

ORIGINAL

Formative Assessment Mediated by Multimedia Resources: Key to Enhancing Understanding and Knowledge Retention in Higher Education

Evaluación formativa mediada por recursos multimedia: Clave para potenciar la comprensión y retención del conocimiento en la educación superior

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ABSTRACT

Formative assessment has gained increasing relevance in higher education by focusing on continuous feedback and the development of competences beyond final grading. However, traditional practices often prioritise memorisation, which limits deep understanding and knowledge retention. Within this framework, multimedia resources offer new pedagogical possibilities by presenting information in an interactive and multisensory manner, enhancing both motivation and content assimilation. The aim of this study was to analyse the impact of formative assessment mediated by multimedia resources on the understanding and retention of knowledge among university students. A mixed-method approach with a quasi-experimental design was applied, using a sample of 180 students distributed into a control group and an experimental group. The instruments included comprehension tests, two-week retention questionnaires, perception scales, and semi-structured interviews with lecturers. The results showed that students in the experimental group, who participated in assessment activities supported by interactive videos, simulators, and digital platforms, obtained significantly higher scores in immediate comprehension and medium-term retention. In addition, they reported greater motivation, clearer understanding of the content, and stronger engagement with autonomous learning. In contrast, the control group maintained a stable performance but with lower involvement and recall. In conclusion, the integration of multimedia resources into formative assessment represents an effective strategy for improving the quality of learning in higher education, providing evidence of its potential to transform teaching and assessment processes at the university level.

Keywords: Formative Assessment; Multimedia Resources; Understanding; Retention; Higher Education.

RESUMEN

La evaluación formativa ha adquirido creciente relevancia en la educación superior al centrarse en la retroalimentación continua y el desarrollo de competencias más allá de la calificación final. Sin embargo, las prácticas tradicionales suelen priorizar la memorización, lo que limita la comprensión profunda y la retención del conocimiento. En este marco, los recursos multimedia ofrecen nuevas posibilidades pedagógicas al presentar la información de manera interactiva y multisensorial, potenciando tanto la motivación como la asimilación de contenidos. El presente estudio tuvo como objetivo analizar el impacto de la evaluación formativa mediada por recursos multimedia en la comprensión y retención del conocimiento en estudiantes universitarios. Se aplicó un enfoque mixto con diseño cuasi-experimental, utilizando una muestra de 180

estudiantes distribuidos en un grupo control y un grupo experimental. Los instrumentos incluyeron pruebas de comprensión, cuestionarios de retención a dos semanas, escalas de percepción y entrevistas semiestructuradas con docentes. Los resultados mostraron que los estudiantes del grupo experimental, que participaron en actividades evaluativas apoyadas en videos interactivos, simuladores y plataformas digitales, obtuvieron puntuaciones significativamente más altas en comprensión inmediata y retención a mediano plazo. Además, reportaron mayor motivación, claridad en los contenidos y disposición hacia el aprendizaje autónomo. En contraste, el grupo control mantuvo un rendimiento estable, pero con menor involucramiento y recuerdo posterior. En conclusión, la integración de recursos multimedia en la evaluación formativa representa una estrategia eficaz para mejorar la calidad del aprendizaje en educación superior, aportando evidencias sobre su potencial para transformar los procesos de enseñanza y evaluación universitaria.

Palabras clave: Evaluación Formativa; Recursos Multimedia; Comprensión; Retención; Educación Superior.

INTRODUCTION

Formative assessment has become established in recent decades as an essential pillar of higher education, as it allows for continuous monitoring of student progress and provides timely feedback that strengthens learning.^(1,2) Unlike summative assessment, which focuses on the final grade, formative assessment seeks to generate a reflective process that promotes self-regulation, metacognition, and the development of competencies.⁽³⁾ In this sense, its application represents a strategic pedagogical resource for improving educational quality.

At the same time, the incorporation of multimedia resources into teaching has transformed university learning environments, promoting interaction, motivation, and meaningful knowledge construction. Tools such as interactive videos, digital infographics, simulators, and online platforms have been shown to enhance understanding by presenting information in a multisensory way, reducing cognitive load and stimulating content retention.^(4,5) These resources are also in line with the current learning styles of students, who demand more dynamic and personalized educational experiences.

Despite these advances, significant challenges remain in university assessment processes. One of these is low knowledge retention, attributed in part to assessment practices that focus on memorization rather than active learning.⁽⁶⁾ Likewise, the predominance of assessments oriented toward final results limits the development of critical and analytical skills. Added to this is the digital divide, which creates inequality in access to technologies and hinders the implementation of innovative strategies based on multimedia resources.⁽⁷⁾

In this context, the integration of multimedia technologies into formative assessment presents itself as a pedagogical alternative that could significantly improve understanding and knowledge retention. By combining continuous feedback with the communicative power of digital resources, teachers can design more effective experiences that not only measure learning but also enhance it.⁽⁸⁾

This raises the need to analyze: How does formative assessment mediated by multimedia resources enhance understanding and knowledge retention in higher education students? This question guides the present study, whose purpose is to provide empirical and reflective evidence on the effectiveness of such strategies in the university setting, contributing to the strengthening of educational innovation in the region.

Literature Review

Formative assessment in higher education

Formative assessment has been defined as a systematic and continuous process whose main purpose is to monitor and improve learning through immediate feedback and constant regulation of student performance.^(9,10) Black and Wiliam emphasize that formative assessment should not be reduced to an isolated strategy, but rather constitute a comprehensive pedagogical practice that encourages active student participation and shared responsibility in the learning process.⁽⁹⁾ Sadler complements this view by pointing out that the true value of feedback lies in its formative nature, allowing students to recognize the gap between what they know and what they need to achieve.⁽¹⁰⁾ Along these lines, Nicol underscores the importance of self-assessment and peer assessment as mechanisms that strengthen autonomy, metacognitive skills, and critical thinking, which are key aspects of higher education.⁽¹¹⁾

Multimedia resources in teaching and assessment

Multimedia resources have evolved from simple teaching aids to become essential mediators for active learning. These include interactive videos, digital infographics, simulators, dynamic presentations, and educational management platforms that integrate multiple sensory modalities.⁽¹²⁾ According to Mayer, the use of multimedia allows information to be processed through verbal and visual channels, which increases cognitive efficiency and facilitates the understanding of complex concepts.⁽¹³⁾ Moreno and Mayer show that multimodal

learning environments not only increase knowledge retention but also strengthen motivation by offering experiences that are closer to the interests and learning styles of today's students.⁽¹⁴⁾ In addition, recent research shows that the use of interactive platforms contributes to more autonomous learning, as students can access resources on demand, participate in adaptive assessments, and receive immediate feedback, thus consolidating an environment conducive to formative assessment.^(12,14)

Understanding and knowledge retention in digital environments

Understanding and knowledge retention are central constructs in university learning and have been addressed from different theoretical perspectives. Ausubel argues that meaningful learning occurs when new information manages to anchor itself in the student's previous schemas, ensuring better long-term retention.⁽¹⁵⁾ Sweller, for his part, warns that an overload of working memory prevents the transfer of knowledge to long-term memory, raising the need to design teaching resources that balance the complexity of the content and the cognitive abilities of students.⁽¹⁶⁾ The integration of multimedia stimuli helps to overcome these limitations by distributing information across different sensory modalities, thereby reducing unnecessary cognitive load and facilitating the construction of more durable schemas.^(13,14) Recent empirical evidence confirms that the use of audiovisual and interactive resources not only promotes immediate retention but also improves students' ability to apply what they have learned in practical contexts and transfer it to new academic and professional situations.^(15,16)

Theoretical Basis

This research is based on various conceptual frameworks that explain how formative assessment mediated by multimedia resources enhances understanding and knowledge retention. First, Mayer's multimedia learning theory states that students learn more effectively when information is presented verbally and visually, as the brain processes multisensory stimuli better by integrating images, narratives, and texts simultaneously.⁽¹³⁾ This theory supports the use of videos, simulators, and infographics as tools that facilitate the construction of more robust mental representations.

From the perspective of Vygotsky's sociocultural theory, learning is conceived as a socially mediated process in which cultural and technological tools play a key role in the construction of knowledge.⁽¹⁷⁾ Multimedia resources, in this sense, act as mediators that expand the zone of proximal development by offering interactive scaffolding that allows students to tackle more complex tasks with digital support.

Likewise, the constructivist approach maintains that learning is an active and meaningful process that is built on interaction with the environment and the resolution of authentic problems. The use of multimedia resources encourages this interaction by placing students in dynamic scenarios that promote exploration, experimentation, and collaboration.⁽¹⁸⁾

Finally, the relationship between formative assessment and metacognition is essential, as immediate feedback and self-assessment allow students to reflect on their cognitive processes, identify errors, and adjust their learning strategies.^(11,19) This link not only strengthens understanding and retention, but also drives the development of self-regulation skills that are indispensable in contemporary higher education.

METHOD

This study was developed using a mixed-method approach, which combines quantitative and qualitative techniques to obtain a comprehensive view of the phenomenon. This type of approach is particularly useful in educational research because it allows numerical findings to be corroborated with the interpretive richness of qualitative data.⁽²⁰⁾ According to Creswell and Plano Clark, the complementarity between the two approaches strengthens the validity of the results by allowing for methodological triangulation, which contributes to greater consistency and reliability in the analysis.⁽²¹⁾

In terms of design, a comparative quasi-experimental model was applied, with the formation of two groups: an experimental group, exposed to formative assessment activities mediated by multimedia resources, and a control group, which worked under traditional assessment modalities. This design is widely used in educational studies because it makes it possible to establish causal relationships in contexts where absolute control of variables is not feasible.⁽²²⁾ In this way, we sought to identify the extent to which the integration of multimedia resources affects the understanding and retention of university knowledge.

The sample consisted of 180 students from different higher education programs, divided into two equivalent groups. The selection criteria were based on intentional non-probabilistic sampling, considering the accessibility and availability of the participants. According to Hernández-Sampieri et al., this type of sampling is appropriate in applied research in the field of education, as it facilitates working with specific groups without affecting the internal validity of the study.⁽²³⁾ The equitable distribution between the control group and the experimental group ensured the comparability of the results.

The data collection instruments were designed based on previous studies on assessment and learning.

Comprehension tests were administered in pre-test and post-test formats, which allowed for the measurement of immediate learning progress after the intervention.⁽²⁴⁾ Retention questionnaires were also administered two weeks after the exper , in order to analyze the permanence of knowledge in medium-term memory.⁽²⁵⁾ Likert scales validated in similar research were included to investigate students' perceptions of the use of multimedia resources in formative assessments.⁽²⁶⁾ Finally, semi-structured interviews were conducted with teachers to gather qualitative perceptions about the relevance, advantages, and limitations of the methodology implemented.⁽²⁷⁾

The procedure involved structured planning in two phases. In the first phase, diagnostic tests were administered, and teachers were trained in the use of multimedia resources in assessment processes. In the second phase, differentiated activities were developed: the experimental group worked with resources such as interactive videos, simulators, dynamic presentations, and online learning platforms, while the control group continued with traditional written assessments. Both interventions were applied during the same academic period to ensure comparability. According to Yin, comparative designs enrich the interpretation of results by allowing similar contexts to be contrasted under different conditions.⁽²⁸⁾

Regarding data analysis, inferential statistical tests were applied in the quantitative component, such as Student's t-test to compare means between the experimental group and the control group, and ANOVA to examine significant differences based on comprehension and retention variables.⁽²⁹⁾ In the qualitative component, the interviews were subjected to thematic content analysis, which allowed for the identification of patterns, emerging categories, and recurring perceptions in the teachers' discourses. According to Braun and Clarke, this approach is appropriate in educational research because it facilitates understanding how actors experience and value the processes implemented.⁽³⁰⁾

RESULTS

This section presents the findings derived from the application of the data collection instruments, organized sequentially to respond to the research objectives. First, the quantitative results corresponding to the comprehension tests (pre-test and post-test), the medium-term retention assessment, and the comparative analysis between groups using statistical tests are presented. Next, the results related to student perception of formative assessment mediated by multimedia resources, collected using Likert scales, are included. Finally, the qualitative findings from the teacher interviews are presented, which complement the interpretation of the quantitative data and provide a broader view of the strengths and limitations of the intervention.

Table 1 presents the results of the pre-test of comprehension administered to the control and experimental groups before the pedagogical intervention. It can be seen that the control group (n=90) obtained an average of 12,1 points (SD=3,0), while the experimental group (n=90) achieved an average of 12,4 points (SD=3,1). These initial scores are very similar, indicating that both groups started at an equivalent level of comprehension at the beginning of the study. This equivalence is essential to ensure the validity of the quasi-experimental design, as it allows subsequent differences to be attributed mainly to the intervention carried out and not to previous discrepancies between participants.

Table 1. Results of the pre-test of comprehension (control and experimental groups)			
Group	n	Mean (M)	Standard deviation (SD)
Control	90	12,1	3,0
Experimental	90	12,4	3,1

Table 2 shows the results obtained in the post-test of comprehension administered after the intervention. The control group (n=90) achieved a mean score of 13,6 points (SD=3,0), while the experimental group (n=90) obtained a significantly higher mean score of 16,9 points (SD=2,7). These results show that, although both groups improved compared to the pre-test, the experimental group achieved a more notable increase in performance. The observed difference suggests that the use of multimedia resources in formative assessment had a positive impact on content comprehension, promoting more effective learning compared to traditional assessment strategies.

Table 2. Post-test comprehension results			
Group	n	Mean (M)	Standard Deviation (SD)
Control	90	13,6	3,0
Experimental	90	16,9	2,7

Table 3 compares the pre-test and post-test gain results in both groups using Student's t-test. The control

group recorded an average improvement of +1,5 points, with a statistically significant difference ($t(89)=4,2$, $p<0,001$, $d=0,45$), indicating moderate progress after the traditional intervention. In contrast, the experimental group showed an average gain of +4,5 points, with a highly significant effect ($t(89)=13,1$, $p<0,001$, $d=1,35$). These results show that the formative assessment strategy mediated by multimedia resources not only increased comprehension, but did so to a much greater extent than the traditional method, achieving an effect size considered large.

Table 3. Comparison between pre-test and post-test (Student's t-test for groups)

Group	Difference Mean (Post-Pre)	t(gl)	p	Cohen's d
Control	+1,5	4,2(89)	<0,001	0,45
Experimental	+4,5	13,1(89)	<0,001	1,35

Table 4 presents the results of the retention test administered two weeks after the intervention. The control group ($n=90$) achieved an average of 13,9 points ($SD=3,1$), while the experimental group ($n=90$) obtained a higher average of 15,8 points ($SD=2,8$). Both groups showed a slight decrease in their scores compared to the post-test, reflecting the natural loss of information over time. However, the decline was more pronounced in the control group (-1,7 points) than in the experimental group (-1,1 points). These findings suggest that formative assessment supported by multimedia resources not only improves immediate understanding but also contributes to greater stability in medium-term knowledge retention compared to traditional methods.

Table 4. Retention results at two weeks

Group	n	Mean (M)	SD	Drop from post-test
Control	90	13,9	3,1	-1,7
Experimental	90	15,8	2,8	-1,1

Table 5 presents the comparison between the groups in the retention test using Student's t-test. The results show statistically significant differences in favor of the experimental group ($t(178)=4,38$, $p<0,001$, $d=0,65$), which corresponds to a moderate-high effect size. This confirms that students assessed with multimedia resources retained a greater proportion of knowledge after two weeks compared to those assessed using traditional methods. In pedagogical terms, this finding supports the hypothesis that the incorporation of multimedia tools in formative assessment not only improves immediate comprehension but also promotes the consolidation of learning in long-term memory, reducing the natural loss of information.

Table 5. Comparison of retention (Student's t-test)

Comparison	t(gl)	p	Cohen's d
Experimental vs. Control	4,38(178)	<0,001	0,65

Table 6 shows the results of students' perceptions regarding the use of multimedia resources in assessment processes, measured using a Likert scale. It can be seen that the experimental group reported significantly higher scores in all dimensions evaluated: motivation ($M=4,24$, $SD=0,56$), conceptual clarity ($M=4,18$, $SD=0,60$), and perceived usefulness ($M=4,12$, $SD=0,58$), compared to the control group, whose averages were lower (motivation: $M=3,71$, $SD=0,69$; clarity: $M=3,68$, $SD=0,65$; usefulness: $M=3,66$, $SD=0,70$). The reliability analysis showed high internal consistency values in all dimensions (Cronbach's α between 0,84 and 0,88), which reinforces the validity of the results. The differences found were statistically significant ($p<0,01$ in all cases), indicating that students perceive multimedia-mediated assessment as more motivating, clear, and useful for their learning process.

Table 6. Student perception of multimedia resources (Likert scale 1-5)

Dimension	Cronbach's α	Control (M $\pm$ SD)	Experimental (M $\pm$ SD)	p (t)
Motivation	0,88	3,71 $\pm$ 0,69	4,24 $\pm$ 0,56	<0,01
Conceptual clarity	0,86	3,68 $\pm$ 0,65	4,18 $\pm$ 0,60	<0,01
Perceived usefulness	0,84	3,66 $\pm$ 0,70	4,12 $\pm$ 0,58	<0,01
Total scale	0,90	3,68 $\pm$ 0,68	4,18 $\pm$ 0,58	<0,01

Table 7 presents the emerging categories derived from the thematic analysis of the semi-structured interviews conducted with the participating teachers. Three main themes accounted for most of the perceptions:

Timely and specific feedback: Teachers emphasized that the use of multimedia resources facilitated immediate correction of students' errors, allowing them to guide the learning process in real time. One representative quote notes: "The simulators showed the error at the moment it occurred, which encouraged correction and active learning."

Conceptual clarity through visual aids: It was noted that videos and infographics helped explain abstract processes in a more accessible way, improving understanding. One teacher said: "The videos made it easier to explain complex concepts, making them more understandable for students."

Student autonomy and participation: Respondents agreed that the use of interactive platforms promoted more autonomous learning, encouraging participation and responsibility in knowledge construction. Example quote: "Digital resources encouraged students to review on their own and take greater responsibility for their progress."

Taken together, these categories show that formative assessment mediated by multimedia resources not only increases academic performance but also strengthens key pedagogical dimensions such as motivation, conceptual clarity, and autonomy, qualitatively complementing the quantitative results of the study.

Table 7. Emerging categories from teacher interviews		
Category	Brief description	Illustrative quote
Timely feedback	Immediate correction of errors	"The simulators showed the error at the time, which prompted correction."
Conceptual clarity	Improved understanding through visual aids	"The videos facilitated the explanation of abstract processes."
Autonomy and participation	Students were more active and responsible for their progress	"Digital resources encouraged students to review on their own."

Figure 1 shows a comparison of the average scores obtained by the control and experimental groups in the pre-test, post-test, and retention tests. It can be seen that both groups started at similar levels in the pre-test; however, after the intervention, the experimental group achieved significantly higher averages in the post-test and maintained better results in the retention test two weeks later. These data reflect the positive impact of formative assessment mediated by multimedia resources on learning comprehension and stability.

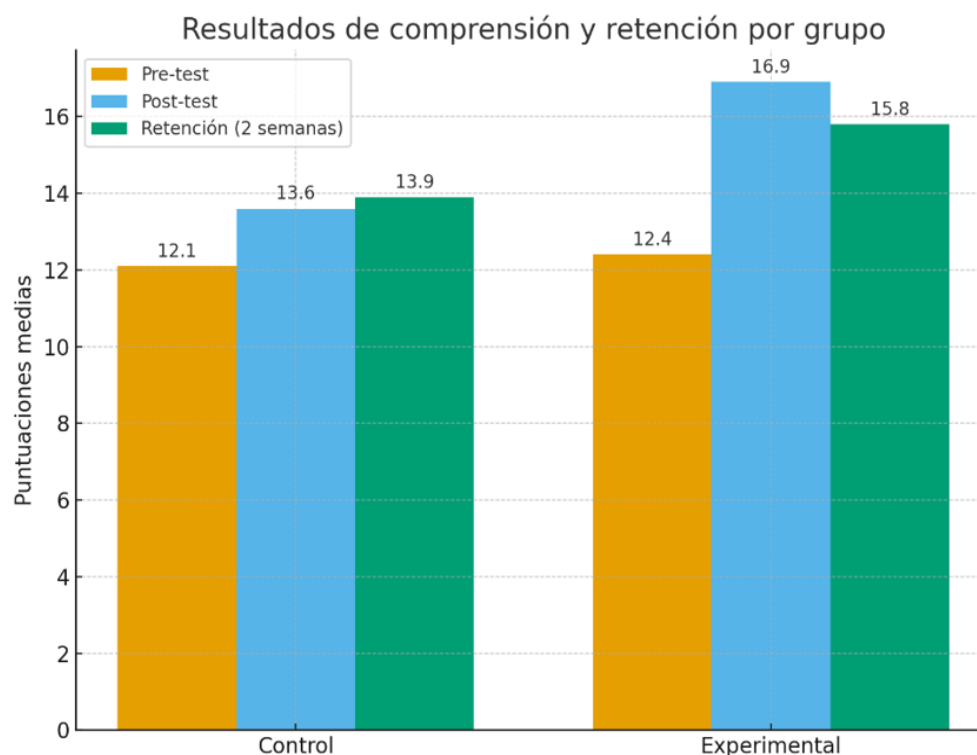


Figure 1. Comparative graph of results: shows the pre-test, post-test, and retention averages in the control and experimental groups

Figure 2 shows the scatter plot that relates the mean comprehension scores (post-test) to the retention scores at two weeks in the control and experimental groups. A positive trend can be seen: the higher the level of comprehension achieved, the greater the subsequent retention. The experimental group is located in the upper right corner of the graph, showing superior performance in both variables compared to the control group, which confirms the positive effect of multimedia mediation in formative assessment.

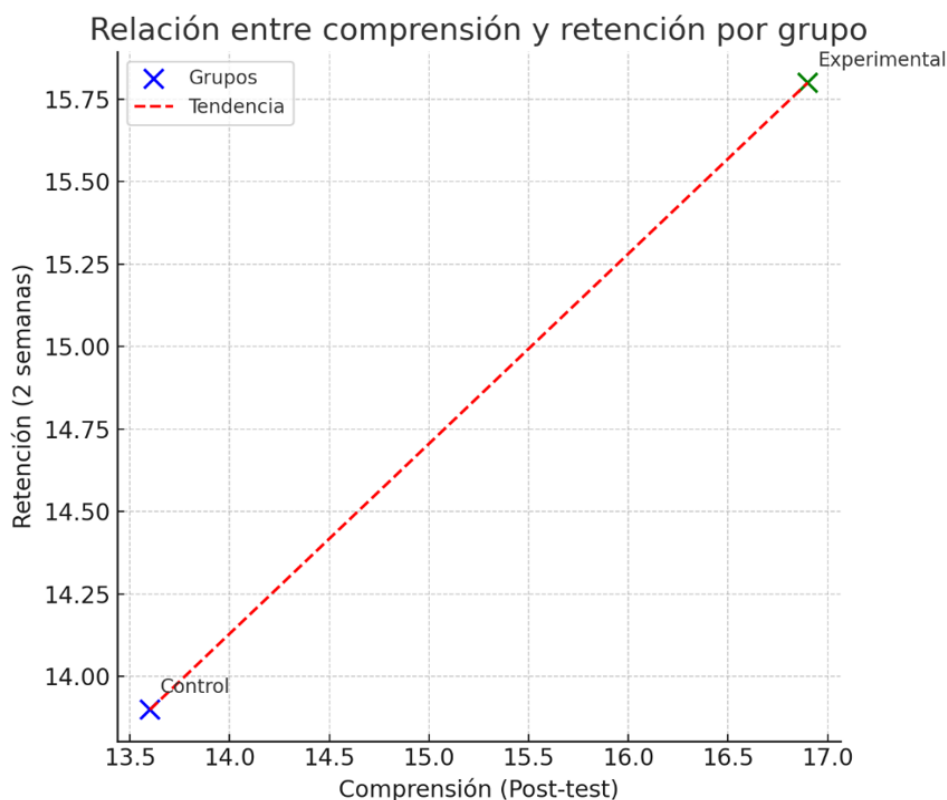


Figure 2. Scatter plot showing the relationship between comprehension (post-test) and retention (2 weeks) in the control and experimental groups

In summary, the results of the study show a clear advantage of the experimental group over the control group, both in immediate comprehension and in medium-term knowledge retention. Added to this is a favorable student perception of formative assessment mediated by multimedia resources, which is valued as motivating, clear, and useful, along with teacher testimonials that highlight its impact on feedback, conceptual clarity, and student autonomy. These findings reinforce the relevance of integrating digital resources into university assessment practices and lay the foundations for the critical reflection developed in the Discussion section, where the results obtained are contrasted with the scientific literature and their pedagogical implications are analyzed.

DISCUSSION

The results obtained in this study show that formative assessment mediated by multimedia resources enhances understanding and knowledge retention in university students. This finding coincides with the contributions of Black and Wiliam, who emphasize that formative assessment should be conceived as a continuous process that allows learning to be regulated in real time through immediate feedback.⁽¹⁾ Unlike summative approaches, which focus on grading, this type of assessment promotes reflection, and active student participation. Likewise, our findings confirm Sadler's assertion that feedback is effective only when it reduces the gap between the student's current performance and the expected level of learning.⁽²⁾ The significant increase in comprehension evident in the experimental group suggests that the incorporation of multimedia resources is an effective means of facilitating such feedback, providing visual and interactive support that improves content assimilation.

In terms of immediate comprehension, the experimental group showed much greater progress than the control group. This is related to Mayer's theory of multimedia learning, which states that the simultaneous processing of verbal and visual information favors the construction of more solid mental representations and the transfer of knowledge to new situations.⁽¹³⁾ Moreno and Mayer reinforce this idea by showing that multimodal environments not only increase comprehension but also encourage student motivation and active participation.

⁽¹⁴⁾ The results of this study coincide with these proposals, as the experimental group not only improved their post-test scores but also rated the conceptual clarity of the assessment activities positively, demonstrating that multimedia resources facilitate the comprehension of complex content.

In terms of knowledge retention, the data showed that students in the experimental group retained more of what they had learned after two weeks. This can be explained from the perspective of Ausubel's meaningful learning, which states that information is retained longer when it is substantively integrated into the student's cognitive structure.⁽¹⁵⁾ Complementarily, Sweller's cognitive load theory argues that an excess of poorly organized information overloads working memory and prevents transfer to long-term memory.⁽¹⁶⁾ In our case, multimedia resources helped distribute information more evenly across sensory channels, reducing unnecessary load and allowing learning to consolidate with greater stability. The fact that the experimental group showed a smaller drop in retention scores than the control group confirms that multimedia environments are not only useful for short-term learning but also ensure greater retention of knowledge in long-term memory.

In terms of student perception, the results of the Likert scale indicated that the experimental group rated multimedia-mediated activities more positively in terms of motivation, conceptual clarity, and perceived usefulness. This is consistent with Nicol's approach, which emphasizes that self-assessment and co-assessment strengthen students' self-regulation and metacognitive skills, while also enhancing their intrinsic motivation.

⁽¹¹⁾ Similarly, previous studies indicate that when students perceive clarity and usefulness in assessment processes, they tend to become more actively involved in their learning.⁽²⁶⁾ Our findings corroborate this trend, as participants in the experimental group highlighted that multimedia resources made the content more understandable and facilitated self-assessment of their progress.

Finally, the qualitative findings from the teacher interviews complement and reinforce the quantitative results. The testimonies highlighted three key aspects: timely feedback, conceptual clarity, and student autonomy. These elements are directly related to Vygotsky's sociocultural theory, which conceives of learning as a process mediated by cultural and social tools, in this case, digital resources.⁽¹⁷⁾ Likewise, the use of multimedia technologies functioned as scaffolding that expanded the zone of proximal development, allowing students to tackle more complex tasks with interactive support. On the other hand, from the perspective of constructivism, learning occurs more effectively when students interact with their environment and actively participate in the construction of knowledge.⁽¹⁸⁾ The interviews showed that multimedia-mediated activities fostered more autonomous and participatory learning, which supports the importance of integrating these tools into formative and summative assessment. In addition, the qualitative analysis conducted using Braun and Clarke's approach identified recurring patterns that reflect not only improved performance but also a change in the way teachers and students conceive of the assessment process.⁽³⁰⁾

Overall, the discussion confirms that the incorporation of multimedia resources in formative assessment has a positive impact in multiple dimensions: it increases immediate understanding, promotes knowledge retention, improves student perception, and transforms teaching practices toward more dynamic and participatory models. These results suggest that innovation in university assessment requires moving toward methodologies that integrate technology as a pedagogical mediator, responding to the demands of higher education in a digital and globalized context.

Theoretical implications

The results of this study reaffirm that formative assessment, when integrated with multimedia resources, is a pedagogical strategy that strengthens understanding and knowledge retention in higher education. From a theoretical perspective, the findings corroborate the validity of Mayer's⁽¹³⁾ multimedia learning theory and Sweller's⁽¹⁶⁾ cognitive load theory, showing that the combination of verbal and visual stimuli contributes to optimizing cognitive processes and consolidating meaningful learning. Likewise, Vygotsky's approach to the role of cultural mediators in learning is reinforced,⁽¹⁷⁾ highlighting that digital resources function as scaffolding that expands the possibilities of formative assessment in university contexts.

Practical implications

In the pedagogical sphere, research shows that multimedia-mediated formative assessment not only improves immediate performance but also ensures greater retention of knowledge in the medium term. This has a direct impact on teaching planning, as it guides educators toward adopting more dynamic and student-centered strategies. The immediate feedback, conceptual clarity, and motivation identified in this study are key elements that teachers can integrate into their assessment practices to increase the effectiveness of the teaching-learning process. In addition, the high positive rating of these strategies by students reinforces their relevance in contexts where motivation and participation are critical to academic success.

Future lines of research

Although the results are encouraging, further research with larger and more diverse samples, including

different university disciplines and cultural contexts, is recommended. It would be relevant to analyze how multimedia resources influence higher-order learning, such as critical thinking or problem solving, as well as to explore the effectiveness of different types of resources (simulators, augmented reality, mobile learning) in formative assessment. Finally, longitudinal studies could provide evidence on the sustained impact of these strategies on academic performance and long-term learning self-regulation.

CONCLUSIONS

The present study demonstrated that formative assessment mediated by multimedia resources is an effective strategy for enhancing understanding and knowledge retention in university students. The results showed that the experimental group, exposed to assessment activities supported by videos, simulators, and interactive platforms, achieved significant improvements compared to the control group, both in immediate understanding and in medium-term retention.

From a pedagogical perspective, it was confirmed that multimedia resources facilitate timely feedback, increase motivation, and contribute to greater conceptual clarity, which is consistent with multimedia learning theory and sociocultural learning theory. Likewise, the positive perceptions of students and teachers corroborate the value of integrating technology into formative assessment processes.

In summary, the evidence obtained highlights the need for higher education to incorporate dynamic, technology-mediated assessments, not only to improve academic performance, but also to foster autonomy, participation, and meaningful learning in students.

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FINANCING

None.

CONFLICT OF INTEREST

None.

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