Multidimensional indicator to measure quality in education

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A B S T R A C T

In this research, a multidimensional indicator to measure quality in education in public high schools is proposed. In the study, carried out in the Atlántico region in Colombia, the initial step was to identify the factors that directly affect education quality through databases and teacher surveys. Then, statistical analysis was performed through multiple regression to develop an equation of weighted factors, based on the quantification of each factor's importance in influencing education quality, allowing the identification of the most relevant factors. Additionally, a quality measurement methodology is proposed based on categorizing the most critical factors into extrinsic and intrinsic factors, obtaining a consistent result with the conditions at each school. The results of the study demonstrate the relevance of extrinsic factors, mainly the social context. Such results imply that beyond the activities performed to strengthen classroom teaching, the social component is a crucial factor to improve education quality and that variables such as extracurricular activities support the students' integral formation and positively impact their academic performance.

1. Introduction

The role that education quality plays in sustainable development is a topic that has gained increasing importance in society (Jalongo et al., 2004). Even though education has become a relevant discussion topic and multiple efforts have been made to drive for its substantial improvement, there is still a considerable gap between the results obtained to date and the education goals proposed by the United Nations Development Program (UNDP) (López, 2010). The failure at pursuing the UNDP goals is evidenced by the fact that there are still 617 million children in the world who are not receiving the minimum levels of learning required to achieve the sustainable development goals. Therefore, the reduction of this number is a critical task (Murillo and Román, 2010). In the case of Latin America, there is no consensus between governments, teachers associations, parents associations, researchers, and other organizations on what the concept of quality in education means, leading to many actions that may not have the required impact on it.

Whereas a growing consensus has been made around the concept of education quality as including the factors involved in addressing the cognitive, expressive, citizenship, and value-based aspects required for

the integral development of human beings, education assessment generally does not include a holistic process. In this sense, it can be said that education assessment remains trapped in a system that is limited and reduced to reviewing students' performance only in curricular areas such as language, mathematics, and sciences (Sahu et al., 2013). To address this problem, the government of Colombia has implemented since 2015 an evaluation method for high schools' institutions, known as the Synthetic Index of Education Quality (ISCE, for the acronym in Spanish). This index comprises four elements: *i)* The progress, which measures the schools' improvement regarding the national standardized test for high school students (ICFES-Saber, for the acronym in Spanish). In this element, the mean result obtained by the students during the current year is compared against the mean obtained the previous year, assigning to this change a weight of 40% in the index; *ii)* The second element is efficiency, which considers the proportion of students promoted to the next school year (10% weight); *iii)* The third element is performance, which allows comparing those schools' standings out from the rest in the country regarding the ICFES-Saber test scores (40% weight); *iv)* Finally, the last element considered in the ISCE index is the school environment, which reviews the context in which the students take their lectures, based on a survey taken at schools simultaneously

Table 1

Most relevant quality factors.

Quality factor	Associated authors
School administration	Jalongo et al. (2004), López (2010), Murillo and Román, 2010, Sahu et al. (2013), Gambhir et al. (2016), Viswanadhan (2007), De La Orden (2009), Du et al. (2010), Shah (2012), Ahmad (2015), Shuang (2015), Ko (2017), Liu (2017), Veras, 2005, Udouj et al. (2017)
Teachers	Jalongo et al. (2004), Blanco (2011), Volosovets et al. (2017), López (2010), Blanco (2011), Murillo and Román, 2010, Sahu et al. (2013), Gambhir et al. (2016), Viswanadhan (2007), De La Orden (2009), Du et al. (2010), Tsinidou et al., 2010, Lupo (2013), Ahmad (2015), Shuang (2015), Bezpalko et al. (2016), Ko (2017), Liu (2017), Udouj et al. (2017)
Curriculum design and development	Jalongo et al. (2004), Blanco (2011), Murillo and Román, 2010, Sahu et al. (2013), Gambhir et al. (2016), Viswanadhan (2007), De La Orden (2009), Du et al. (2010), Tsinidou et al., 2010, Lupo (2013), Ahmad (2015), Shuang (2015), Bezpalko et al. (2016), Ko (2017), Liu (2017)
School environment management	Jalongo et al. (2004), Blanco (2011), Volosovets et al. (2017), Blanco (2011), De La Orden (2009), Ahmad (2015), Shuang (2015), Ko (2017), Liu (2017), Veras, 2005, Udouj et al. (2017)
Extracurricular activities	Jalongo et al. (2004), Volosovets et al. (2017), Sahu et al. (2013), Viswanadhan (2007), Ahmad (2015), Shuang (2015), Liu (2017)
Administrative management	Murillo and Román, 2010, Sahu et al. (2013), Viswanadhan (2007), De La Orden (2009), Tsinidou et al., 2010, Shah (2012), Lupo (2013), Shuang (2015), Ko (2017), Veras, 2005, Udouj et al. (2017)
Financial management	López (2010), Gambhir et al. (2016), Viswanadhan, (2007), De La Orden (2009), Veras, 2005
Educational resources and infrastructure	Jalongo et al. (2004), López (Blanco, 2011), Sahu et al. (2013), Gambhir et al. (2016), Viswanadhan (2007), De La Orden (2009), Tsinidou et al., 2010, Lupo (2013), Ahmad (2015), Shuang (2015), Bezpalko et al. (2016), Ko (2017), Liu (2017), Veras, 2005, Udouj et al. (2017)
Learning outcomes	Blanco (2011), Murillo and Román, 2010, Viswanadhan (2007), De La Orden (2009), Du et al. (2010), Shah (2012), Bezpalko et al. (2016), Liu (2017)
Social participation	Jalongo et al. (2004), Blanco (2011), Murillo and Román, 2010, Gambhir et al. (2016), Du et al. (2010), Shuang (2015)
Student perceptions	Shah (2012), Lupo (2013), Ahmad (2015), Shuang (2015) and Bezpalko et al. (2016)
Context	Sahu et al. (2013), Gambhir et al. (2016), Du et al. (2010)
Inclusion	Plancarte (Cansino, 2017)

with the ICFES-Saber tests (10% weight) (Gambhir et al., 2016).

ISCE is another proposal providing evidence that these indexes include elements that many researchers consider not to impact the quality of education and to be focused mainly on curricular areas. There is still much discussion in educational entities on which of the methodologies should be used to obtain an objective measurement of education quality, keeping in mind that the mainstream notion in the academic community and government entities is that education quality refers only to the students' performance in standardized tests (Viswanadhan, 2007). Such a definition is rather misleading, especially when several authors approach the definition of education quality from a multidimensional perspective, such as interests, methods, models, and systems (De La Orden, 2009).

This research aims to provide an objective tool to measure education quality, considering the drawbacks of the different indexes used nowadays for this purpose. Therefore, this article proposes a multidimensional index that effectively measures education quality at the schools in the Atlántico region in Colombia. This index aims to identify the factors that mainly influence education quality and its influence degree. In

doing so, the government can become aware of the factors that should be tackled to improve the educational field, enhance its processes' efficiency, and ensure that quality outcomes are among the best international standards.

2. State of the art

Quality is defined by the international standard ISO 9000 (2005) as the degree to which a set of inherent characteristics of an object (product, service, process, person, organization, system, or resource) fulfills needs or established expectations, which are generally implicit or mandatory (Du et al., 2010).

This definition of education quality becomes confusing when incorporated into the educational context as it can be a subjective term assessed from different perspectives. Therefore, authors have disagreed on the term's meaning, which has led to various concepts associated with education quality (Shah, 2012).

When the term quality is mentioned in education, the concept tends to take on a meaning that comprises complexity and multiple dimensions (Ahmad, 2015), implying that the idea should be approached from different perspectives. However, these perspectives avoid discussing education quality in abstract and general terms. Therefore it is necessary to explain the perspective used when discussing education quality.

Education quality includes multiple factors that must work in synergy to achieve the satisfaction of all stakeholders, as pointed out by Sahaney, Banwet, and Karunes (Shuang, 2015). Tangible factors such as students, teachers, administrative staff, physical facilities and infrastructure, teaching, learning outcomes, and curricular and extracurricular activities are all critical criteria for the study's approach and improvement towards the search for excellence (Shuang, 2015).

Given the importance of defining the factors that most affect education quality at high schools, a literature review by Crissien et al. (Ko, 2017) identifies the most relevant factors to consider for adequately studying the reality at schools. Such factors are summarized in the following table: Table 1.

3. Methodology

The research was carried out in the Atlántico region, located on the north coast of Colombia, South America. It consisted of different stages aligned with the research objective, as displayed in Fig. 1.

4. Case study

4.1. Advanced search of factors that directly affect education quality

This step was carried out using specialized databases such as Scopus, Web of Science, Google Scholar, and IEEE. The objective was to find all the factors that directly affect schools' education quality, considering the academic level at which each factor was used to improve education quality.

As a result of the review, the following factors were selected to be considered within the study for the correct measurement of education quality:

- School administration: This factor refers to how school directors contribute to schools' strategic and pedagogical direction.
- Teachers: This factor refers to skills teachers have, which allow them to teach effectively.
- Curriculum design and development: This factor refers to the relevance of the objectives, contents, methodological criteria, and evaluation techniques as the cornerstone of the academic activity.
- School environment management: This factor refers to the conditions conducive to learning in the high school classroom.
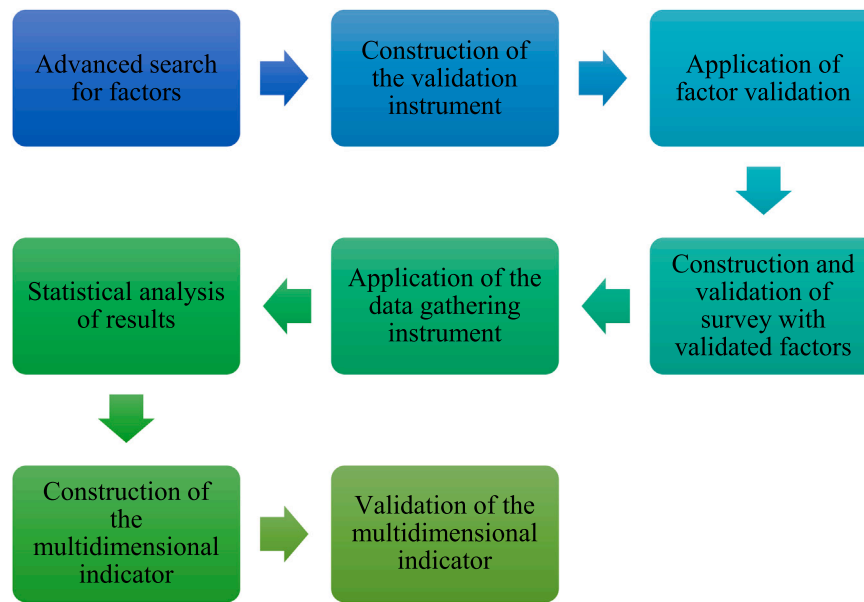
Fig. 1. Steps of the methodology.

- Extracurricular Activities: This factor refers to the playful and recreational activities carried out outside the classroom that provide positive experiences for students.
- Administrative Management: This factor refers to the administrative services that support supervision and monitoring activities in the execution of educational and social programs implemented in the school
- Financial Management: This factor refers to how resources are assigned to continuous improvement tasks within the institution
- Educational resources and infrastructure: This factor refers to the availability of physical or didactic tools that support teaching activities in the classroom.
- Learning outcomes: This factor refers to essential competencies and skills acquired by the student within the learning process within the school.
- Social participation: This factor refers to the involvement of stakeholders (e.g., parents and community) within the educational process of the schools.
- Student perception: This factor refers to the degree of satisfaction that students have about each of the educational components of the institutions
- Context: This factor refers to the variables such as local and international socio-cultural conditions, types of interactions, the generated interests, beliefs, among others.
- Inclusion: This factor refers to how the institutions include equity in the learning and administrative processes.

4.2. Construction of the instrument to validate the education quality factors

A survey was designed to validate the relevance of each of the above factors and determine whether they should be included in an objective measurement tool of education quality. The survey asked teachers from public high schools in the Atlántico region (Colombia) about their perceptions of the factors to consider. A Likert scale was used in the process, in which five means total agreement and one means complete disagreement.

At this stage, the basis for validation was the number of active teachers in the Atlántico region, and the following sample size equation was applied to the total population:

Table 2
Results of the factor validation survey.

Quality factor	Average
School administration	4.46
Teachers	4.69
Curriculum design and development	4.66
School environment management	4.46
Extracurricular activities	4.14
Administrative management	4.42
Financial management	4.46
Educational resources and infrastructure	4.45
Learning results	4.38
Social participation	4.32
Student perceptions	4.35
Context	4.36
Inclusion	4.50

$$n = \frac{Z^2 + p \times q}{e^2 + \frac{Z^2 \times (p \times q)}{N}} \tag{1}$$

Where.

n = sample size.

Z = desired confidence level.

p = proportion of the population with the desired characteristic (success).

q = proportion of the population without the desired characteristic (failure).

e = Acceptable error level.

N = Population size.

According to the latest data provided by the Colombian Statistics Administration (DANE), the population of teachers in the Atlántico region was 6996 [32]. When these values are inserted into the above formula (Eq. (1)), the target sample size is 365 teachers for a confidence level of 95% with a 5% error. This total of 365 was distributed proportionately among the five subregions of the Atlántico region (Center, Metropolitan, East, Coastal, and South) to cover the entire study territory.

4.3. Application of the factor validation instrument

The survey was applied to small focus groups in which the study

Table 3
List of factors and subfactors.

Quality factor	Subfactors	Number of questions in the survey (variables)
School administration	School educational project, educational objectives, institutional mission and vision, institutional values, education policy planning, and monitoring	12
Teachers	Teacher ratio, student/teacher ratio, teacher conformity, percentage of teachers with graduate degrees, professional experience, academic production, assigned hours, teacher training.	15
Curriculum design and development	Contents taught, teaching contents and curricular innovation, the usefulness of the contents, bilingual teaching, reforms in teaching methods and aids, effectiveness of the teaching methods reforms, textbook selection, combination of theory and practice, assessment.	16
School environment management	Strategies to develop a learning culture, student abidance of institutional regulations, professional ethics of teachers, safety rules, health conditions, communications channels, development of autonomy.	9
Extracurricular activities	Percentage of students in extracurricular activities, number of extracurricular activities in science, technology, and culture.	2
Administrative management	Academic planning and monitoring, inspection of the teaching/assessment process, facilitation of various teacher and student demands, teacher supervision and assessment, teacher recognition.	10
Financial management	Fund available for teaching staff, spending in education per student, external contributions.	3
Educational resources and infrastructure	Number of classrooms, classroom capacity, number of laboratories, laboratory capacity, the sufficiency of the library, sufficiency of computer rooms, teacher support equipment and resources, facilities assigned to teaching work, sports facilities, cultural facilities, medical facilities.	25
Learning outcomes	Percentage of students who pass the school year, desertion rate, repetition rate, knowledge, and skills.	4
Social participation	Participation by civil society organizations, local community participation, family participation.	10
Student perceptions	Monitoring of student perceptions,	3
Context	Socioeconomic, safety, study, access.	4
Inclusion	Creation of an inclusive culture, inclusive policies, inclusive practices.	2

objectives were explained to schoolteachers. Then, their perceptions on each of the factors found in the literature were recorded numerically.

The survey's results indicate widespread acceptance of every one of the factors found in the literature, given that all responses averaged more than 4 points. The results of each factor are displayed in Table 2:

Table 4
Summary of the most significant variables.

Factor	Question number	Estimate	Standard Error	Statistical T	P-Value
School environment management	P1.5	2198	0685	3209	0,0017
Extracurricular activities	P1.6	386	1200	3218	0,0017
Educational resources and infrastructure	P1.8	1185	0462	2561	0,0118
Learning outcomes	P1.20	1462	0470	3106	0,0024
Curriculum Design and Development	P7.5	2129	0433	4908	0,0000
Context	P7.16	2693	0622	4323	0,0000
Context	P7.17	1865	0468	3979	0,0001
Inclusion	P2.34	1016	0417	243	0,0164
School administration	P2.3	2398	0604	3969	0,0001

4.4. Construction and validation of the survey using the factors validated by the Likert scale

The scientific literature review in the specialized databases produced 13 primary factors, which were validated in the above step. In turn, each of these factors has some subfactors, from which questions will be derived to carry out a thorough diagnosis of each school. Table 3 displays the list of factors and subfactors.

Based on these factors and subfactors, the survey was designed to assess each one on a Likert scale. This survey was addressed to the schools' principals in the Atlántico region.

The relevance of the designed survey was validated using Cronbach's Alpha, which is an indicator of the internal consistency of the questions [33], [34]. The Cronbach's Alpha value for the survey was 0.88, which indicates a high level of correlation between the questions and their reliability for making an accurate characterization of reality.

4.5. Application of the survey instrument at high schools of the Atlántico region

The population of public high schools in the Atlántico region was calculated considering different sources of information. The first source was the number of public schools officially listed on www.datos.gov.co. Only the schools in the Atlántico region, excluding its capital city (Barranquilla), were obtained from this source. To this number, the schools reported by the education office of the city of Barranquilla were added.

The conjunction of these two databases adds up to a population of schools in the Atlántico region of 278 [35], [36]. By incorporating the values into the above formula, a sample size of 118 high schools was obtained.

4.6. Statistical analysis

Once the survey was carried out, multiple linear regression was used to assess the relationship between a metric dependent variable (ICFES 2018 test results) and several independent variables. These variables represent the responses to the survey. As it can be observed in Table 3, each factor is related to some subfactors. In the case of the factor' School administration,' it is related to 5 subfactors. In order to gather the information associated with this factor (School administration), 12 questions were included in the survey. Some subfactors are covered by one question and others by more than one question. Each question is interpreted in the model as an independent variable, meaning that the first factor (School administration) has 12 variables associated with it. This

Table 5

Categorization of the significant variables.

Factor	Subfactor	Question number	Question	Category
School environment management	Student Compliance with Institutional Regulations	P1.5	How many students were subject to detention during the previous school year?	Intrinsic
Extracurricular activities	Number of Extracurricular Activities in Science, Technology, and Culture	P1.6	Indicate the number of extracurricular activities in science, technology, and culture.	
Educational resources and infrastructure	Equipment And Resources To Support The Teaching Function	P1.8	How many air conditioning units does the school have?	
Learning outcomes	Percentage Of Students Passing School Year	P1.20	What percentage of students successfully passed the school year?	
School board administration	Institutional Mission and Vision	P2.3	Does the school have a mission and vision statement?	
Inclusion	Create Inclusive Culture	P2.34	Does the school build a mentality in favor of an inclusive community?	
Curriculum Design and Development	Teaching Contents and Curriculum innovation	P7.5	How often are the school's curricular contents updated?	
Context	Socioeconomic	P7.16	What is the average socioeconomic level of the neighboring community?	Extrinsic
Context	Access	P7.17	What is the average educational level of the students' relatives?	

process yielded 115 questions in the survey to cover all the 13 factors considered in the study.

Once the assumptions of homoscedasticity, normality, independence, and linearity were verified, backward elimination was used to select the variables (subfactors) with more influence on the outcome of the process. This process yielded the results shown in Table 4.

The results observed in Table 4 were obtained with the regression model, yielding a p-value of less than 0.05 in the ANOVA. This ANOVA also yielded an adjusted R-squared value of 99.07, showing that the data and model fit a linear model adequately. Only the variables with a p-value smaller than 0.05 were kept in the model. The Equation of the fitted model is shown in Eq. (2).

$$ICFES\,Score = 2{,}198*P1.5 + 3{,}864*P1.6 + 1{,}185*P1.8 + 1{,}462$$
$$*P1.20 + 2{,}129*P7.5 + 2{,}693*P7.16 + 1{,}865$$
$$*P7.17 + 1{,}016*P2.34 + 2{,}398*P2.3 \qquad (2)$$

The developed multiple linear regression model explains 99.0% of the variability found in ICFES test scores, which indicates that these variables (questions related to some factor) should be the focus for every school principal.

The Kolmogorov-Smirnov test was used to assess the normality assumption, obtaining a p-value of 0.3, which allows us to conclude that the residual values behave according to a normal distribution with a 5% significance level. The average of the residual values was 0.18, with a 95% confidence interval between −0.68 and 1.02. Since the interval includes zero, it can be concluded that the average error is zero.

The residual values were plotted, relating the dependent variable, the predicted values, and the row number to test for homoscedasticity and determine the model's predictive capacity. Since no significant trends were found in the behavior of the residual value graphs, it is assumed that the model fulfills the homoscedasticity assumption.

The Durbin Watson statistic was 2.09, concluding that there is no autocorrelation in the predicted errors.

4.7. Construction of the multidimensional indicator

Initially, the variables that were found to be most relevant were categorized by their control level, i.e., some variables can be controlled by the schools, which were called intrinsic variables. In contrast, extrinsic variables are those that are not within the range of action of school management. Table 5 displays the categorization of the variables.

The categorization of the variables by type will set the basis for how the schools will be measured. Given the extrinsic nature of the variables P.7.16 and P.7.17, these variables are not controlled by the schools, which implies that they should not be rated in the same manner as the

Table 6

Ranges of classification of results.

Minimum value		Maximum value	Classification
4.5	<= X <	5	A+
4	<= X <	4.5	A
3	<= X <	4	B
2	<= X <	3	C
1	<= X <	2	D

other variables.

With this relevant detail as a starting point, the following are the steps used to calculate the education quality management of each school:

1. The maximum score that each specific institution can obtain must be calculated. For this purpose, the value of the extrinsic variables is deducted from the formula, and the maximum possible score (5) is assigned to each intrinsic variable.
2. The relative score of each school is calculated by replacing each variable with the score obtained by each school. In this step, both intrinsic and extrinsic variables are included.
3. Once these two values have been calculated, the final indicator is calculated as follows (Eq. 3):

$$Educational\,quality = \frac{Relative\,score\,obtained}{Maximum\,possible\,score} \times 5 \qquad (3)$$

4. Based on the above score, the schools are classified into ranges using Table 6, which is based on the same school classification ranges used by ICFES:

Considering that the government measures schools' performance without considering that some factors cannot be controlled by the schools (extrinsic variables associated with the context factor), the current measure is not fair. This measurement is essential to schools because it is related to more funding by the government. With the proposed approach, this comparison is more appropriate, and the education quality management is adequately captured with the inclusion of the correction factor due to the extrinsic variables.

4.8. Validation of the indicator

The indicator was validated using a survey aimed at learning the school directors' perceptions on the following aspects of the indicator:

Table 7
Factors and subfactors weights.

Factor	Subfactor	Estimate	Relative weight
School environment management	Student Compliance with Institutional Regulations	2198	12%
Extracurricular activities	Number of Extracurricular Activities in Science, Technology and Culture	3860	21%
Educational resources and infrastructure	Equipment And Resources to Support the Teaching Function	1185	6%
Learning outcomes	Percentage Of Students Passing School Year	1462	8%
School board administration	Institutional Mission and Vision	2398	13%
Inclusion	Create Inclusive Culture	1016	5%
Curriculum Design and Development	Teaching Contents and Curriculum innovation	2129	11%
Context	Socioeconomic	2693	14%
Context	Access	1865	10%

- The methodology used: It refers to how the study was performed and the tools used to obtain the indicator.
- Consistency of the items: It refers to how the questions were worded and the extent to which they covered all the factors.
- Scope of measurement: It refers to the coverage and scope of the quality factors included in the indicator.
- Quality and accuracy: It refers to how the indicator displays the results if it has consistency according to their experience.
- Relevance of the indicator: It Refers to the level of significance and objectivity of the results produced by the indicator.

All the above were measured on a Likert scale, where five means Totally agree, 4 Agree, 3 Undecided, 2 Disagree, and 1 Totally disagree. The mean score obtained by the group of experts was 4,75. This grade demonstrates a high level of acceptance of every point of the indicator by the school directors.

5. Analysis of results

The statistical analysis suggests that nine variables (questions) explain 99% of the variation of the ICFES tests (see Table 7). Additionally, these questions correspond to 8 of the 13 factors considered in the study. Regarding the number of questions, this implies a reduction from 115 to 9 variables (questions). This is relevant for prioritizing the significant variables.

It is essential to highlight that some of the subfactors identified as triggers of variability in education quality go beyond the activities to strengthen classroom teaching. The study found that activities outside the classroom are not only beneficial but that the extracurricular activities in science, technology, and culture have the highest relative weight (21%). This intrinsic factor (extracurricular activities), combined with the context factor (extrinsic) in its socioeconomic and access subfactors, and the intrinsic factor related to the development of an inclusive mentality (Inclusion), account for 51% of the weighting, which implies that leveraging these factors is beneficial for the integral development of the students. It is essential to point out that the access subfactor refers to the average educational level of the students' relatives. This 51% proves that learning depends on activities unrelated to the classroom environment or curricular development and planning. Therefore, schools should give students a more integral education.

These results show that schools should be viewed as a dynamic entity that constantly interacts with the social reality, supported by extracurricular activities that reinforce what was learned in the classroom (weight of 21%) and by fundamental factors such as the school's administration (13%), school environment management (12%), and curricular development (11%), without setting aside essential factors

such as learning results (8%) and educational resources and infrastructure (6%) and taking into consideration a factor that is gaining increasing importance in everyday school life, which is inclusion, with 5% of the total weight.

The school has no incidence on 24% of the final weight because those included in the context factor are extrinsic variables that have substantial weight within the model. Consequently, even though the schools cannot control these, they must be monitored and should not be excluded from the actions taken within the institution, the mayor, and the governor's office.

It should be highlighted that the intrinsic factor with the most significant weight in the study was extracurricular activities, with 21% of the total. This shows the importance of implementing more activities to strengthen the students' skills in science, technology, and culture because they are directly and proportionally related to education quality. Their importance lies in reinforcing and driving cognitive capabilities and skills and influencing the students' socio-affective, citizenship, and moral dimensions.

This result runs against most people's preconceptions about expected results because of the widespread notion that improving the schools' physical facilities and educational resources lead to a proportional quality increase. Nevertheless, this study shows that enhancing activities outside the ordinary curricular contents has a weight that is almost four times greater (21%) than those related to physical facilities (6%).

Additionally, the economic allocation made to organize and implement extracurricular activities is in most cases less than the allocations that would be made to improve the physical, educational facilities. Moreover, its impact is faster and more noticeable in terms of scope and time.

6. Conclusions

Numerous studies address the issue of measuring education quality and the factors that determine a high-quality education. However, many studies focus only on some factors and do not consider all education-related factors, obtaining unreliable indicators.

This study identifies the factors used to measure education quality in all educational levels, essential for objectively measuring education quality. It determines with statistical analysis the factors with the most significant impact on education quality, confirming that it is a multidimensional concept. The most relevant factors are School administration, Curriculum design and development, School environment management, Extracurricular activities, Financial management, Educational resources and infrastructure, Inclusion, and Context.

In the specific case of the Atlántico region, in one of the most important findings of this study, these eight factors explain 99.9% of the variability of the response variable. In this case, the response variable is the score in the 2018 ICFES national test. These eight factors can be seen in Table 7. This table also shows that these eight factors cover nine subfactors or variables. The first seven factors are intrinsic in the same table, and the last one (Context) is extrinsic. This classification was made to obtain a more equitable and objective indicator for the different schools of the department.

The study found that extracurricular activities have a relevant impact on the quality of education with a weight of 21%. This result confirms that the outcome of learning processes depends not only on classroom activities and knowledge transfer. Depending on the context of each school, students may face some challenges such as gang recruitment and drugs consumption. Extracurricular activities may help keep students away from being involved in those conflicts or problems that may arise in each context, positively impacting their learning processes. Combining this factor with other noncurricular factors such as Context and Inclusion amounts to 51% of the total weight.

The extrinsic factor (Context) and its two subfactors (socioeconomic and access) add up to 24% of the weight, showing that the influence of the context in the outcome of the learning process is relevant. Therefore,

Table 8

Factors and subfactors weights and relation.

Factor	Subfactor	Type	Category	Relative weight
School environment management	Student Compliance with Institutional Regulations	Management	Intrinsic	12%
School board administration	Institutional Mission and Vision	Management	Intrinsic	13%
Inclusion	Create Inclusive Culture	Management	Intrinsic	5%
Extracurricular activities	Number of Extracurricular Activities in Science, Technology and Culture	Extracurricular activities	Intrinsic	21%
Educational resources and infrastructure	Equipment And Resources to Support the Teaching Function	Infrastructure	Intrinsic	6%
Learning outcomes	Percentage Of Students Passing School Year	Classroom activities	Intrinsic	8%
Curriculum Design and Development	Teaching Contents and Curriculum innovation	Classroom activities	Intrinsic	11%
Context	Socioeconomic	Context	Extrinsic	14%
Context	Access	Context	Extrinsic	10%

the direct comparison the government makes of the different schools is not fair. Instead, the comparison should be made with the adjustment proposed in this research to have a more equitable national school rank.

On the other hand, proper school management also has a relevant impact on the outcome of the learning process. In this research, it was found that factors such as the school's administration (13%), school environment management (12%), and inclusion (5%) also have a relevant impact on the quality of education. This fact shows that factors associated with school administration add up to 30% of the weight. The weight of the factors related to classroom activities, such as curricular development (11%) and learning results (8%), represent 19% of the total weight. Finally, educational resources and infrastructure add up to 6% of the total weight. All this information is summarized in Table 8.

Given the multidimensional nature of the indicator, and having demonstrated the relative importance of each of the most significant variables for education quality, this tool will enable school administrators to make better decisions as they will have the basics they require to focus their actions on improving the variables that most affect high school performance. Furthermore, this tool will enhance economic efficiency at the schools by enabling them to make better use of their financial resources. Proper allocation of resources to improve the outcome of the learning process is very important in public schools, considering that the government gives additional support to schools with a better result in the national ICFES exam. In this sense, the proposed method to adjust the performance considering the school context will help schools with a poorer context have access to additional government funds.

On the other hand, in the case of secondary education, the variables that did not turn out to be significant for the model should not be neglected in the schools' daily activities because the indicator identifies the key areas that should be addressed and improved by schools. Still, other factors that also have direct effects on education quality should not be set aside.

This indicator can become the basis for future research on the difference in the average values found between the schools in the district of Barranquilla compared to those outside the city. Also, using the comparison against the maximum scores that the sub-regions can obtain as a baseline, this project may serve as a basis for future research to observe whether the level of variation of these average values increases depending on how far away each region is from the district of Barranquilla.

It is suggested to undertake studies relating education quality management with indicators such as GDP, poverty indicators, or basic needs indicators to determine whether these indicators correlate with the students' performance in the classroom and how they affect education quality management.

Although technology has indeed provided numerous benefits to public high schools, it is suggested to carry out studies on the resilience of the schools in the face of extraordinary events such as natural disasters or a pandemic. It is essential to identify these events' impact on school performance and quality management, considering that technology allows remote lectures and libraries access. Nevertheless, it is necessary to identify complementary actions that could mitigate such effects as much as possible in laboratories, arts, and sports, for example.

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