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The quantitative and qualitative rubric in algebraic operations learning assessment in students of eighth year of general basic education

La rúbrica cuantitativa y cualitativa en la evaluación del aprendizaje de las operaciones algebraicas en estudiantes de educación general básica

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Abstract

This article analyzes the importance of designing a taxonomic rubric to assess the learning of algebraic operations in eighth-grade students in basic general education. The manuscript



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posits as a fundamental problem the lack of application of rubrics as an assessment tool that allows students to develop the skills, competencies, and abilities acquired in mathematics. To address this problem, the author designs a didactic guide for designing a taxonomic rubric that employs the Marzano and Kendall taxonomy, which focuses on mental processes and memory related to the information students acquire. It clarifies some guidelines regarding the principles and types of assessment, the learning cycle, and the assessment of learning in mathematics. It explains the characteristics, elements, and types of rubrics, the domains of learning, and the taxonomic levels with a view to achieving appropriate assessment. This research employs a mixed-methods approach, combining qualitative and quantitative methods, supported by various documentary and field sources, and includes a correlational scope, thus providing an existing perspective on the problem. Relevant findings include the deficiency in the use of rubrics due to the lack of information and descriptors to guide the evaluation process in order to achieve a detailed learning outcome, change the action of evaluating to valuing, experience changes in motivation and participation, and ultimately, rediscover the desire to learn with appropriate evaluation instruments.}

Keywords

Educational assessment, teaching guide, algebraic operations, quantitative rubric, qualitative rubric, Marzano and Kendall taxonomy.

Resumen

El artículo analiza la importancia del diseño de la rúbrica taxonómica para evaluar el aprendizaje de las operaciones algebraicas en estudiantes de octavo año de educación general básica. El manuscrito plantea como problema base la falta de aplicación de rúbricas como instrumento de evaluación que permiten a los estudiantes desarrollar las destrezas, competencias y habilidades adquiridas en el área de la matemática. Ante este problema el autor diseña una guía didáctica para el diseño de la rúbrica taxonómica que emplea la taxonomía de Marzano y Kendall orientado a los procesos mentales y la memoria sobre la información que va adquiriendo el estudiante. Aclara algunas pautas acerca de los principios y tipos de evaluación, ciclo del aprendizaje y la evaluación del aprendizaje en matemática. Explica las características, elementos y tipos de rúbricas, los dominios del aprendizaje y los niveles taxonómicos con miras a alcanzar una evaluación adecuada. Es una investigación con un enfoque cualitativo y cuantitativo que se respalda con varias fuentes de tipo documental, de campo y un alcance correlacional así logra una perspectiva existente de la problemática. Como hallazgos relevantes están la falencia en la utilización de la rúbrica debido a la falta de información y descriptores que guíe el proceso de evaluación con la finalidad de lograr un resultado detallado del aprendizaje, cambiar la acción de evaluar por valorar, experimentar cambios en la motivación y participación, en definitiva, redescubrir el deseo por aprender con instrumentos de evaluación apropiados.

Palabras clave

Evaluación educativa, guía didáctica, operaciones algebraicas, rúbrica cuantitativa, rúbrica cualitativa, taxonomía de Marzano y Kendall.

1. Introduction

The level of education in Ecuador reached a turning point with the 2020 pandemic, bringing about a radical shift in the methodology, content, and resources used for teaching. Thanks to significant technological advancements, the renowned artificial intelligence emerged in



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2022, capable of generating concrete answers to any question in seconds. In some ways, the development of this autonomous tool has devalued critical thinking, human judgment, and analytical skills due to the availability of pre-processed responses.

In education, assessment has traditionally focused on the grade of a final product or result, neglecting the development of genuine student learning. Similarly, the adaptability of digital educational resources has changed how we learn and has also fostered a reliance on applications that cater to the whims of completing assignments.

In Ecuador, teachers face a challenging process in applying assessment techniques, methods, and instruments that not only measure final results but also the process involved in achieving meaningful learning. Thus, rubrics are seen as an alternative that surpasses traditional assessment due to the advantages the tool provides. Well-implemented rubrics are instruments structured with clear criteria for evaluating an activity. Subject to various descriptors, they measure the step-by-step process of each partial achievement with a defined rating scale for each level. The final grade provides a broader perspective for identifying strengths and weaknesses during the learning process, supported by timely feedback. The assessment guidelines propose the regulations that must be followed in the Teaching and Learning Process (TLP), considering assessment not as an end in itself but as a means to improve educational processes. The goal is the student's holistic development through appropriate support and feedback at each stage of learning, determined by the teacher's high capacity, competence, and professionalism.

In mathematics, the usefulness of an assessment tool that values the process is essential; currently, students arrive at the answer using any application, but they are unaware of the process followed to arrive at that answer. For this reason, the rubric, with its taxonomic approach, allows for the demonstration of the development of skills that the student acquires in solving a problem or exercise. The rubric's value lies in its integration of Marzano and Kendall's taxonomy, which focuses on the development of thinking across six levels, emphasizing gradual learning. The incorporation of metacognition allows students to engage in deep reflection, as do cognitive, procedural, and attitudinal processes. This promotes the value of learning styles and leads to a more effective and meaningful evaluation.

Methodologically, this study has applications in education globally and specifically in the area of mathematics, encompassing the evaluation guidelines established by the Ministry of Education of Ecuador for student learning. It presents a qualitative and quantitative approach in a narrative, rather than experimental, manner. The method is interpretive for understanding the problem, and the scope is correlational in predicting a result. The research is documentary and field-based, culminating in a proposed didactic solution.

The manuscript is comprised of three sections: the first presents the theoretical framework explaining the research topic; specifically, it provides a conceptual explanation of the characteristics, types, and digital educational resources that generate rubrics as assessment tools in Mathematics. The second section explains the methodology used in the research process. The third section presents the results obtained from exploring the problem in relation to the characteristics of the research instrument, namely the rubric, as well as its application in learning assessment and the contribution of a guide for designing taxonomies and rubrics in the field of Mathematics.



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2. Literature review

This research aimed to analyze the usefulness of rubrics in mathematics education. It examined previous studies in the field of education related to the design of assessment instruments that offer a detailed perspective on learning. The theoretical framework addresses the study variables using information sources appropriate to the research problem.

2.1 The rubric

A rubric is a tool used to evaluate an activity or task according to specific parameters. Fraile et al. define it as a document that details a task according to certain evaluation criteria corresponding to a level of quality and assigning a grade (Fraile et al., 2017, p. 1328). From this perspective, a rubric is presented as a matrix that describes an action or set of actions using criteria that serve as a guide for assessing progress, and a grade related to the level of complexity can be assigned.

2.1.1 Elements of a rubric

A rubric is a matrix containing key elements for its correct application. In the process of developing a rubric, it is essential to define the descriptors, the rating scale, and the criteria (Gatica-Lara & Uribarren-Berrueta, 2013, p. 64). These components form three essential parts that must be logically and coherently interconnected to facilitate the effective evaluation of learning outcomes, as shown in Table 1.

Criteria Concepts/Categories	Scales/Levels of performance			
	4	3	2	1
Aspects to be evaluated	Descriptors Evidence to be obtained	Descriptors Evidence to be obtained	Descriptors Evidence to be obtained	Descriptors Evidence to be obtained

Table 1. Key elements of a rubric. Source: (Gatica-Lara and Uribarren-Berrueta, 2013, p. 62).

2.1.2 Types of rubrics

Rubrics are defined in two main groups: analytical rubrics and holistic rubrics. These differ in their design, elements, and final results, as detailed below: Analytical rubrics offer a more detailed perspective compared to holistic rubrics, which provide a more general overview. Fraile et al. specify that analytical rubrics are more precise in their criteria, levels, and qualitative descriptions, while holistic rubrics are more general and do not highlight strengths and weaknesses (Fraile et al., 2017, p. 1328). As they explain, the application of a rubric depends on what is being evaluated, considering either the detailed process or the final product. If the goal is to identify strengths and weaknesses, an analytical rubric should consider a specific overview of the process. If the goal is to assess a final activity, a holistic rubric, which provides a comprehensive overview, should be used. Finally, the differences between each type of rubric are described as shown in Figure 2.



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Holistic	Analytical
Integrates the student's performance.	Part of the student's performance.
Levels of achievement focused on quality.	Levels of achievement focused on improvement.
Less time required to grade.	More time required to grade.

Figure 1. Differences between the holistic and analytical rubrics. Adapted from: (Gatica-Lara and Uribarren-Berrueta, 2013, p. 62).

2.2 Taxonomic rubric criteria

The taxonomic rubric has been proposed in the field of Mathematics to clearly define the level at which the indicators are intended to be achieved. There must be complete coherence between this level and the verbs used to assess mathematical learning (Tipán-Renjifo, 2022). The evaluation criteria are based on levels of increasing complexity, which are related to the taxonomy. Atonal argues that taxonomies allow for the classification of cognitive processes involved in learning, organizing them into levels that correspond to different degrees of mental complexity. These are structured around domains of knowledge that include everything from basic memorization skills to higher-level processes such as analysis, evaluation, and creation. Furthermore, the author emphasizes that the difference between the levels lies in the degree of difficulty of the mental process required for each one, which allows for more effective planning of learning objectives (Atonal, 2020, p. 86).

A detailed process is easy to understand when the actions to be followed are prioritized and systematized. In education, taxonomies are key for setting objectives and developing skills for student learning. Bloom's and Marzano-Kendall's taxonomies are the most widely used to ensure students' appropriate cognitive development.

In assessment, congruence between what is taught and what is learned is important for the application of an assessment instrument. Atonal explains the use of a taxonomy for assessment, stating that taxonomic levels link innate abilities in individuals (Atonal, 2020, p. 99). He also affirmed that during learning, progress is evident with a hierarchy of actions to be completed, highlighting skills and competencies acquired in relation to critical thinking, as shown in Figure 2.



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BLOM Learning objectives: <ul style="list-style-type: none"> - Remember - Understand - Apply - Analyze - Evaluate - Create 	MANZANO Information processing <ul style="list-style-type: none"> - Self-system - Metacognitive - Cognitive 	SOLO Understanding <ul style="list-style-type: none"> -Pre-structural -Uni-structural -Multi-structural -Relacional -Extended abstract
FINK Significant learning <ul style="list-style-type: none"> -Foundational knowledge -Application -Integration -Human dimension -Caring -Learning to learn 	WEBB Thinking complexity:- <ul style="list-style-type: none"> Rote/Memorization -Processing -Strategic -Extended 	ANDERSON Y KRATHWOHL Separates knowledge and process: <ul style="list-style-type: none"> -Factual -Conceptual -Procedural -Metacognitive

Figure 2. Types of taxonomies and levels. Adapted from: (Atonal, 2020, pp. 86-92).

2.2.1 Rubric Criteria for an Evaluation

The rubric, as an assessment tool, has its own structure that allows it to focus on a specific task. As Garcia-Valcarcel et al. mention, several criteria are related to the performance levels that define the quality of learning to be assessed. Furthermore, these levels allow for the establishment of clear descriptors that guide both the teacher and the student regarding what is expected to be achieved in each phase of the assessment process (Garcia-Valcarcel et al., 2020, p. 74). Consequently, the identification of criteria in an assessment will depend on the desired level within the assessment context, thus fostering self-assessment and peer assessment, which represents an achievable goal. The criteria highlighted in Figure 3 are shown below.

Student Reflection <ul style="list-style-type: none"> -Formative value - Achievement or failure in objectives 	Construction Value <ul style="list-style-type: none"> -Teacher-student interaction -Performance improvement 	Deep Learning <ul style="list-style-type: none"> -Concrete expectations - Quality
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Figure 3. Criteria to consider in the evaluation with a rubric. Adapted from: (Garcia-Valcarcel et al., 2020, p. 75)

2.3 Principles of Evaluation

Assessment is understood as a systematic process of gathering information that allows for the evaluation of student learning within a given educational context. To maintain its pedagogical character, it must be based on principles that guide its purpose, structure, and application. Sánchez-Mendiola and Martínez-González state that effective assessment requires clarity in the objectives to be evaluated, the use of methods appropriate to the learning context, and a variety of instruments that promote a comprehensive assessment of performance. They also emphasize that assessment should be understood as a means to support the continuous improvement of the educational process, not as an end in itself. These principles are essential for promoting fair, formative assessment practices aligned with learning objectives (Sánchez-Mendiola & Martínez-González, 2022, pp. 17-21).



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Likewise, the characteristics of educational assessment are related to student learning, starting with the question every teacher has thought about: "What am I going to assess?" This central axis is accompanied by appropriate techniques, strategies, and instruments that provide a current understanding of the student's knowledge acquired in class, as demonstrated in an assessment.

2.3.1 Evaluation criteria

Assessment criteria allow for the identification of achievement levels through clear and objective benchmarks that guide the evaluation of learning. They act as a bridge between educational objectives and the evidence gathered in the classroom, strengthening curricular coherence. Furthermore, they guide pedagogical decision-making and promote the continuous improvement of the learning process (Sánchez-Mendiola & Martínez-González, 2022, pp. 21-23). In the case of assessing algebraic operations using quantitative and qualitative rubrics, these criteria allow for the establishment of precise descriptors that guide both teachers and students toward the achievement of clear and measurable mathematical competencies.

2.3.2 Evaluation indicators

Assessment indicators allow us to observe and evaluate the degree of development of a competency or expected learning outcome through clear descriptions of student performance. In this sense, Gatica-Lara and Uribarren-Berrueta argue that assessment criteria, also called indicators or guides, are essential elements in rubric design, as they reflect the processes and content deemed significant for educational achievement. These must be accompanied by quality definitions that specify what the student should demonstrate at each achievement level and scoring strategies that allow us to distinguish between exemplary and emerging performance (Gatica-Lara & Uribarren-Berrueta, 2013, pp. 62-64). Applying this structure to mathematics, and particularly to the learning of algebraic operations, allows us to construct clear, objective, and formative rubrics that guide both the teaching, and the assessment of student progress based on observable and measurable evidence.

2.3.3 Types of Evaluation

In the academic sphere, assessment is an essential element of the teaching-learning process. It not only allows for the evaluation of student results but also generates relevant information for adjusting and improving pedagogical interventions. According to Sánchez and Martínez, educational assessment should be conceived as a systematic, continuous activity integrated into the learning process, fulfilling diagnostic, formative, and summative functions. Diagnostic assessment aims to identify prior knowledge, skills, and attitudes at the beginning of an educational cycle; formative assessment focuses on supporting learning by providing constant feedback; and summative assessment allows for the evaluation of achievements at the end of a unit or period (Sánchez-Mendiola & Martínez-González, 2022, pp. 17-23). This comprehensive view of assessment is fundamental for designing and implementing instruments such as quantitative and qualitative rubrics in mathematics, as it facilitates a more complete and contextualized evaluation of the learning of algebraic operations in eighth-grade students.

This perspective is especially relevant in the context of assessing algebraic operations. The implementation of quantitative and qualitative rubrics requires continuous, flexible evaluation focused on the student's actual learning, rather than solely on the final grade. At the end of the educational process, there is the summative assessment, which aims to evaluate all the knowledge acquired over a period of time. Its objective is to measure



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achievements and whether or not the learning objectives established in the respective lesson plans were met. The final summative assessment helps inform decisions regarding adjustments to the methodology or the overall lesson plan.

2.3.4 Evaluation Moments

Assessment in education unfolds in three fundamental phases: diagnostic, formative, and summative. These stages fulfill specific functions within the teaching-learning process, facilitating more effective pedagogical intervention focused on the student's needs. As Sánchez and Martínez point out, each type of assessment has a distinct purpose and is applied at different points in the educational process. These are represented schematically in Figure 4, which illustrates the sequence and relationship of the three phases within the assessment cycle (Sánchez-Mendiola & Martínez-González, 2022, p. 60).

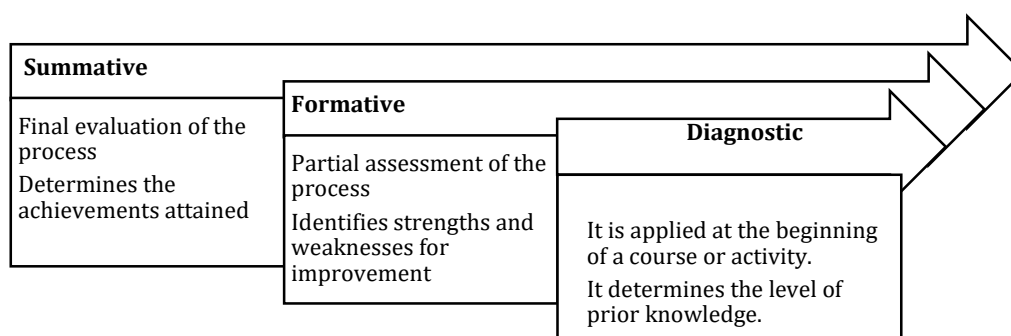


Figure 4. Evaluation moments. Adapted from: (Sánchez-Mendiola and Martínez-González, 2022, pp. 21-22)

2.3.5 Comprehensive Assessment in Mathematics

Comprehensive assessment in mathematics represents an approach that goes beyond simply measuring theoretical or mechanical knowledge. This type of assessment seeks to holistically evaluate students' competencies, considering both their conceptual understanding and their ability to apply content in real and meaningful situations. According to Castillo-Arredondo and Cabrerizo-Diago, a truly formative mathematics assessment should include different levels of analysis, from identifying basic procedures to solving complex problems, integrating logical reasoning, the use of mathematical language, data interpretation, and the ability to transfer learning to everyday contexts. This perspective allows for the evaluation not only of mastery of formulas and algorithms, but also of students' ability to interpret, argue, and make well-founded decisions from a mathematical perspective (Castillo-Arredondo & Cabrerizo-Diago, 2010, pp. 268-270). In this sense, the comprehensive approach contributes to the development of critical thinking and learner autonomy, key aspects for an education oriented toward performance and the resolution of real-world problems. One of the key aspects of a comprehensive assessment is the inclusion of activities that strengthen students' critical thinking and creativity. Problems should be presented that are relevant to everyday life to encourage logical problem-solving. Furthermore, the assessment allows for self-assessment and peer assessment among students, strategies that enable them to reflect on their own learning and receive feedback.



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2.3.6 Assessment of Mathematics Learning

In mathematics, the assessment of learning is of vital importance and can be carried out in various ways, such as written exams, practical tests, projects, and ongoing formative assessments. Ongoing assessments tend to be the most widely used, offering teachers the opportunity to identify areas for improvement or reinforcement, or to provide feedback on student knowledge.

2.3.7 Skills assessment

In the field of mathematics, skills-based assessment has emerged as a key methodology for evaluating learning because it focuses on measuring practical skills and specific competencies of each student. This approach to teaching emphasizes evaluating not only what students know, but also what they can do with the knowledge they have acquired. Skills-based assessment aligns with the societal shift of recent years, where practical skills and the ability to apply knowledge in everyday situations are highly valued. Thus, skills-based assessment goes hand in hand with the needs of the job market and various requirements of companies, which seek individuals who not only possess the knowledge, but also know how to apply it and put it into practice when solving problems.

The fundamental or most notable characteristic is its focus on authenticity. Assessments often involve projects, case studies, and simulations. They promote critical thinking, problem-solving, and self-assessment—essential competencies for today's world, where students must be able to adapt to new situations, innovate, and think critically and objectively.

2.3.8 Competency-Based Assessment.

Competency-based assessment refers to the combination of knowledge, skills, attitudes, and values that students need to perform in different aspects of their professional field. The shift to competency-based assessment implies a change in how teaching and learning are conceived and carried out. One of the main characteristics of competency-based assessment is the authenticity of the students; assignments, tests, and everything submitted are based on a real-world context, giving students the opportunity to demonstrate their competence in contexts in which they operate. This increases the relevance and importance of the learning. Furthermore, education becomes continuous and formative, providing students with regular feedback throughout the teaching and learning process, where students are responsible for their own progress. It also requires a more personalized approach to teaching; teachers not only develop specific competencies but must also adapt to the individual needs and contexts of their students.

In today's world, where technological evolution and scientific advancement are progressing exponentially compared to previous decades, competency-based assessment is gaining greater relevance. Educational institutions now seek to ensure that individuals not only possess practical knowledge related to different subjects, but also that they can apply it innovatively to problem-solving or innovation.

3. Methodology

This research has a broad scope in education and a specific focus on mathematics. It presents an interpretive method that aims to reveal the behavior of educational stakeholders in the learning process, guided by evaluation criteria. The study context allows for the exploration of visible behavioral changes in the phenomenon, with the final results presented in a positive light in the conclusions, enabling the generalization of the situation.



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The quantitative phase handles the non-experimental aspect through observation of the existing study situation, supported by the calculation of Cronbach's alpha, data tabulation, and the necessary numerical results. The qualitative phase employs a narrative approach through the analysis of the collected information, providing a general and specific view of the study situation based on the results of applying the data collection instruments.

The study variables are related within the educational field by calculating Pearson's correlation coefficient, which determines the degree of direct or indirect association. It is inferred that the evaluation instrument modifies the way specific content is learned, as reflected in the final results obtained. Designing a tool that provides a better overall or specific perspective on learning assessment will positively or negatively influence the student, taking into account their context. Furthermore, it draws on the expertise of students experiencing the current state of educational assessment as a primary source, supported by a review of online documents with research validity as a secondary source, and fieldwork through direct observation of the issues, accompanied by the application of instruments that gather the necessary information for the study.

3.1 Population and Sample

Two hundred students from the upper sub-level of Basic General Education enrolled in the 2023-2024 academic year were considered, forming the entire population. Due to the number of individuals, the population is considered as the sample for the information collection process, along with the five teachers from the Mathematics area detailed in Table 2.

Stratum		Educational institution
Students	Teachers	
40	1	Educational Unit Sagrados Corazones Centro
40	1	Intercultural Bilingual Community Educational Unit "Tinku Yachay"
40	1	Intercultural Bilingual Educational Unit Muyu Kawsay
40	1	American School of Quito
40	1	Educational Unit "Nelson Torres"
200	5	Total

Table 2. Population distribution.

3.2 Techniques for data processing and analysis

For collecting data from the student questionnaire, Google Forms survey management software was used due to its ease of access via a link. Subsequently, the database of all respondents was downloaded in Comma-Separated Values (CSV) format. Data tabulation and pie chart creation were performed using Microsoft Excel. Finally, the results were compiled and presented in a Microsoft Word document.

For the questionnaire for teachers, data collection was carried out through pre-scheduled interviews. Participants' responses were recorded and later transcribed into text format. Once all the information was gathered, the qualitative analysis software ATLAS.ti was used in AI mode to identify words and sentences that were congruent both with each other and with each of the questions posed. This process provided a clear and organized perspective for the study.



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4. Results

The results of the research validate the researcher's proposal to design rubrics that align taxonomic levels for appropriate assessment in mathematics. Using two instruments, the current situation regarding the application of assessment tools to 8th-grade students in basic general education is analyzed.

Figure 5 shows that 57% of students indicate that they only sporadically or never perceive a positive attitude toward the importance of achieving learning outcomes when a rubric is used in class. The rubric fosters the development of shared metacognitive skills between teachers and students (Alcón-Latorre & Menéndez-Varela, 2016). Assessment should focus on measuring what students are able to do with the acquired knowledge, building upon the meaningful learning developed in class. Furthermore, recognizing and motivating each partial achievement is an effective incentive for achieving overall success. Furthermore, the rubric offers a detailed view of each phase of the learning process, considering the completed achievements and allowing their verification in the final grades, thus favoring the articulation between the qualitative and the quantitative.

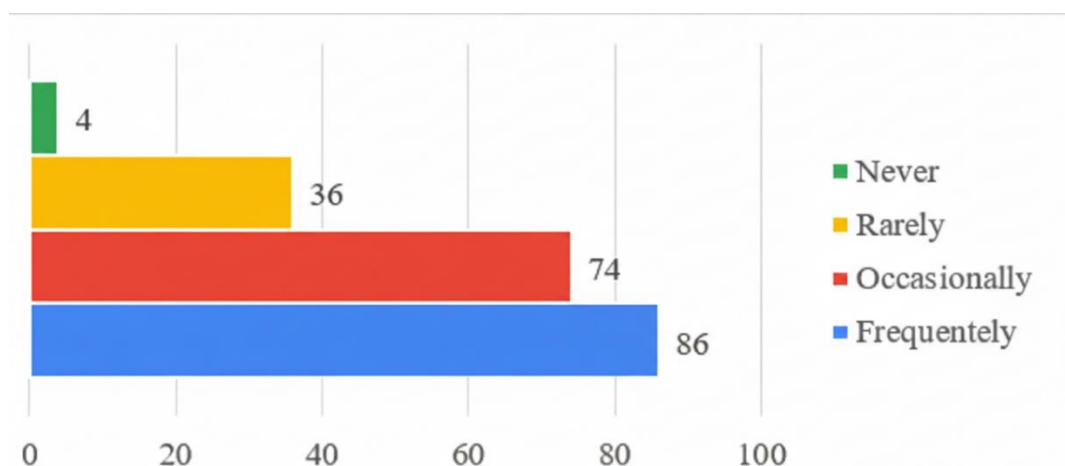


Figure 5. Use of the rubric to assess learning achievements.

Figure 6 shows that 52% of students indicate that they are unfamiliar with or have never used different assessment tools aligned with the learning process applied in teaching practice. The learning process varies among students due to their different learning styles; therefore, it is necessary to employ diverse methods to assess acquired knowledge. However, most students have been assessed solely through traditional instruments, considering written tests as an established tool. The variety of assessment methods continues to expand with the use of Information and Communication Technologies (ICTs), opening new possibilities for identifying emerging skills developed by new generations.



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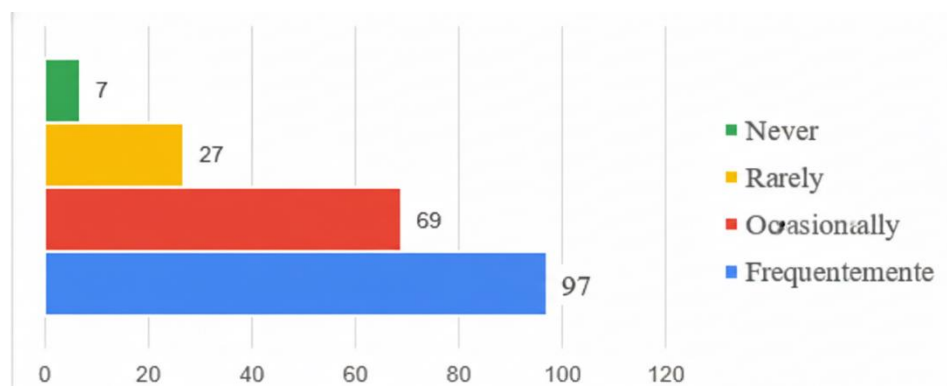


Figura 6. El docente aplica los instrumentos de evaluación adecuados en el proceso de aprendizaje.

Figure 7 illustrates the use of platforms to measure individual progress, adapting to new, effective, and inclusive systems aligned with learning objectives. Interaction with mathematical concepts is made accessible to all students through gamification, resulting in more engaging and personalized teaching that increases learning effectiveness and assessment accuracy.

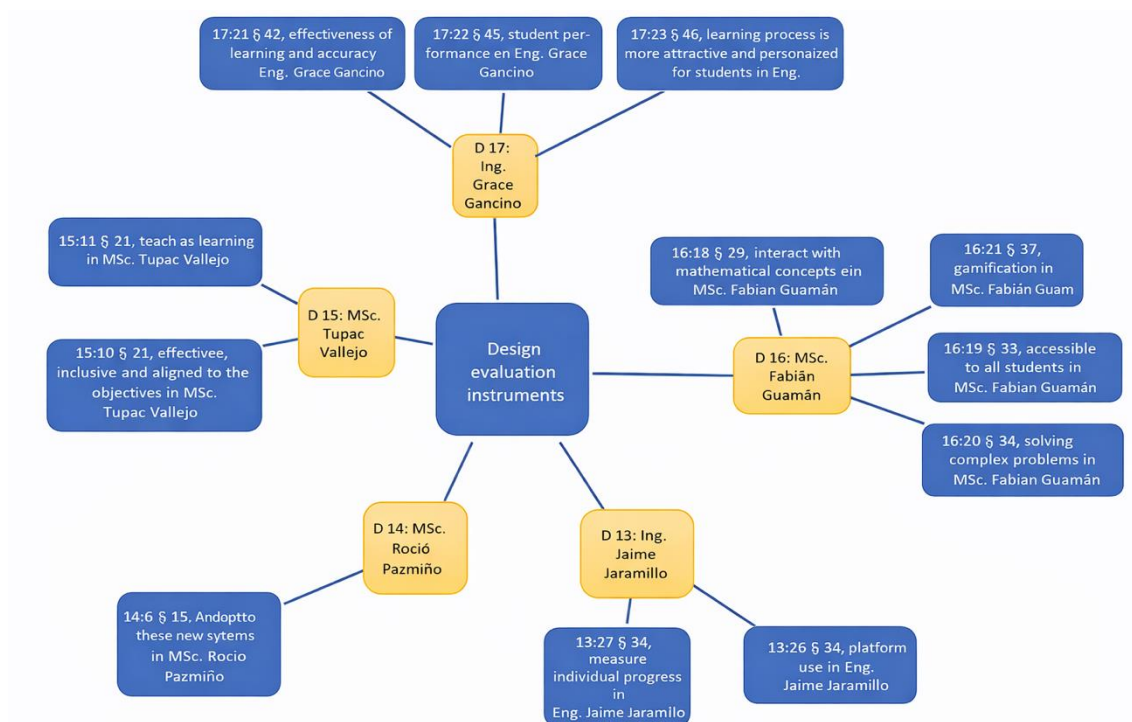


Figure 7. Consistent responses regarding the design of assessment instruments with digital tools.

5. Discussion

The structural characteristics of assessment rubrics were analyzed in relation to the guidelines established by the Ministry of Education of Ecuador. In this regard, Alcón-Latorre and Menéndez-Varela point out that an effective rubric must be aligned with curricular



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content, learning objectives, and quality standards, thus facilitating a coherent, objective, and transparent evaluation. Furthermore, they propose that rubric design should respond to specific criteria that allow for a clear assessment of students' performance level for each indicator. However, the results obtained in this study show that 37% of students believe that teachers do not present the information contained in the rubrics clearly, visibly, and appropriately, while 57% indicate that they do not perceive an objective assessment of their learning achievements when evaluated using this instrument. These perceptions contrast with those presented by Alcón-Latorre and Menéndez-Varela, who state that a well-designed rubric should contain precise, understandable descriptors aligned with quality criteria, which should be applied progressively throughout the learning process (Alcón-Latorre and Menéndez-Varela 2016, pp. 3-4).

Comparing the theoretical framework and background with the results, it is evident that the rubric was not applied correctly due to a lack of the necessary information to guide the evaluation process. This prevented good results and generated a negative impact, attributable to a poorly structured instrument implemented by the teacher. The rubric lacks the characteristics of being objective, structured, and efficient from the process to the final result, in relation to parameters that assess the construction of knowledge acquired by the student. The lack of descriptors makes the rubric an ineffective instrument for the desired level of achievement and fails to fulfill its function of evaluating skills and abilities during the learning process.

The assessment of algebraic operations learning in eighth-grade students was contextualized, considering current approaches to the use of instruments such as rubrics. Within this framework, Buelvas et al. emphasize that formative assessment should be geared towards reinforcing students' prior knowledge in order to develop competencies meaningfully, allowing for more conscious and participatory learning (Buelvas et al., 2023, p. 56). According to the results obtained in this study, 40% and 45% of students indicated a lack of clarity regarding the assessment guidelines, demonstrating a lack of explanation on the part of the teacher. Furthermore, 52% of respondents stated that they did not perceive an appropriate application of assessment instruments during class. These data are complemented by the percentages of 72% and 76% of students who stated that digital educational resources are only occasionally or never used as part of an assessment with differentiated formats. These results highlight the need to improve both the planning and communication of assessment criteria in the classroom, as well as to integrate digital tools that diversify the ways of assessing mathematical learning.

Sixty percent of students do not feel motivated during the assessment process, supported by 50% and 41% of students who do not understand the actions taken by the teacher, such as preparatory activities, participation, and appropriate feedback at each stage of the assessment. Thus, 57% and 58% of students do not perceive a positive attitude from the teacher during the learning process, but rather a focus solely on the final result. These data are related to the guidelines for implementing learning assessment processes proposed by the Ministry of Education in 2023, which value the teacher's role in the acquisition of skills and abilities at each level, as reflected in an assessment. The results are indicators of improvement in the teaching-learning process.

Comparing the theoretical framework and background with the results, there is a lack of dialogue between teachers and students regarding changes in evaluation guidelines. Furthermore, the diverse evaluation instruments detailed in current Ministerial Agreements are not being used, and digital resources are underutilized during the evaluation process. The need for evaluation remains, and the lack of motivation,



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participation, and feedback from teachers in class continues to be a source of concern. Students observe that evaluation focuses solely on the final result, disregarding the process they followed to arrive at a correct or incorrect answer.

Medina et al. analyze teachers' perceptions of rubric use in formative assessment and conclude that rubrics are valued for their clarity, objectivity, and contribution to analyzing students' academic performance. While their benefits for strengthening skills such as critical thinking and self-reflection are acknowledged, it is also noted that their effective application depends on teacher training and the educational context (Medina et al., 2023). These perceptions support the use of rubrics as a teaching tool that promotes inclusive and formative assessment, key aspects for improving the learning of algebraic operations in mathematics.

The design of a teaching guide based on the use of rubrics as a key pedagogical resource was proposed to facilitate the achievement of learning related to algebraic operations. In this context, Medina et al. maintain that rubrics constitute an effective assessment tool in the area of Mathematics; they not only allow for the evaluation of final products, but also the formative processes through which students develop skills and abilities. The results obtained reflect a consensus among the participating teachers regarding the usefulness of rubrics for strengthening competencies such as critical thinking, reflection, and problem-solving. They also underscore the need to integrate appropriate resources, continuous feedback, and inclusive strategies that promote more equitable and contextualized assessment within the classroom.

Comparing the theoretical framework and background information with the results, teachers are aware of the skills students should master in mathematics, and this is reflected in the grades. Assessment is traditional, using exercises and answers, and despite training on assessment methods, teachers do not experiment with new assessment tools. A rubric, however, is an instrument that provides detailed feedback on the process and final product, which are key to mathematics. An effective rubric for evaluating the learning of algebraic operations in eighth-grade students should combine qualitative and quantitative elements. Qualitatively, the rubric should clearly describe the performance levels, the specific skills at each level, and the ability to solve exercises. Quantitatively, it should assign numerical scores to each performance level, allowing for a precise and objective evaluation.

The rubric should include criteria that consider the problem-solving process, not just the final result, as this constitutes a comprehensive assessment of student learning. An example of a quantitative and qualitative rubric for the assessment of learning algebraic operations is presented.

6. Conclusions

An analysis of the structural characteristics of assessment rubrics was conducted in relation to the guidelines of the Ecuadorian Ministry of Education. On average, 47% of teachers do not use rubrics appropriately in assessments, according to the guidelines established by the Ministry. The main issues affecting the structure of a rubric as an assessment tool are the following: 37% (failing to specify the necessary information) and 57% (failing to assess learning outcomes). This is because the rubric lacks the necessary guidance for students during the activity, resulting in low grades that do not accurately reflect the level of achievement of the student or group of students being assessed.



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The assessment of learning among eighth-grade students in basic general education is contextualized, revealing that, on average, 57% of students perceive the assessment of algebraic operations as a tedious process to be completed without any appeal. This is evidenced by data such as: 42.5% (lack of knowledge of the assessment parameters), 52% (lack of recognition of the assessment instruments), and 74% (lack of use of digital educational resources) in relation to the assessment tool used. Similarly, 54% of students perceive the teacher's activity as weak, based on data such as: 60% (lack of motivation), 46% (lack of participation in activities), and 58% (lack of perception of a positive attitude) in relation to the environment before, during, and after an assessment. This indicates that the assessment processes in algebraic operations are mechanical, based on solving exercises in anticipation of a good grade, neglecting the purpose of a comprehensive assessment that involves student participation.

A teaching guide based on rubrics was deemed beneficial for clarifying the mathematical skills students should develop. According to teachers, these skills are primarily demonstrated through problem-solving in traditional, standardized tests. Teaching materials and assessments are typically created individually, without experimentation with new assessment tools and instruments. Ongoing professional development in teaching and learning topics provides opportunities for change in the approach and methods of evaluating content. This study proposes the design of quantitative and qualitative rubrics for assessing the learning of algebraic operations in eighth-grade students. It addresses the issue of rubrics not being effectively applied in assessments due to the instrument's structure, the specific skills being evaluated, and a lack of experience among mathematics teachers who focus solely on correct and incorrect answers without recognizing the student's progress as they tackle exercises or problems on tests. The assessment for algebraic operations is mediocre without the support of digital educational resources, which are a trend in current education, at every stage—before, during, and after—resulting in mediocre grades and failing to fulfill the purpose of a test, which is to identify students' strengths and weaknesses to improve the teaching-learning process.

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Declaration of authorship-CRediT

DIEGO TIPÁN-RENJIFO: Problem statement, theoretical development, methodology, validation, data analysis, and drafting of the first draft.

EDGAR CAZARES-FUENTES: Critical review of the content, methodological supervision, project management, instrument design, final editing, and pedagogical recommendations.

DIEGO FREIRE-LLIVE: Data collection, fieldwork, organization of results, qualitative analysis, and writing of results and conclusions.

Artificial intelligence usage statement

The authors report that they partially used the ChatGPT tool – GPT-4 model (OpenAI), July 2025 version – during the manuscript preparation stage, specifically for: support in the syntactic restructuring of some paragraphs, the creation of alternative versions of titles and subtitles, and the generation of preliminary examples that were subsequently reformulated



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manually. Artificial intelligence was not used to draft sections related to methodological design, data analysis, interpretation of results, or academic discussion. All content suggested by the tool was critically reviewed, verified, and modified by the authors, who assume full responsibility for the final text, its accuracy, and its scientific rigor.



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