corresponding sublevel; they constitute the previous steps towards the achievement of the general objectives of the area. The objectives of the area by sub-level cover the set of learning of each area in the corresponding sub-level. (p. 21)

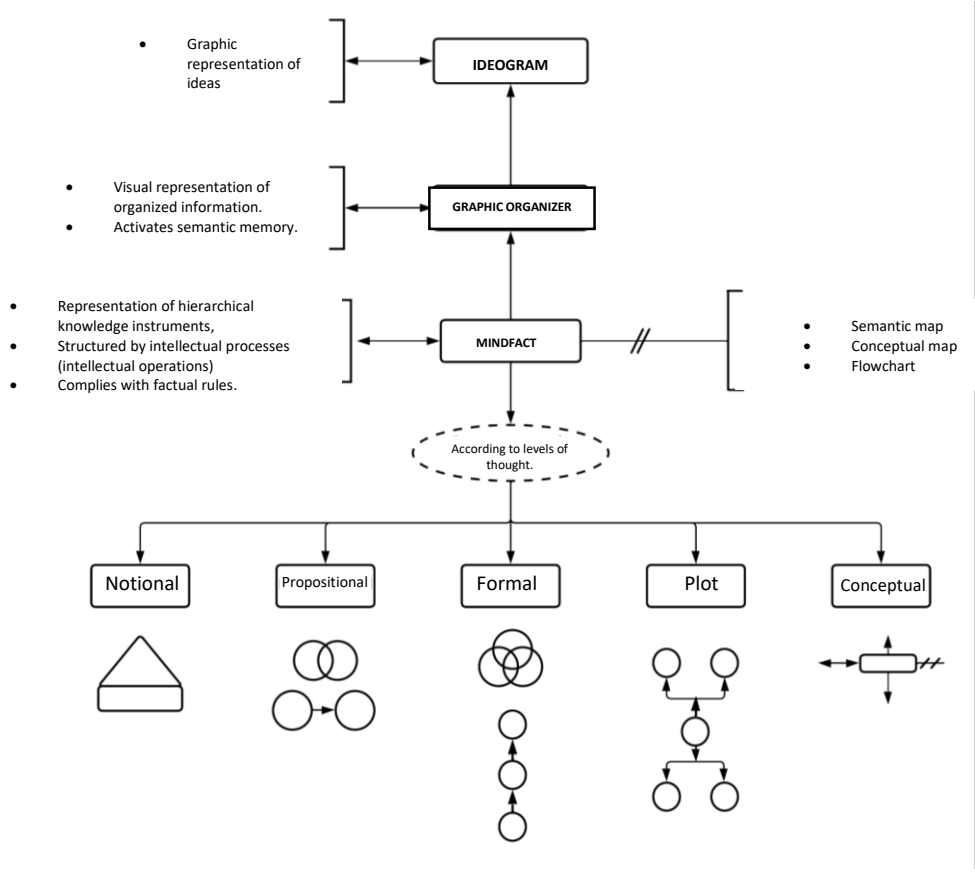

Figure 3. Conceptualization of mentefact. Adapted from: De Zubiría et al., 2019

In the case of Conceptual Pedagogy, curricular characteristics are defined by learning achievements, which include the acquisition of knowledge, skills and formative competencies. This pedagogical model is context-focused and interdisciplinary. In addition, it focuses on the needs of the labor market, unlike the traditional curriculum that focuses

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only on the knowledge to be transmitted to students. Moreover, according to the European Center for the Development of Vocational Education and Training (2011) "the definition of learning achievements promotes teaching and learning practices in different places and through different strategies, always learner-centered" (pp. 3-4).

For learning achievements to become the "generic outcome statements of what a learner is expected to have achieved at the end of a level of learning" (Moon, 2004, p. 3), emphasis should be placed on the learner's ability to perform an action, expressing it in terms of the human dimensions: affectivity, cognition and praxis. Each outcome should include a single action verb, followed by its complement and a context sentence. Precision in the wording implies avoiding ambiguous terms such as knowing, comprehending, learning or understanding; being related to the competencies selected and adapted to the educational level. In addition, they should be stated in such a way that the degree of acquisition by the students can be checked. According to Royo (2010) "to formulate them, it is necessary to include a verb that indicates the action, one or several terms for the object of the action, and others to express the level of detail, character or context of the execution" (p. 20).

2.3 Learning assessment

Evaluation is a key element that indicates the level of achievement of the established purposes, the effectiveness of teaching, students' progress and the effectiveness of the didactic resources used. In addition, it allows reflection on the planning and development of the educational process (De Zubiría et al., 2019). According to Julian De Zubiría (2015)

> evaluation must contemplate the three human dimensions. In this sense, a description and explanation of the current level of development is required, taking into account the context and the personal, social and family history of the person being evaluated. In addition, it is important to prioritize the assessment of modifiability and to recognize that assessment is necessarily an intersubjective process. The quality of the assessment is based on the proposed objectives having appropriate criteria and instruments, so that the diagnosis allows the selection of the most appropriate option (pp. 233-241).

Experts in educational assessment assign three purposes: to diagnose, to form and to add up.Standardized tests are considered a valuable tool for assessment, as they have been used and maintained according to educational and social needs for content standardization. According to George-Reyes (2020) "these tests are used to verify the learning achieved by students, as well as to obtain indicators to compare the educational systems of different regions or even countries" (p. 420).

For the design of standardized assessments, a methodological framework is defined to make the assessment operational and to provide precise guidelines for structuring the instrument. This methodological framework contains information on the types of assessment, items, instruments, scoring rule, cut-off points and assessment time, as shown in Table 2. (INEVAL, 2021, pp. 11-14).

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Component	Property
Target population	Characterization of the subjects to whom the evaluation will be applied, considering age group and referential number of the target population.
Type of assessment	Identification of the purpose of the evaluation according to the evaluating agent, the use of results or the moment of application.
Type of items	Selection of the type of item, number of plausible answers and number of correct answer options.
Number of items	Determination of the number of items proposed.
Type of instrument	Establishment of the type of instrument to be used in the evaluation.
Time of assessment	Specification of the duration of the evaluation based on data from past evaluations or pilot evaluations.
Cognitive levels	Specification of the cognitive levels of the taxonomy or theory to be used, as reflected in the instrument.
Calculation of cut-off points and scoring rule	Indication of the minimum cut-off point above which the subject will be considered to pass or fail the evaluation, including the qualification rule.
Evaluating agent	Definition of the person or institution that will apply the evaluation instrument; in case there are different roles, the function of each participant is described.
Application considerations	Establishment of the necessary regulations to guarantee adequate levels of reliability in the application of the evaluation according to the population and the modality of application of the instrument.

Table 2. Components of the methodological framework for a standardized assessment. Adapted from: (INEVAL, 2021, pp. 11-14)

2.4 Pandemic Education

The covid-19 health crisis forced governments to implement control measures to reduce the spread of the virus, such as social isolation (Fong et al., 2020, p. 977), suspension of economic activities (Rahman et al., 2020, p. 2), mandatory use of masks, border closures (Lau et al., 2020, p.8), reduction of transportation services (Tirachini and Cats, 2020, p. 15) and, of course, discontinuation of face-to-face mode in educational institutions (Crawford, 2020, p. 20).

Despite this, educational institutions have implemented strategies to continue academic programs through virtual education. However, this modality presents problems such as the lack of technological resources on the part of students, reflecting the economic limitations they face and restricting their access to connectivity and digital media at home. In addition, for Sánchez-Almeida et al (2021) “mandatory social isolation as a preventive measure also affects the performance of students in virtual environments, as well as in the emotional sphere and in the family environment” (p. 695).

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Thus, this opens the debate on the possible benefits and risks of excessive exposure of students to technologies due to online education. Torres-Toukoumidis et al. (2021) highlights "the lack of dynamics and practical interactions and admits that this modality does not provide a safe environment to develop thinking and comprehension skills" (p. 3).

Compared to more conventional pedagogical approaches, where teaching is done unilaterally from teacher to student (implying passivity), virtual or blended environments encourage more interactive communication between both parties. However, to achieve this, active techniques that promote more participatory learning must be applied, otherwise the potential offered by ICTs would be wasted. The construction of knowledge in these virtual environments highlights the importance of collaboration and mutual support among members of the educational community, which contributes positively to teaching and learning, as well as to the intellectual enrichment of all those involved. In fact, Hinojo & Rodríguez Fernández (2012) state that many of the new educational strategies are based on cooperation in learning, such as group learning, peer tutoring or collaborative learning (p. 162).

3. Methods and instruments

3.1 Research design

The present research used a transectional non-experimental quantitative approach. This was because no variables or study categories were manipulated and a single measurement was made through the application of the Assessments of Appropriation of Apprehension Achievement in the subject of Physics. In addition, a correlational-causal approach was used to define the relationships between the modality of study and the level of appropriation of learning achievement at a single point in time, establishing causal explanations (Álvarez, 2020; Huaire, 2019).

3.2 Population

The group of participants in this study were students from Eighth Grade of General Basic Education (EGB) to Third Grade of General Unified Baccalaureate (BGU), legally enrolled, and 442 students took the assessments of Appropriation of Learning Achievement in the subject of Physics, whose distribution by level and modality is shown in Table 3.

Grade	Students in Semi attendance	Students in Virtuality	Total
Eighth Grade EGB	29	50	79
Ninth EGB	43	44	87
Tenth EGB	42	44	86
First BGU	48	24	72
Second BGU	21	47	68
Third BGU	30	20	50
Total	213	229	442

Table 3. Population distribution

One student was excluded from this group, who has curricular adaptations of level III, because he has medical conditions related to Refractory Epilepsy with Intelligence Quotient (IQ) of 73.

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3.3 Data Collection Techniques and Instruments

For this research, the Assessments of Appropriation of Learning Achievement were used as the main instrument. The Lev Vygotsky Educational Unit carried out a face-to-face evaluation of the basic subjects with the objective of analyzing the impact of the blended and virtual classes on the students. The results of the evaluation made it possible to establish comparisons on the academic performance of both populations and conclusions were reached that have been useful for the design and development of an Institutional Educational Quality Improvement Plan. The evaluations sought to verify the levels of appropriation of the knowledge instruments developed in the subjects, but this research focuses on the results obtained in the subject of Physics during the first quarter of the 2021-2022 school year.

3.4 Procedure

The instrument was designed according to *the Learning Achievement Appropriation Assessment Plan Matrix*. The mediators recorded the learning achievement to be evaluated, together with the corresponding code for its identification, the level (Elementary, Basic and/or Advanced) and the type of achievement (Praxeutic or Cognitive), as well as the wording of the question and the response options. Each instrument consisted of 20 multiple-choice questions with 4 response options, only one of which was true. The questions were grouped by themes, covering several levels and distributed as follows: 10 items on elementary level apprehension achievement, 7 items on basic level apprehension achievement, and 3 items on advanced level apprehension achievement.

The items were structured with the objective of demonstrating students' appropriation and applicability of knowledge, avoiding focusing only on the application of formulas or memorization without reasoning. In addition, cumulative evaluations were carried out, which included all the contents addressed during the first quarter of the 2021-2022 school year.

Once the Planning Matrices were elaborated, the teachers sent to the assistant principals of each level to perform a first review and correction on the structure of the questions. Each reviewer analyzed whether the question was related to the topic proposed in the Pre-Learning Triangle, the Pre-Learning Achievement Matrix, the contents developed in the Pre-Learning Notebook and the measurement of applicability of the Intellectual Operations and/or Knowledge Instruments taught in class. In order to carry out this review, the Matrix to evaluate Instruments was used.

Once the planning was approved, the mediators created the evaluation instrument based on a template provided. Other mediators from the same field and teaching at other levels reviewed these documents. At this stage, it was verified that each question had only one answer and that it was related to the learning objectives set by the area for each level.

3.5 Data processing

For the treatment of the data collected in this research, the statistical software R was used, which is a language and environment for computational statistics (R Core Team, 2022). Several statistical tests were applied to compare the results of the evaluations between students who attended blended classes and students who attended virtual classes. First, the Kolmogorov-Smirnov test for two samples was used to verify whether the distribution of the data in both modalities was normal. Subsequently, Levene's test for homogeneity of variances with center at the median was applied to assume equality of variances between samples. Finally, the T-test for two independent samples was used to determine if there

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were significant differences between the results of both modalities, establishing a significance level of 0.05.

The data obtained were presented in tables and graphs to facilitate their understanding and analysis. In addition, descriptive analyses were carried out to calculate measures such as the mean, median and standard deviation of the results obtained in the evaluations. All statistical analysis was performed in accordance with the specific objectives and hypothesis stated in this research.

4. Results

After the application of the instrument, the database was organized in order to analyze the scores and create tables and graphs with the help of R software.

Figure 4 shows the results obtained in the evaluation of cognitive and praxical achievement, divided into 6 parts corresponding to the three levels of educational achievement evaluated. Each part of the graph represents the concentration of the number of successes according to the blended or virtual modality in each of the levels. In general, a similar trend can be noted between both modalities, where the number of correct scores in the basic and elementary cognitive achievement levels are quite similar; however, the blended mode presents a slight advantage in the basic and advanced achievement levels.

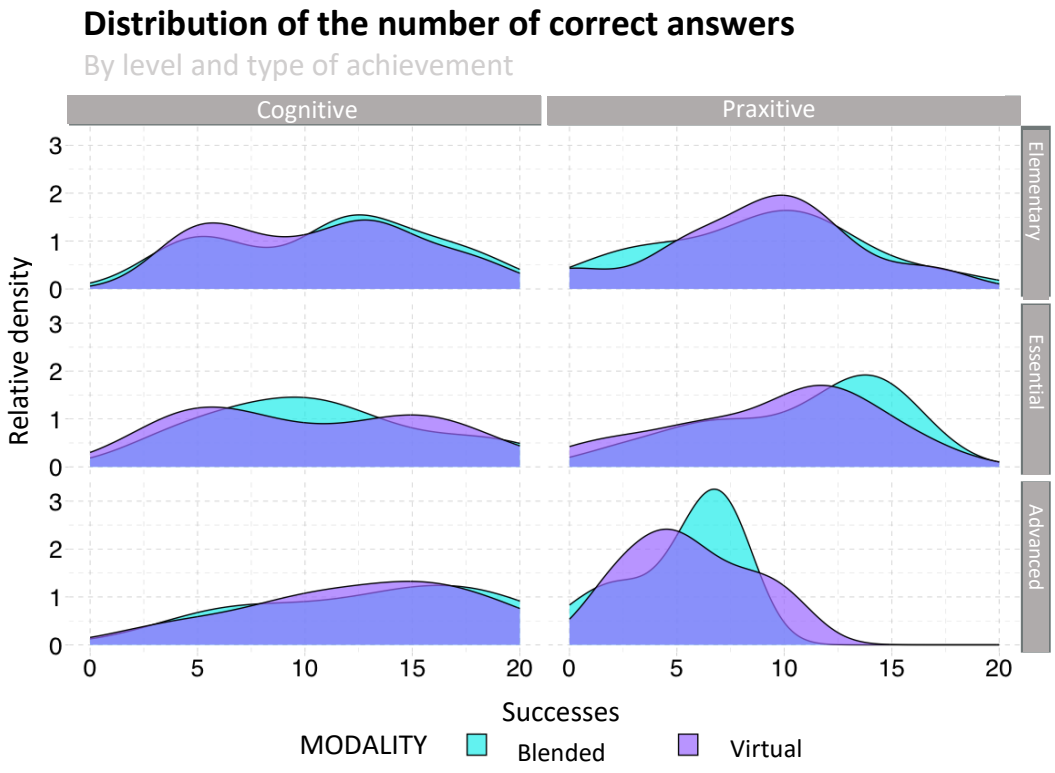

Figure 4. Percentage of successes according to modality, type and level of learning achievement

Figure 5 presents a comparison between the blended and virtual teaching modalities, in terms of the level of student learning achievement in the levels of Upper Basic and High School. In Upper Basic, a similar distribution can be observed in elementary and basic achievement, but with a slight advantage for the blended learning modality as of 10

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successes. As for advanced achievement, the virtual modality stands out with a prevalence in this category.

At the baccalaureate level, there is an uneven distribution in advanced achievement, but a higher proportion of correct answers is observed in the virtual modality. However, for elementary and basic level achievement, the distribution is more balanced between the two modalities.

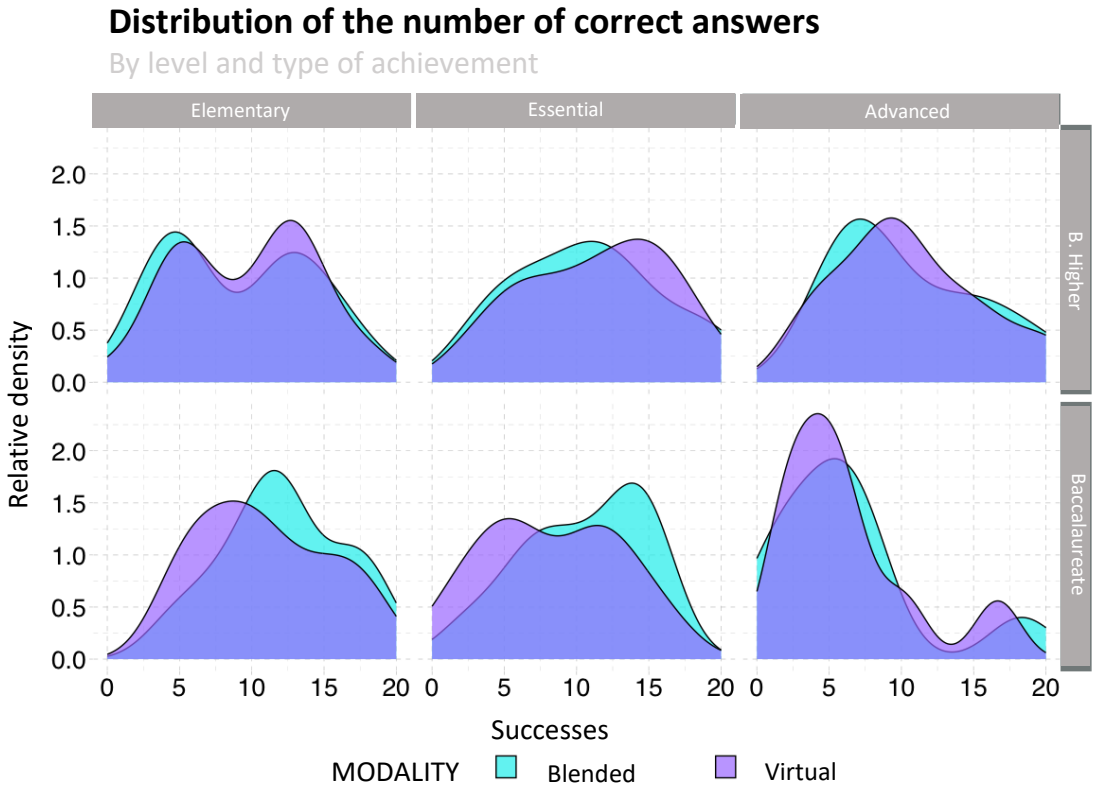

Figure 5. Percentage of successes according to modality, level of achievement and educational level

Figure 6 shows a graph divided into 12 parts, showing the results of students from different educational grades in relation to the levels of learning achievement. In Tenth grade, there is no significant difference between both modalities, but this distribution changes for the lower grades according to achievement level. In Bachillerato, the blended learning modality presents better results in most achievement levels, presenting very marked concentrations of successes.

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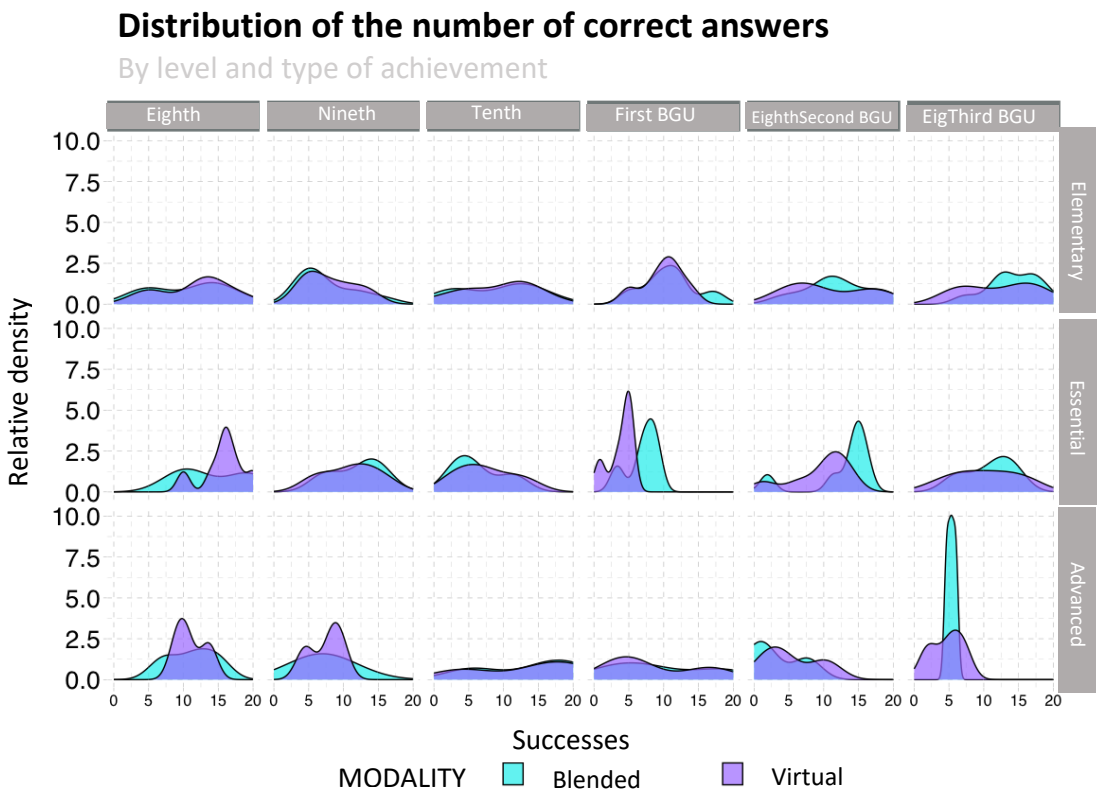

Figure 6. Percentage of successes according to modality, grade and level of learning achievement

Table 4 presents the results of three statistical tests carried out to evaluate the differences between the teaching modalities in terms of the hits obtained by the students. The purpose of these tests was to determine the normality of the sample distribution, as well as the differences in the variances and means of the scores according to the study modality.

Test	Objective	Value	p-value
Kolmogorov-Smirnov test for two samples	Compare the observed cumulative distribution function of hits by mode with a theoretical normal distribution.	D = 0.10833	0.482 < 0.05
Levene's test for homogeneity of variances with center at median	Calculate the equality of variances for the modality-dependent hits.	F = 4.3025	0.03913 < 0.05
T-test for two independent samples	Test whether the means of the modality-dependent hits are equal or not.	t = -0.5486	0.5838* > 0.05

Table 4. Statistical tests employed. (* presents a confidence interval of [-3.4814; 1.9647])

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5. Discussion

In this section, the results obtained through the analysis of the data collected in the study were discussed. The differences found between the teaching modalities in terms of cognitive and praxetive achievement were examined, and the possible reasons behind these differences were explored. In addition, the implications of these findings for online and face-to-face education were discussed, as well as recommendations for improving the quality of teaching in both modalities.

The perception of the blended modality as more effective relative to the virtual modality may be based on the fact that the in-person interaction and support provided in this modality may have a positive impact on student performance compared to the virtual modality. In addition, feedback is given in a better way in the blended mode, since the teacher can interact more directly with the student and provide a more personalized and effective response. However, it is important to keep in mind that the effectiveness of each modality may vary depending on factors such as the quality of the educational material and the teacher's ability to adapt to the online platform.

The results of the statistical tests indicate that the value of: D = 0.10833 and that, p-value = 0.482 >0.05, suggesting that the distribution is normal for Kolmogorov-Smirnov tests. Furthermore, for Levene's test that evaluates the homogeneity of variances between the two apprehension modalities, using the median as the center; the results showed that: F = 4.3025 and that, p-value = 0.03913 < 0.05, suggesting that it can be assumed that the samples are homocedastic.

Through the t-test for two independent samples, it is evaluated whether there is a significant difference in the hits obtained according to the study modality. The t-value obtained in the test was -0.5486, indicating that the difference between the means of the two groups is not significant. Furthermore, p-value = 0.5838 > 0.05, which means that, there is not enough evidence to reject the null hypothesis: the means of the hits are equal for both modalities. That is to say, no significant differences were found between the successes obtained by the students in the blended and virtual modalities in terms of their mean.

According to the results obtained in the evaluation of appropriation of learning achievements in both study modalities, there is no significant difference in the appropriation of these achievements by the students. It is important to emphasize that this similarity in the results is not due to differences in the environment or resources, but rather to the importance of the learning achievements as a guide for teaching. In this sense, the implementation of Conceptual Pedagogy, which emphasizes the clarity of learning objectives and their follow-up, may have contributed to the homogeneity of the results obtained in both study modalities.

The present investigation demonstrates that the study modality does not have a significant effect on the acquisition of learning. However, it is important to reflect on the importance of the didactic components that influence educational success. In this sense, a change in the current perspective is proposed, emphasizing the importance of teaching objectives or purposes, in order to then design pedagogical activities and strategies to achieve these objectives. Finally, special attention should be paid to the evaluation process, considering that it not only allows measuring the learning acquired, but also provides valuable information to provide feedback to the teaching process and adjust the objectives and strategies in a timely manner. In this way, the success of education can be guaranteed, regardless of the study modality used.

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In education, it is essential that students acquire knowledge, not just information. Knowledge refers to the deep and meaningful understanding of concepts, while information is simply the accumulation of data. The results obtained in learning depend on the development of the instruments of knowledge through mentefacts, that is, cognitive tools that allow the construction and understanding of complex knowledge. Therefore, it is important that teachers teach students how to structure information to consolidate knowledge and its applicability.

6. Conclusions

1. The covid-19 pandemic did not significantly affect the appropriation of learning achievements in the students of Higher Basic and Baccalaureate of the Lev Vygotsky Educational Unit in the subject of Physics, during the 2021-2022 school year.
2. The instruments designed and validated by experts are reliable and valid for the evaluation of learning achievements in the subject of Physics.
3. No significant differences were found in the appropriation of learning achievements between the virtual and blended learning modalities, with respect to the mean number of correct answers.
4. The hypothesis is partially accepted, since a slight advantage was found in the academic achievement of students who attended blended classes compared to those who attended virtual classes in basic and advanced achievement levels. However, no significant differences were found in the appropriation of learning achievements between the two modalities.

Among the limitations encountered, it should be noted that the assignment of students to the study modalities (virtual and blended learning) was not random but depends on factors such as the availability of technological resources or geographic location determined by the context of each student. On the other hand, the emotional situation of the students was not taken into account as an intervening variable, and it is possible that it influenced the results obtained and were not controlled in the study.

Based on the results and findings of this study, future research can be proposed taking into account a longitudinal study, in which the sample of students at different educational levels and in different areas of study is expanded, in order to evaluate whether the results obtained in this study are applicable to other subjects and educational levels. Likewise, the evaluation of the quality of virtual education can be deepened by means of a study that relates it to the factors that can influence its effectiveness, such as course design, interaction with the teacher, among others.

Bibliographic references

Brito Albuja, J. (2013). *Modelo pedagógico formativo* (1st ed., Vol. 1, pp. 7–51). Líderes Ediciones.

Brito, J. (2019). Resultados del aprehendizaje [Personal communication].

Castro, J. (2017, October 20). La matemática como la base lógica de pedagogía conceptual. II Congreso Internacional de Etnomatemática y II Simposio Internacional de Etnociencias.

Licencia Creative Commons Atribución 4.0 Internacional (CC BY 4.0)

CEDEFOP. (2011). Al definir los resultados del aprendizaje en los currícula, todos los alumnos cuentan. Nota Informativa, 9060 ES, 1–4. Centro Europeo para el Desarrollo de la Formación Profesional. https://www.cedefop.europa.eu/files/9060_es.pdf

Crawford, J. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. J*ournal of Applied Learning & Teaching, 3*(1), 1–20. https://doi.org/10.37074/jalt.2020.3.1.7

De Zubiría, J. (2015). *Los modelos pedagógicos*. Magisterio Editorial. (Original work published 2002)

De Zubiría, M. (2000). Pedagogías del siglo XXI: Mentefactos I: El arte de pensar para enseñar y de enseñar para pensar. Fundación Alberto Merani.

De Zubiría, M., Vinueza, T., Portero, R., Coral, L., Rosas, J., y Giraldo, J. (2019). Pedagogía conceptual: una puerta al futuro de la educación. Ediciones de la U.

George-Reyes, C. (2020). Pruebas estandarizadas y calidad de la educación en México, sexenio 2012-2018. *Universidad Y Sociedad*, *12*(4), 418–425. http://scielo.sld.cu/scielo.php?pid=S2218-36202020000400418&script=sci_arttext&tlng=en

Hinojo, M. A., y Rodríguez Fernández, A. (2012). El aprendizaje semipresencial o virtual: nueva metodología de aprendizaje en Educación Superior. *Revista Latinoamericana de Ciencias Sociales, Niñez Y Juventud*, *10(*1).

Huaire, E. (2019). Método de investigación. Acta Académica. https://n2t.net/ark:/13683/pY8w/w8Y

INEVAL. (2021). Elaboración y validación de modelos y estructuras de evaluación. INEVAL.

Kennedy, D. (2007). Redactar y utilizar resultados de aprendizaje. University College Cork.

Ministerio de Educación del Ecuador. (2019). Currículo de los Niveles de Educación Obligatoria Nivel bachillerato *1*, 20–23. Ministerio de Educación del Ecuador.

Moon, J. (2004). Linking Levels, Learning Outcomes and Assessment Criteria [In-Person]. 1–30. https://www.ehea.info/media.ehea.info/file/Learning_Outcomes_Edinburgh_2004/77/4/040701-02Linking_Levels_plus_ass_crit-Moon_577774.pdf

Popper, K. R. (1996). In search of a better world (pp. 17–49). Psychology Press.

Royo, J. (2010). *Un modelo de guía docente desde los resultados de aprendizaje y su evaluación.* Universidad de Zaragoza. https://ice.unizar.es/sites/ice.unizar.es/files/users/leteo/bibliografia/modelo_guia_docente.pdf

Sánchez-Almeida, T., Naranjo, D., y Reina, J. (2021). Análisis del desempeño académico de estudiantes de una institución de educación superior en Ecuador, antes y durante la pandemia - [Analysis of the academic performance of students from a higher education institution in Ecuador, before and during the pandemic]. Innovaciones

Licencia Creative Commons Atribución 4.0 Internacional (CC BY 4.0)

Docentes En Tiempos de Pandemia. VI Congreso Internacional sobre aprendizaje, innovación y cooperación. https://doi.org/10.26754/cinaic.2021.0136

Tirachini, A., & Cats, O. (2020). COVID-19 and Public Transportation: Current Assessment, Prospects, and Research Needs. Journal of Public Transportation, 22(1). https://doi.org/10.5038/2375-0901.22.1.1

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