ARTÍCULO ORIGINAL

Gac Méd Caracas 2025;133(1):134-144
DOI: 10.47307/GMC.2025.133.1.12

Influence of the quality of remote education on the satisfaction of Colombian university students

Influencia de la calidad de la educación remota en la satisfacción de estudiantes universitarios colombianos

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SUMMARY

Background: *In the global context of increasing reliance on remote education, driven by diverse circumstances, examining how its quality influences student experience and satisfaction is imperative. Such analysis is crucial for identifying areas of improvement and ensuring that remote education aligns with the standards required for effective learning. Accordingly, this study aims to evaluate the impact of the quality of remote education on student satisfaction at a higher education institution in Colombia.* **Methods***: This research employs a quantitative approach with a non-experimental design, utilizing convenience sampling to survey 520 undergraduate students from a public university. Data was analyzed using exploratory factor analysis and Spearman correlation.* **Results:** *The study identified three primary dimensions: technological limitations, teaching strategies, and concerns about educational quality. Despite the availability of technological tools, the PLA factor exhibited an average loading of 0.58, which negatively influenced the relationship between concerns about educational quality (0.63) and teaching strategies (0.65). These findings suggest that, although enhancements were made to teaching strategies, they did not significantly alleviate concerns regarding educational quality.* **Conclusions:** *The findings underscore that the quality of remote education substantially affects student satisfaction. Consequently, it is recommended that targeted strategies be developed to optimize this educational modality, particularly in settings with technological constraints, to enhance student experience in higher education institutions.*

Keywords: *Student satisfaction, remote education, educational quality, teaching strategies, undergraduate.*

DOI: https://doi.org/10.47307/GMC.2025.133.1.12

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Recibido: 14 de septiembre 2024
Aceptado: 6 de febrero 2025

RESUMEN

Introducción: *En un contexto global donde la educación remota ha ganado protagonismo debido a diversas circunstancias, es fundamental comprender cómo su calidad afecta la experiencia y satisfacción de los estudiantes. Este tipo de análisis es esencial*

para identificar áreas de mejora y garantizar que la educación en entornos remotos cumpla con los estándares requeridos para el aprendizaje efectivo. Al respecto, este artículo busca evaluar la influencia de la calidad de la educación remota en la satisfacción de los estudiantes de una institución de educación superior en Colombia. **Métodos:** *Se realizó un estudio cuantitativo con un diseño no experimental, utilizando un muestreo por conveniencia que incluyó a 520 estudiantes de programas de licenciatura en una universidad pública; se empleó el análisis factorial exploratorio y la correlación de Spearman.* **Resultados:** *Se identificaron tres dimensiones principales: limitaciones tecnológicas, estrategias de enseñanza y preocupaciones sobre la calidad educativa. Aunque se ofrecieron herramientas tecnológicas, el factor PLA mostró una carga promedio de 0,58, lo que afectó negativamente la relación entre las preocupaciones por la calidad educativa (0,63) y las estrategias docentes (0,65). Esto evidencia que, a pesar de las mejoras implementadas en las estrategias de enseñanza, estas no lograron disminuir significativamente dichas preocupaciones.* **Conclusiones:** *Los hallazgos confirman que la calidad de la educación remota impacta en la satisfacción de los estudiantes. Por ello, se recomienda desarrollar estrategias que optimicen esta modalidad educativa, especialmente en contextos con limitaciones tecnológicas, para mejorar la experiencia en las instituciones de educación superior.*

Palabras clave: *Satisfacción estudiantil, educación remota, calidad educativa, estrategias de enseñanza, pregrado.*

INTRODUCTION

The quality of higher education is a dynamic and multifaceted concept that has evolved, reflecting each era's social, political, economic, and cultural changes (1). This requires higher education institutions (HEIs) to adapt to contemporary demands, not to become obsolete, and maintain themselves as epicenters of knowledge construction (2). UNESCO (3) emphasizes that the quality of higher education should be understood as a multidimensional concept encompassing all university functions and activities, from teaching and academic programs to research, personnel, students, infrastructure, and the academic environment. Furthermore, educational quality is conceptualized from an integrating perspective that articulates the economic, political, and social spheres in which the protagonists of higher education are immersed (4). This articulation reflects a dynamic and contextualized approach to quality, which incorporates the diverse perspectives of professors, students, and the demands of the professional environment (2). At this intersection, evaluation is a key component that ensures that the education offered by Higher Education Institutions (HEI) meets the established standards (5).

Another important approach comes from the notion of student-centered quality, which postulates that higher education should prepare students for personal and social transformation, enabling them to acquire the necessary skills to advance in the future (6). This approach emphasizes the preparation of students for active engagement with society, highlighting the importance of an education that is not only technical or academic but also personally transformative (7).

Student satisfaction is essential to evaluating the quality of education in HEIs. It reflects the level of fulfillment of students' expectations and needs and is directly related to the perception of the quality of the educational service provided (8). This link is crucial for HEIs since high satisfaction can translate into higher student retention, better graduation rates, and a stronger institutional reputation (9,10).

Student satisfaction has been defined in multiple ways. Sánchez (11) and Surdez et al. (12) conceptualize it as both a cognitive and emotional perception of students regarding the adequacy of educational services to meet their educational expectations and needs. This definition highlights the multidimensional nature of satisfaction, which encompasses emotional, academic, and infrastructural aspects.

In the Colombian context, implementing quality management systems, such as ISO 9001, has promoted a more structured approach to measuring student satisfaction. However, Sanchez's research (11) suggests that the application of these standards in Colombian HEIs is not always carried out with the necessary rigor, possibly due to a lack of depth in the subject or methodological limitations in their implementation. The COVID-19 pandemic added

a layer of complexity, as HEIs had to quickly adapt their teaching and evaluation processes to a virtual environment, which has affected students' perception of educational quality (13,14).

In other words, student satisfaction is a crucial indicator of educational quality in HEIs. Its measurement and understanding allow institutions to improve their processes and services and ensure that students achieve their academic and personal goals in an environment that adequately responds to their needs and expectations (15). Adopting appropriate methodologies and considering contextual factors are essential to achieve an accurate and useful assessment of student satisfaction, especially in times of change and adaptation.

In the context of the COVID-19 pandemic, the concept of quality in higher education was tested due to the need to implement Emergency Remote Education (ERE) (16). This modality differs significantly from traditional e-learning, as it was conceived as a temporary and urgent response to a global health crisis without the rigorous planning and instructional design that characterize formal online education (16). ERE, therefore, is presented as an improvised solution to provide continuity to the educational process in an emergency context (17).

Although ERE and e-learning share technological tools, their implementation and objectives differ. While e-learning is based on constructing robust and planned learning environments that foster constant interaction and meaningful learning, ERE is a transitional measure that seeks to facilitate temporary access to education during a health crisis (18). This fundamental difference directly impacts the quality of education students receive, especially for the most vulnerable due to their lack of access to adequate technological resources (19).

This unexpected transition to ERE exposed not only the limitations of students' access to technology but also the lack of preparation of many teachers to deliver education using Information and Communication Technologies (ICT) (20). Recent studies have explored student satisfaction in the context of ERE, identifying factors that significantly influence student perception, such as the quality of interaction between students and teachers, the accessibility and quality of digital resources, and the institutional support received (21,22). However, there is little research in Colombia to understand how ERE quality affects student satisfaction in undergraduate programs.

Given this scenario, the central research question arises: How does remote education quality influence undergraduate students' satisfaction at a higher education institution in Colombia? The results of this research will enable public universities to make informed decisions about improving educational service in times of crisis, thus ensuring a more satisfactory learning experience for students.

METHODS

The present study adopts a quantitative approach that allows scientific research to be developed through orderly and systematic steps (23). This approach begins with an idea that, when delimited, leads to formulating objectives and research questions and recognizing the existing literature to elaborate the theoretical framework. Hypotheses are established based on research questions, and the variables to be measured in a specific environment are determined. Subsequently, the data collected are analyzed using statistical methods, allowing conclusions to be drawn about the hypotheses proposed (24).

The research design is non-experimental since the researcher does not manipulate the independent variable. In this type of design, pre-existing circumstances are observed retrospectively without being intentionally provoked by the researcher. Thus, independent variables occur naturally, without the possibility of direct manipulation, which limits control over them (25).

The fieldwork involved 520 students enrolled in the "Licenciatura en Tecnología" program at the Universidad Pedagógica y Tecnológica de Colombia. These participants, who are teachers in training, are being prepared to instruct at various educational levels—including primary, secondary, and middle school—within the technology field across diverse contexts. Their academic preparation emphasizes key areas such

as electronics, electricity, graphic expression, computer science, and mechanics.

The study employed non-probabilistic convenience sampling (26). From an ethical standpoint, all participants provided informed consent, which detailed the objectives and purposes of the research while safeguarding the privacy and confidentiality of the information collected (27).

Data was collected using the original instrument developed by Villa et al. (13), the COVID-19 class quality perception scale. Data analysis was performed with R software, version 4.2 (28). In addition, exploratory factor analysis was used to identify the underlying structure of the variables (29,30), and Spearman's correlation was used to evaluate the relationships between them (31).

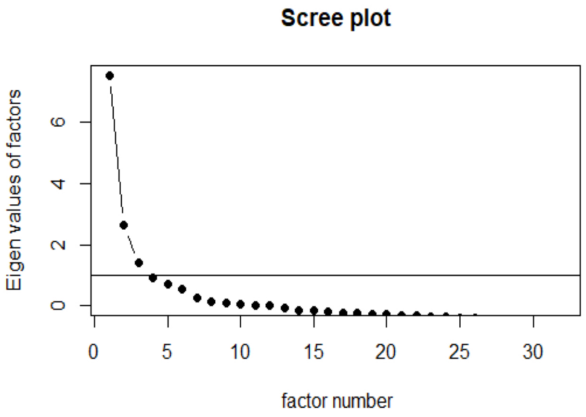

Figure 1. Factor Extraction.
Note: The graph shows the number of factors identified in the original Villa et al. scale (13). It was taken from results obtained through R 4.2 software.

RESULTS

1. Construct validity and reliability analysis

To assess the construct validity of the COVID-19 scale of perception of classroom quality in times of COVID-19, an Exploratory Factor Analysis (EFA) was performed on the 32 items that make up the instrument. Initially, the data structure was verified to determine if they were appropriate for a factor analysis. This verification was carried out by elaborating a polychoric correlation matrix, Bartlett's test of sphericity, and the Kaiser-Meyer-Olkin (KMO) test of adequacy (30). The results showed that the variables presented sufficiently high correlations to proceed with the AFE (32). The KMO index obtained was 0.87, a value considered meritorious and indicating that the data are suitable for factorization (33).

Once the adequacy of the data was confirmed, factors were extracted using the Unweighted Least Squares Estimation method (34). This method was selected because it effectively treats ordinal variables and provides reliable results with small samples. To determine how many factors should be retained, the Scree Test (35) was used, which helped to identify three main factors (Figure 1), coinciding with the findings of Villa et al. (13).

Subsequently, the factorial model was constructed by applying an Oblimin rotation, which is frequently used in the social sciences because it allows a more precise identification of the underlying structure of the variables, considering the possible correlation between the factors. This rotation seeks a solution that conforms to the principle of simple structure, thus facilitating the interpretation of the relationships between the identified factors (32).

The Exploratory Factor Analysis (EFA) identified three latent factors, each associated with a set of variables with specific factor loadings. Following the criteria of Villa et al. (13), only the variables with a factor loading greater than 0.40 were retained, which led to keeping 20 of the 32 original items of the scale. Then, a new AFE was performed with the reduced version of the scale, a process necessary after the elimination of items to validate the instrument's structure and guarantee its consistency (35). This repetition ensures that the adjusted scale maintains its ability to measure the dimensions of the theoretical construct (36). The results of the adjusted AFE are presented in Table 1, showing the final factor structure of the cleaned instrument (factor loadings range from 0.45 to 0.78).

Table 1. Exploratory Factor Analysis (20 variables)

	Ítem	F1	F2	F3
1.	I must share the computer with people in my family. For this reason, I cannot always attend remote classes.	0.51	0.07	0.05
2.	The computer I use has damaged audio and/or camera.	0.55	0.07	0.10
3.	I don't have a computer; I access classes from my cell phone.	0.64	0.03	0.00
4.	My internet access is limited.	0.61	-0.09	-0.03
5.	I have internet access, but poor connectivity.	0.57	0.04	0.09
6.	My data is insufficient to access all remote classes.	0.69	0.04	0.04
7.	My knowledge of virtual platforms is limited.	0.59	-0.08	-0.18
15.	I do not do the class readings because I cannot access them.	0.46	-0.21	0.10
8.	The teachers have an excellent command of the platform.	-0.01	0.67	0.02
9.	In remote classes, teachers encourage interaction.	-0.16	0.56	0.09
10.	The professors open counseling spaces to solve doubts that were not solved during remote classes.	-0.19	0.47	-0.11
13.	The teachers are innovative and keep me motivated in class.	0.09	0.78	-0.10
16.	Teachers provide easily accessible support material.	-0.14	0.66	0.09
19.	Teachers incorporate new strategies facilitating learning in remote classrooms.	0.08	0.78	-0.06
11.	The requirement in remote classes is limited to the development of workshops.	0.03	0.03	0.60
12.	Virtual education discourages human relationships, which are necessary to strengthen learning.	0.06	-0.11	0.73
14.	In remote classes I learn little because I easily lose my concentration.	0.10	-0.13	0.59
17.	The lack of a direct relationship between teachers and students weakens the construction of analytical and critical thinking.	-0.04	0.02	0.66
18.	Remote classes decreased learning content.	-0.05	0.03	0.76
20.	Remote classes changed assessments impacting quality.	0.06	0.12	0.45

Note. Results obtained through the RStudio program

The factors identified in Table 1 reflect various dimensions of the educational experience during remote classes. The first-factor groups variables that illustrate students' constraints in accessing remote classes. The second factor highlights strategies employed by faculty and their role in remote education. The third factor addresses concerns about the quality of the educational process as a result of the transition from face-to-face to online learning. These factors are based on previous studies (8,13-15,21,36-39), which have assessed satisfaction with remote education, especially highlighting that of Villa et al. (13). Consequently, factors F1, F2, and F3 in this research are labeled as Perceived Access Limitations (PLA), Teaching Strategies Adopted by the Teacher (EEAP) and Concerns about Educational Quality (PCE), respectively.

In this research, the reliability of each factor was assessed using Cronbach's alpha coefficient. Since this coefficient is more appropriate when examining the reliability of individual factors in a scale with multiple dimensions, instead of analyzing the instrument as a whole, Cronbach's alpha was calculated for each of the three factors identified (40). The values obtained for the PLA, EEAP, and PCE factors were 0.77, 0.80, and 0.78, respectively, indicating that the internal consistency of the EEAP factor is satisfactory and that the PLA and PCE factors are close to reaching that level (24).

2. Analysis of the results of each factor

This section analyzes the most representative loadings of the factors PLA, EEAP, and PCE. In the research, factor loadings higher than 0.60 were considered more significant (41). Within the PLA factor, items that reflect significant student

restrictions when accessing remote classes stand out. For example, the variable "I do not have a computer, I access classes from my cell phone" presents a factorial loading of 0.64, highlighting the limitations caused by the lack of economic or technological resources (42). Likewise, the factor loading of 0.61 for "my access to the Internet is limited" underscores the influence of geographic and economic barriers on students' connectivity (43). Similarly, the factor loading of 0.69 associated with "my data is insufficient to access all remote classes" evidences the difficulties of those students who rely on mobile data packages, which are often insufficient for sustained remote education (44).

The EEAP factor shows high factor loadings that reflect a positive perception of the methodologies employed by teachers during the ERE (13). For example, the variable "teachers have an excellent command of the platform" presents a loading of 0.67, indicating that institutional training and self-learning have been effective in improving teaching skills in the use of digital tools such as Moodle, Google Meet and Zoom, as well as in the creation of multimedia materials (45). Similarly, the significant loading of 0.78 on "teachers are innovative and make me stay motivated in class" suggests that adopting creative and innovative methodologies was crucial in maintaining student motivation during the pandemic (46).

In addition, the loading of 0.66 on "teachers provide easily accessible support material" highlights the effectiveness of combining formal platforms with communication tools, such as WhatsApp and YouTube, to ensure pedagogical continuity (47). The loading of 0.78 on "teachers incorporate new strategies facilitating learning in remote classes" demonstrates how teachers have adopted dynamic and flexible educational approaches, encouraging collaborative work and active student participation, thus facilitating learning and the acquisition of digital competencies (48).

The analysis of the PCE factor reveals a growing concern among students about the quality of remote classes in crises (13). The factor loading of 0.73 on the variable "virtual education discourages human relationships, necessary to strengthen learning" indicates that the reduced social interaction in ERE has negatively affected students' learning, limiting direct contact with classmates and professors (49). This concern is complemented by the loading of 0.66 on "lack of direct relationships with professors and students weakens the construction of analytical and critical thinking", highlighting the importance of face-to-face interaction for developing critical skills essential in academic training (50). In addition, the factor loading of 0.76 on "remote classes diminished learning content" reflects the debate that has arisen on what essential content should be prioritized in a remote education context, especially in the face of the curricular reduction that was implemented in several Latin American countries during the pandemic (51).

3. Correlation analysis between factors

Spearman's correlation analysis determined the relationship between the factors PLA, EEAP, and PCE, which make up the construct of perception of the quality of the ERE classes. Table 2 shows that the correlation between the PLA and EEAP factors is negative on average, with a Rho in the range of -0.11 to -0.50 and a statistically significant correlation coefficient (ϱ=0.01), i.e., less than 0.05. A similar pattern is observed between the EEAP and PCE factors, with a Rho of -0.420 and an ϱ of 0.01, indicating a medium and significant negative correlation. On the other hand, the correlation between PLA and PCE is positive mean, with a Rho between +0.11 and +0.50, also significant (ϱ = 0.01) (31).

These results suggest that the teaching strategies adopted by the teacher have an inversely proportional relationship with concerns about educational quality. That is, a better perception of teachers' preparation and execution of academic activities may decrease students' concerns about educational quality (13). However, this effect may be negatively affected when students' access limitations increase since these limitations have a direct relationship with concerns about educational quality and an inverse relationship with the teaching strategies adopted by teachers. Therefore, the more access limitations students experience, the greater their concerns about educational quality, affecting the teaching strategies' effectiveness (52).

Table 2. Correlation analysis between PLA, EEAP, and PCE factors.

Factors	Rho de Spearman		
	PLA	EEAP	PCE
Percepción de Limitaciones de Acceso (PLA)		-0.311**	
Estrategias de Enseñanza Adoptadas por el Profesor (EEAP)			-0.420**
Preocupaciones sobre la Calidad Educativa (PCE)	0.141**		

** The correlation is significant at the 0.01 level (bilateral).
Note. Results obtained through the RStudio program.

DISCUSSION

The study's results confirm the research hypothesis that remote education quality influences undergraduate students' satisfaction at a higher education institution in Colombia. Despite the institution's efforts to provide technological tools to students with access limitations, the PLA factor showed an average factor loading of 0.58, close to the representative level (greater than 0.60), suggesting difficulties in the teaching and learning process. This situation affected the relationship between the PCE and EEAP factors, with factor loadings of 0.63 and 0.65, respectively, indicating that, although improvements in teaching strategies were implemented, these were insufficient to reduce students' concerns about educational quality significantly.

These results reinforce the findings of Villa et al. (13), which indicate that access limitations modify the relationship between educational quality concerns and teaching strategies, hindering the teaching and learning process. Similarly, Kéri (38) points out that the quality of online classes affects this relationship due to technological restrictions. However, Fatani (8) states that technological challenges do not always cause significant concerns about the quality of classes as long as teaching strategies are effective.

It is also observed that, within the PLA factor, the items related to the use of cell phones, due to the lack of a computer to access remote classes, and limited access, either with data packages or with an Internet network, have greater representativeness. This finding contrasts with that reported by Villa et al. (13), who identified that the most representative variables refer specifically to restrictions in accessing remote classes through a computer, either because of the need to share it with other family members or because of technical problems such as audio or camera failures.

The discrepancy between the results of the present study and that of Villa et al. (13), despite having been carried out in Colombian universities, suggests that the access limitations perceived as relevant by students are not necessarily homogeneous. This divergence could be attributed to the collection of data in different cities, where students are immersed in varied contexts in terms of education, family, social, and economic environment, factors that significantly influence the difficulties in accessing remote classes (14).

It is relevant to note that the research conducted by Dinh and Nguyen (39) in Vietnam. However, it does not explicitly address access limitations as a factor, coinciding with the present study in the importance that students attach to difficulties related to Internet access to participating in remote classes. This similarity may be attributable, despite differences in the two countries' educational, social, family, and cultural environments, to the fact that both Vietnam and Colombia are developing countries. This suggests that such limitations tend to be more prevalent in developing nations, especially during crises such as health emergencies (39).

In the EEAP factor, it is evident that, in agreement with Villa et al. (13), there is a coincidence between the representative items that praise the adequate management of the platform by teachers, the provision of easily accessible

support material, and the implementation of new strategies to facilitate learning. This finding underlines the importance of the role of teachers in the ERE, especially in terms of pedagogical adaptation and flexibility.

It is relevant to note that various investigations have incorporated elements related to the teaching strategies adopted during the health emergency, thus highlighting the active role of teachers in the planning and implementation of training activities (8,13-15,21,36-39,52). These strategies were essential to overcome the challenges perceived by students when accessing remote education (13).

The results of the PCE factor coincide with the study by Villa et al. (13) regarding the representative items that address concerns such as the discouragement that online education experts on human relations that are fundamental to strengthening learning, the weakening of the construction of analytical and critical thinking due to the lack of direct interaction with teachers and peers, and the reduction of learning content. These coincidences suggest that students share concerns about educational quality, given its importance for their professional future. Therefore, comprehensive content coverage, strengthening of human relations, and developing analytical and critical thinking are essential for complete academic training (53,54).

In this context, the findings of the analysis of the construct validity and reliability of the original instrument by Villa et al. (13), called "Scale of perception of the quality of classes in times of COVID-19", applied to students of bachelor's programs, confirm that the construct of perception of the quality of ERE classes is composed of the following factors: i) perception of access limitations, ii) teaching strategies adopted by the professor, and iii) concerns about educational quality, since these largely coincide with the results of the study by Osmani (37) and show a close relationship with the research by Villa et al. (13). In addition, such correspondence is observed in previous research, such as that of Quispe et al. (14), Pérez et al. (36), Hamdan et al. (21) and Fatani (8), specifically concerning the first two factors. The third factor also finds concordance in the studies by Gopal et al. (15), Dinh and Nguyen (39), and Kéri (38).

The dimensionality of the construct of perception of the quality of ERE classes has been scarcely explored in countries such as Brazil, Chile, Jordan, Saudi Arabia, India, Vietnam, and Hungary. At the same time, in some of these nations, it is conceived as a unidimensional construct; in others, it is understood bi-dimensionally (55). However, in countries such as Colombia, Peru, Mexico, Costa Rica (13), and Iran (37), student satisfaction has been evaluated from a multidimensional construct, as in the present research, since the perception of the quality of ERE classes requires the consideration of various factors that reflect its breadth and diversity (13).

In this regard, the pandemic revealed important gaps in the implementation of the ERE, highlighting the need for greater preparation and training in digital skills for both teachers and students (56,57). The lack of preparation and adequate access to the necessary technologies has harmed learning, underlining the importance of continuous training in Information and Communication Technologies (ICT) to ensure quality education in times of crisis and beyond (58).

CONCLUSIONS

It can be stated that the influence of the quality of remote education on the satisfaction of students in bachelor's programs is conditioned by the degree of perceived access limitations. In contexts with fewer limitations, teachers' teaching strategies are more effective in mitigating students' concerns about educational quality. However, when access limitations increase, this positive effect decreases, restricting students' active participation in the educational process.

The analysis of the average factor loadings of the EEAP factor, with a value of 0.65, demonstrates the positive impact of the effort made by teachers to respond to the demands of remote emergency environments. The variables with the greatest representativeness within this factor, with factor loadings of 0.78, highlight that, despite the difficulties of the health emergency, teaching work was essential to improve students' perception. Pedagogical innovations and

new strategies implemented by teachers not only maintained students' motivation but also facilitated their learning in an adverse context, thus reflecting teachers' ability to be flexible and effective in the face of educational challenges in times of crisis.

Authors' contribution

All authors participated in the review's conception, creation of objectives, setting of inclusion criteria, interpretation of the data, critical review of the manuscript, translation of the manuscript, and approval of the final version for publication.

Conflict of Interest. The authors state that they have no conflict of interest

Funding. The study received no financial support from anywhere

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