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Formative assessment for achieving competency in mathematics

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Abstract

The assessment of mathematical competencies is an aspect of paramount importance for involving students in their own learning process. Formative assessment stands out as an opportunity to improve the level of learning achieved; however, in some contexts it is applied partially or systematically, giving priority to summative or final assessment. The aim of this study was to identify the processes that support formative assessment in relation to the achievement of mathematics competencies in basic education. For this purpose, the documentary review technique and an analysis matrix were used as a tool to answer the following question: Which formative assessment processes are relevant to the achievement of mathematics literacy in elementary education? The documents were located in databases such as WoS, Scielo, Redalyc and Google Scholar and then an analysis matrix was applied. It is concluded that formative assessment is of extraordinary relevance for the acquisition of mathematical competences when it applies feedback processes, such as the identification of achievements, self-assessment and co-assessment, in which students are recognized as the main actors of their learning process; therefore, this type of assessment allows them to focus on the internal demand to learn, not only in the areas of knowledge they have to master, but in all aspects of their lives.

Keywords: basic education; student assessment; formative assessment; competencies; mathematics competencies

Review article.

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La evaluación formativa para el logro de competencias en matemáticas

Resumen

La evaluación de las competencias en matemáticas es un aspecto de singular importancia para involucrar a los estudiantes en su propio proceso de aprendizaje. La evaluación formativa se destaca como una oportunidad para potenciar los niveles de aprendizaje logrados; sin embargo, en algunos contextos se aplica parcialmente o de manera asistemática, privilegiando la evaluación sumativa o final. El objetivo del presente estudio fue identificar los procesos que fundamentan la evaluación formativa en términos del logro de las competencias en matemáticas en la educación básica. Para ello, se utilizó la técnica de revisión documental y se empleó una matriz de análisis como instrumento, a fin de dar respuesta al siguiente interrogante: ¿cuáles procesos de la evaluación formativa son pertinentes para el logro de competencias en el área de matemáticas en la educación básica? Los documentos se localizaron en bases de datos como WoS, Scielo, Redalyc y Google Scholar; posteriormente, se aplicó una matriz de análisis. Se concluye que la evaluación formativa es de extraordinaria relevancia para el logro de competencias matemáticas al momento de aplicar procesos de realimentación, tales como la identificación de logros, la autoevaluación y la coevaluación, a partir de los cuales se reconoce al estudiante como el actor principal de su proceso de aprendizaje. Por ello, este tipo de evaluación permite a los estudiantes enfocarse en la demanda interna de aprender, no solo en las áreas de conocimiento que requieren dominar, sino en todos los aspectos de su vida.

Palabras clave: educación básica; evaluación del estudiante; evaluación formativa; competencias; competencias en matemática

Avaliação formativa para alcançar a competência em matemática

Resumo

A avaliação das competências matemáticas é um aspecto de suma importância para envolver os alunos em seu próprio processo de aprendizagem. A avaliação formativa se destaca como uma oportunidade de aprimorar o nível de aprendizado alcançado; entretanto, em alguns contextos, ela é aplicada de forma parcial ou sistemática, dando prioridade à avaliação somativa ou final. O objetivo deste estudo foi identificar os processos que apoiam a avaliação formativa em relação à obtenção de competências matemáticas na educação básica. Para isso, foram utilizadas a técnica de revisão documental e uma matriz de análise como ferramenta para responder à seguinte pergunta: Quais processos de avaliação formativa são relevantes para o alcance da alfabetização matemática no ensino fundamental? Os documentos foram

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localizados em bancos de dados como WoS, Scielo, Redalyc e Google Scholar e, em seguida, foi aplicada uma matriz de análise. Conclui-se que a avaliação formativa é de extraordinária relevância para a aquisição de competências matemáticas quando aplica processos de feedback, como a identificação de realizações, a autoavaliação e a coavaliação, nos quais os alunos são reconhecidos como os principais atores de seu processo de aprendizagem; portanto, esse tipo de avaliação permite que eles se concentrem na demanda interna de aprendizagem, não apenas nas áreas de conhecimento que precisam dominar, mas em todos os aspectos de suas vidas.

Palavras-chave: educação básica; avaliação do aluno; avaliação formativa; competências; competências em matemática

Introduction

The debates on curricular transformation ask why, for what purpose, and to whom the mission of educational systems is directed. One of the aspects has been and continues to be evaluation, especially when a teacher-centered role prevails in the face of a passive student body. This article arises from the demands of an approach between teaching-evaluation and the conditions to achieve quality learning. Taking into account that in the educational systems of Latin American countries, including Colombia, it has been observed that despite the fact that the evaluation model is no longer a directive process (García et al. 2019), traditional evaluation practices that privilege rote learning, without considering a student-centered evaluation, continue to be carried out.

However, the qualification and the distinction between those who pass and those who fail take precedence, in order to meet the bureaucratic requirements of educational administration (Córdoba et al. 2018). This involves a series of contradictions: first, with the theoretical principles of an evaluation linked to the acquisition of competencies, through constant help in terms of identifying and overcoming weaknesses to optimize learning (Muñoz-Jaramillo, 2023); second, with the integral formation of individuals (Medina, 2022).

It also contradicts the evolution of the concept of evaluation, to the extent that it can be considered transcendental to assess the different dimensions of the human being; hence its holistic and integral character, which includes the measurement of knowledge (knowledge or knowing), disposition and practical or procedural performance and the attitudes involved, as well as the forms of understanding, reflexivity and emotionality to respond to a given learning situation (Uzcátegui and Albarrán, 2020).

In this regard, Bizarro et al. (2021) state that «teachers and students have the arduous task of transforming the traditional forms of evaluation into a formative form of evaluation» (p. 874). Thus, «teachers perform a new role, since the context is the one that guides the development of learning, and they have to promote meaningful situations related to this context» (Meléndez et al., 2023, p. 1106). Therefore, an attempt has been made to abandon traditional epistemologies and to adopt contents, methods and techniques that favor an evaluation based on the peculiarities of each context.

For his part, Ruiz (2021) considers that «for many teachers, it is practically impossible to imagine plausible forms of formative evaluation» (p. 659). According to the results of the Mejoredu survey (Comisión Nacional para la Mejora Continua de la Educación, 2020), for any educational institution to adopt this type of evaluation, it is necessary to have training programs for teachers, curricular definitions, support from educational authorities to create a collaborative culture, and for each school to carry out research on the contextual conditions of the students, among other aspects.

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The above points are important in all areas, but mathematics is indispensable in the different disciplines and areas of life; therefore, evaluation cannot be analyzed in isolation from other aspects of didactics, such as planning, facilitation or, mediation and motivation. In terms of planning, this is done from the point of view of fulfilling a program, with evaluation being automatic through strategies and tools (Martínez, 2016, cited in Medina-Zuta and Deroncele-Acosta, 2019), so that pedagogical know-how is instrumental, far from its formative dimension. Planning should give meaning to meaningful and discovering learning, in addition to having diverse strategies for formative assessment.

As for facilitation or mediation, it should be a practice inspired by the recognition of students, which privileges strategies and resources aimed at promoting the development of skills through the appropriation of plural knowledge (Alzate-Ortiz and Castañeda-Patiño, 2020). For this, the teacher, as mediator, must start from an episteme that transcends the rigid, inflexible and not very determinant conceptions regarding the evaluation of mathematical competences, only for grading, without promoting motivation and persistence to learn.

Given that the objective of this article is oriented to identify the processes of formative assessment relevant to the achievement of competencies in the area of mathematics at the basic education level, procedures of analysis and comparison of authors were developed based on the referential and defining understandings of formative assessment as a resource for the achievement of competencies. The analysis of the results allowed us to have a well-founded basis with regard to the identification of conditions for reflection on the identified processes and to reflect on the quality of education according to Silva-Escalante (2023), who states: «the result of the evaluation is known through the achievement of competencies, and it is there that the issue of formative evaluation becomes important» (p. 14).

Methodology

The methodology considered the documentary review technique, defined by Fernández de Silva (2021) as «the search for existing information that the researcher carries out on the basis of previous research, theories or approaches of other scientists and authors, with the aim of clarifying the objectives, conceptualizing the study events and orienting the research work» (p. 32). In terms of tools, an analysis matrix was used, supplemented by three other matrices: registration, topic and file. The data collection consisted of recording the authors consulted and to be consulted, with all their data, the location and the subject or content of interest; the topics were listed according to the complexity of the aspect to be studied, in accordance with the outline of the article. A matrix was then constructed to record the core concepts present in the publications, in the form of research articles, review articles and essays, in both printed and digital formats.

The inclusion criteria were the following: i) formative assessment in basic education and mathematics; ii) Spanish and English language; iii) affiliation of the journal of origin to recognized databases; iv) abstract with at least three elements (objective or purpose, methodological criteria and results). Documents written in a language other than the one required and those without elements demonstrating completeness and appropriateness in their development were excluded. A total of 52 articles from indexed journals were included (see Table 1).

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Table 1

Indexing, temporality and total number of sources selected for the study

Indexing	Temporality			Total
	2018 to 2020	2021 to 2022	2023	
Scielo	3	3	3	9
Scopus	2	3	2	7
Dialnet, Redalyc Latindex Publindex	6	5	3	14
Web of Science	2	2	2	6
Doaj			2	2
Google Scholar	5	5	4	14
Total	18	18	16	52

Background

On the subject of assessment in general, there are statements based on its potential, as well as judgments on the limited use of formative assessment, especially in mathematics, where it is a flashpoint in terms of confrontation between teachers and students (Gómez et al., 2022; Medina and Peralta, 2018); consequently, there is disharmony in the classroom climate and a high risk to the quality of education.

In basic education in Colombia, educational institutions have autonomy in the design, organization and application of assessment. Decree 1290 of 2009 establishes the Institutional System of Student Evaluation (SIEE), which regulates the evaluation processes that must be established in the Institutional Educational Project (PEI), based on the Curricular Guidelines (1998), the Basic Learning Rights (DBA) and the Basic Competence Standards (EBC) in Mathematics, with the aim of taking into account the competences for a comprehensive education, self-knowledge, social, autonomous, critical, with basic and essential learning skills.

In the study carried out by Gómez (2019), in the evaluation of the mathematical competences of 299 students in an educational institution in Colombia, no positive results were obtained in the advanced level of the qualification in three of the basic competences of the field: there were a total of 141 students at an insufficient level in the competence of communication, representation and modeling; 281 students were at the same level in terms of reasoning and argumentation, and 108 in terms of presenting and solving problems. This means that in the field of mathematics, the teaching continues to be traditional, without producing significant learning in the students; that is, it is based on learning by rote, based on computational techniques, without understanding the meaning of the procedures.

Faced with this situation, a study that provides evidence on the use of formative assessment is that of Alarcón et al. (2019), in which they worked on formative assessment strategies for the development of mathematical thinking in fifth grade elementary students, who presented difficulties in the development of Saber tests in the components of variational thinking, modeling processes, communication and problem solving in two educational institutions in Colombia. The objective was to demonstrate the follow-up of the use of formative assessment as a tool to develop variational thinking. Among the results, it is highlighted that the formative assessment allowed students to recognize their learning and difficulties in ratio, direct proportionality and the rule of three, thanks to the fact that they were linked to activities that generated commitment and motivation.

For their part, Ibarra-Sáiz et al. (2023) analyzed the quality of learning outcomes assessment tasks to describe the characteristics of

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assessment tasks according to the perception of teachers and found that the most relevant nuances that assessment should have are the transparency and depth of the tasks, while feedback and student participation in the assessment processes are the least valued.

The reality described is worrying because truthfulness and completeness are part of formative assessment, which is called to appease students' ability to reflect on their own actions and, in turn, to generate a disposition to propositional criticism (Medina-Zuta and Deroncele, 2019). Therefore, it is necessary to strengthen teacher training to promote the use of feedback and, above all, to facilitate student participation in evaluation, which would improve the quality of evaluation tasks and lead to greater achievement of the desired learning outcomes.

In the same sense, we agree with a finding of the Latin American Laboratory for the Evaluation of the Quality of Education (LLECE), which distinguishes formative evaluation and characterizes it as having great didactic value because it «represents a particular educational approach that seeks to give higher profile to students, leading to more meaningful, useful and motivating learning, giving greater value to processes and improvement» (Organización de las Naciones Unidas para la Cultura, las Ciencias y la Educación [Unesco], 2021, p. 2).

Meléndez et al. (2023) conclude that in mediation, as part of the dimensions of the teaching and learning process, it is essential to pay special attention to formative evaluation. Thus, mediation is called to prioritize the socio-emotional and motivational attention of students, considering their experiences. However, the stimulation of metacognitive processes is lacking in relation to formative assessment. The authors argue that the main challenges relate to the need to adjust the objectives and content established in the curriculum in order to have an assessment relevant to the conditions of the students.

Similarly, Medina-Zuta and Deroncele-Acosta (2019) say that one of the problems faced by educational institutions at the elementary and high school levels is the need to deepen the self-reflective capacity of teachers as an alternative and response to the implementation of formative assessment. For these authors, it is essential to strengthen the self-reflective capacity and the disposition to propositional criticism to provide answers to the implementation of formative assessment. This merits a paradigm shift that leads to the promotion and improvement of formative assessment.

Another contribution on learning assessment in general was the study by Cáceres et al. (2018) on the role of the teacher in learning assessment. The authors identified gaps and aspects to be improved in terms of adopting, adapting, diversifying and enriching techniques that allow assessment to become a formative process and, therefore, enriching, permanent, fair, grounded and participatory. They specified the importance of evaluation for understanding and improving student learning and the practices developed in educational institutions.

Valdez et al. (2023), in their research on the application of this type of evaluation of feedback, found that through formative evaluation, students manage to strengthen motivation, self-evaluation, critical thinking and personal improvement. In addition, the regular practice of this type of evaluation improves learning, but it must be a continuous and participatory process.

These studies have provided a diagnosis of the difficulties that students face in academic performance, especially in mathematics, in basic educational institutions in Colombia, a fact that endangers the quality of education. They emphasize key processes such as feedback (Torres and San Martin, 2021), as well as student control and participation through self-evaluation. The results confirm the relevance of formative assessment as an element that directs the search for the achievement of competencies in mathematics, because it allows identifying both the state of progress and the difficulties that students have in achieving significant progress in their studies.

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Considerations about Formative Assessment in Mathematics

The literature distinguishes three types of assessment: diagnostic, summative and formative. The first is a specific and differentiated inquiry for each student (Díaz and Hernández, 2010), prior to the development of any educational process; in a timely manner, before the beginning of any instructional sequence or segment, since its function is to identify and use the students' prior knowledge, taking it into account in the design of the instructional plan.

Summative or final evaluation is used to determine the extent to which educational intentions have been achieved, to assign grades, and to make judgments about the level of learning achieved. This is considered a traditional evaluation that allows for grading and distinguishing who passes, the purpose of which is to meet the bureaucratic requirements required by the educational administration (Córdoba et al., 2018). However, it is important to consider that this type of evaluation, although it has a pronounced use in basic primary and secondary education and responds to learning products in a global way, contributes to making pedagogical decisions that in one way or another affect the educational process (Díaz and Hernández, 2010).

The relevance of formative assessment lies in «promoting personal development, the improvement of knowledge, skills and preparation for the world of work [of future professionals] » (Gallego-Arrufat and Cebrián-de-la-Serna, 2018, p. 139), also considering that mathematics is part of everyday life and manifests itself in all areas of society. Thus, diagnostic and summative assessment are very different from formative assessment, since the latter has positive effects; therefore, its use is recommended as an essential part of teaching and learning in all areas (Tamayo et al., 2023).

The Colombian Ministry of National Education (MEN, 1998), in its curriculum guidelines, defines formative evaluation as a renewing concept that refers to a set of procedures that should be permanently practiced, which should also be understood as inherent to the educational task, to interact the construction of their knowledge and value systems, increase the number of skills and perfect each of them, and that grow within the context of a life in society.

For Valdivia and Fernández (2020), formative evaluation refers to the cyclical process through which students or their teachers carry out the collection (taking and recording) and processing (analyzing and interpreting) of information to make a judgment about learning and thus be able to use it as feedback. From this perspective, «assessment should serve as a tool both for learning and for improving teaching» (MEN, 2018, p. 56). Indeed, Muñoz-Jaramillo (2023) points out: «The ideal end of evaluation is a training that is systematized through the continuous evaluation of its learners, which the different evaluation modalities become a focal point, and therefore, the results» (p. 88).

The above confirms that the purpose of formative assessment in mathematics teaching and learning is to review these situations to adapt or adjust them for the benefit of students, to the extent that processes such as identification of achievement, feedback, self-assessment and co-assessment are recognized (Pasek and Mejía, 2017). In line with this, Pellegrino (2020) states that assessment should help to improve student performance, but not to audit it.

For Filippi et al. (2021), «making explicit and sharing the evaluation criteria of the activity and of each evaluable task or milestone, and having a synchronous or asynchronous dialogue with students about them, will contribute decisively to making assessment more transparent» (p. 397). To this end, it is essential to promote understanding of the process by identifying possible errors or limitations, but also opportunities, potentialities and challenges that could have an impact on the achievement of the desired competencies.

In the educational reality, it is not possible to avoid two aspects: first, the real meaning of formative evaluation, because at all times there must be an interest in highlighting and valuing the successes or achievements that students achieve in the construction process (Pasek and Mejía, 2017; Barboza and Cherres, 2021).This is due to the consolidation of learning, which gives students the opportunity to know what

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criteria are being followed to evaluate their achievements. The second aspect is to consider mistakes as positive, in the sense that through them one learns, because by identifying what one does not know, one works to overcome it, through internalization and responsible adoption of different means to bridge failures.

Bizarro et al. (2021) emphasize that the purpose of formative assessment is to improve and motivate students' autonomy, as it helps them to see their own achievements and difficulties, as well as to reflect on their mistakes. This approach to formative assessment is fundamental to understanding and adjusting the teaching and learning process in the classroom.

In order for assessment to strengthen the quality conditions in mathematics learning, it must meet a series of characteristics, especially the interaction between teacher and student, so that the student internalizes his or her achievements, but also the skills to develop competencies (Muñoz, 2020). In this regard, Lozano and Tamez (2014, as cited in Montenegro et al., 2022) point out that «feedback is adapted to the current times, in which the student is required to develop competencies» (p. 2027) and, with them, achieve meaningful learning with lasting anchors for life (Morales-Aibar and Medina-Zuta, 2020).

Another aspect of formative assessment is flexibility, which is understood as «the ability to adapt the teaching-learning process flexibly according to the needs of the students» (Unesco, 2021, p. 13). Although there are systematized and preconceived processes in this assessment, it can change in the course of its application, making it less rigid (Sánchez et al., 2022).

In this particular case, there is a need for a reflective and flexible teacher who promotes evaluation as an integral pedagogical proposal, where the intercultural factor that enhances the ability to know how to be and live together stands out (Mollo-Flores and Medina-Zuta, 2020; Cruzado, 2022; Salazar, 2023). These characteristics are of interest to obtain reliable or truthful information about how a student thinks, feels, or communicates, as a function of «analyzing their practice and transforming it into situated teaching to achieve the goal of providing quality education» (Rocha and De la Cruz, 2018), and capable of transferring mathematical knowledge to everyday life.

For Unesco (2021), another quality of formative assessment is the ability to adjust in the teaching-learning process according to the needs of the students. This is one of the main advantages associated with formative assessment, which is in agreement with Galarza-Salazar (2021), from the perspective of formative assessment in distance environments, and with Díaz (2018), in science education.

In terms of the opportunities it offers to students, its importance is even more appreciated, «because it will not only make students' learning much more sustainable and enriched, but it will also help them in their performance and motivation» (Azpilicueta, 2020, p. 5).

From the above clarifications, it can be seen that one of the fundamental features of formative assessment is the possibility of providing feedback; this, applied to the field of mathematics, is a way for each person who participates in learning processes to awaken the internal demand to learn, through the shortcomings, but also through the degree of success achieved.

Formative assessment and mathematical literacy

Currently, in educational systems, it is imperative to focus on the development of competencies in the processes of all areas, especially in mathematics and language, because «access to knowledge, to be able to understand it, to adopt a critical stance and to be able to transform it, that is, to form competent citizens» (Gómez, 2019, p. 163), is a right.

It is undeniable that, historically, mathematical knowledge has been and continues to be of particular relevance due to the great variety of situations and areas of life in which it is applied. This circumstance represents a great challenge in terms of promoting knowledge, skills and values that are synthesized in the competencies for achieving performances in accordance with the demands of today's world, as well

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as participation and sound decision making, especially from feedback (Muñoz, 2020).

Similarly, in the curricular perspective, new approaches and paradigms oriented to the development of competencies have been assimilated. «This, in turn, has implied the reformulation of the evaluation process, emphasizing an evaluation of a more formative nature that takes place within the teaching and learning process itself» (Rodríguez-Fenco and Soplapuco-Montalvo, 2019, p. 39).

At this point, formative assessment in mathematics, according to Torres-Corrales et al. (2022), although it is a complex process, its benefits can extend transversely throughout the university education of students, from whom it requires a lot of motivation and perseverance; therefore, the teacher must use didactic forms that, far from being repetitive and rote, are dynamic, entertaining and capable of generating their commitment to the learning process (Orozco, 2022).

Barrientos and Borghouts (cited in Cañadas and Santos, 2021) point out that motivation contributes to the development of initiative, entrepreneurship and learning to learn; it encourages students to take greater responsibility for their learning. Therefore, as stated by Cáceres et al. (2018), it is essential to create spaces that generate interest in learning; here, evaluation performs an essential role, especially when it takes into account transparency, depth, feedback and participation, because credibility and rigor are promoted, in interesting classes that promote valuable learning for students, that is, quality assessment tasks as factors of formative evaluation (Ibarra-Sáiz et al., 2021).

In Colombia, both the Curricular Guidelines (MEN, 1998) and the DBA and Basic Competency Standards (MEN, 2006) are references for quality expectations in terms of knowing and doing (Gómez, 2019). In this sense, the integration of the objectives of education in the field of mathematics is based on the achievement of three competencies: (a) Communication, representation and modeling, which allows students to analyze situations, express themselves about these ideas and make known in written, verbal, algebraic or graphic form, a mathematical expression in a simple way; (b) Problem posing and solving: The student will have the ability to formulate problems, identify and apply the most appropriate strategy for the corresponding verification of the results; c) Reasoning and argumentation: The student will develop the ability to argue the how and why of their approaches, strategies applied, findings, results, formulation of hypotheses (MEN, 1998).

Orozco (2022) points out that these competencies demonstrate three fundamental aspects, namely: «the cognitive aspect (knowledge of the discipline), socio-affective (understood as the disposition and willingness to solve an internal or external demand) and practical (the tendency to act in a continuous, persistent and dedicated manner) » (p. 128). These competencies can guarantee the acquisition and development of knowledge in a sustainable way over time.

Likewise, Córdoba et al. (2018) describe the positive changes that manifest themselves in the attainment of competencies when we move from traditional assessment, which is characterized by being summative and qualifying, to formative assessment. It is understood that, based on the experience, the importance of this valuation model is recognized, which is at the service of the learning of the learner and its consequences in society.

From the above references, it can be affirmed that, in the acquisition of competences, formative assessment promotes the integral development of the student in terms of autonomy and independence of criteria, and, above all, generates an improvement in the level of learning, since the student acquires confidence when receiving, in oral or written form, the strengths as well as the difficulties of his/her evidence, which allows him/her to arrive at meaningful learning (Cáceres et al. 2018).

For Uzcátegui and Albarrán (2020), verification is relevant as the end of any evaluation process; however, for this it is essential to promote changes and transformations in the forms of teaching aimed at generating self-reflection on one's own thinking. Thus, formative evaluation is seen as a new challenge for 21st century education.

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Formative assessment, although it includes value judgments on the student's appropriation of knowledge (Pomares et al., 2018), by demonstrating the skills and abilities to generate solutions to specific problems from a specific knowledge, is a way that favors each person who participates in the learning process, arousing the internal demand to learn through the shortcomings, but also through the degree of success achieved. The emphasis is on how each student performs the process, providing individualized feedback to support students and teachers (Niño and Bahamonde, 2019; Molina et al., 2020).

However, one of the threats is that many teachers are still reluctant to implement them. According to Mola et al. (2021), the leading role of the learner is not exercised in teaching, because evaluations are mainly limited to the results at the end of each educational period, weakening aspects such as regulation and feedback during the development of the learning process. In this way, a teaching process is put into play that, according to Yepes and Gutiérrez (2022), is flexible, dynamic and participatory, based on strategic planning and formative evaluation, which allows accessible and inclusive environments for meaningful learning. Thus, it can be said that the formative process is influenced by the performance of the teacher, who must have sufficient academic training, relevant materials, research on teaching and learning, sociocultural phenomena and the wisdom granted by teaching experience (Mendoza et al., 2019).

Discussion

In discussing the above considerations, it can be affirmed that formative assessment has implications for the acquisition and reinforcement of mathematical competences. However, there are still some aspects to be considered in this changing reality. In the first place, there are several theoretical developments that need to be analyzed and understood, as well as contributions in the modality of proposals to be implemented and evaluated to what extent they contribute to strengthening formative assessment to lead students to be more curious about mathematical applications, critical thinking and to expose independent points of view.

This also leads to the formulation of concerns for future studies: What is the epistemological knowledge that supports the practice of formative assessment from the voice and actions of teachers? What proposal would support the practice of formative assessment in mathematics in which students and teachers navigate to build meaningful learning? And to what extent would teachers be willing to free themselves from standardized curricular schemes that, while purporting to embrace a constructivist and holistic educational ideal, are based on rigid and traditional forms of assessment that deny the possibility of setting new goals based on what has been achieved and, beyond that, on what has not been achieved?

Conclusions

After consulting and analyzing different authors who present their criteria on the processes related to formative assessment on its potentialities within the teaching-learning process, it is clear that it is important to comply with processes such as feedback, co-evaluation and hetero-evaluation, since if they are not complied with, there may be implications in the achievement of competences in the field of mathematics.

Feedback emerges as one of the most essential elements of formative assessment, since it provides information on the success or otherwise of the level of achievement, allows self-criticism and reflection by the students, as well as identifying their interests in terms of what motivates them most, checking what their concerns are, and then integrating all this into classroom life based on the teacher's reflection and commitment.

Co-evaluation and hetero-evaluation are linked to the conditions of transparency, flexibility and the possibility for students to reflect on their own performance, key aspects that are very relevant in mathematics, because they require review and analysis processes to check both the results and the strategies used in each procedure, as well as possible errors. According to the reality of the mathematics learning process, students

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are satisfied with checking whether the results were correct or not, without considering the reasons for the error and possible strategies for correction and improvement.

Conflict of interest

The authors declare that they have no personal, political, intellectual, racial, religious or other conflicts of interest that might affect the reliability of this publication.

Ethical responsibilities

The methodological processes performed did not involve human subjects; therefore, no declaration of ethics or bioethics committees or ethical responsibilities is required.

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Contribution

Jimmy Alexander Moreno Castro: Principal investigator. Selection and processing of bibliographic sources, registration, analysis, comparison of authors, writing of the text.

Jairo Guillermo Moreno Castro: Analysis and interpretation of results, writing of the summary, introduction, style review, grammatical contributions, organization of the text; contributions regarding methods, discussion and conclusions.

The authors participated in the preparation of the manuscript, read and approved it.