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ORIGINAL

Exploratory factor analysis of an instrument that evaluates the relationship between language development theories and methodological processes in third grade of pre-basic education and first grade of basic education

Análisis factorial exploratorio de instrumento que evalúa la relación entre las teorías del desarrollo del lenguaje y los procesos metodológicos en tercer grado de educación prebásica y primer grado de educación básica

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ABSTRACT

An adequate development of language skills in the third year of pre-primary education and the first grade of primary education is fundamental. It lays the foundation for future learning and effective communication. Research on the relationship between language theories and methodological processes in the educational field is crucial. It helps reduce the gap between scientific knowledge of language development and the pedagogical procedures applied. Exploratory factor analysis (EFA) was applied, starting with the excluded items test, the results showed a Cronbach's Alpha of 0,921, and Kaiser-Mayer-Olkin KMO of 0,580, and a Bartlett test with a value of 682 856 and significance of 0,000, as well as a sedimentation graph that allowed rejecting the null hypothesis of the test. This statistical validation guarantees that the instrument is reliable and valid for research aimed at identifying the relationship between language development theories and pedagogical procedures in the third grade of pre-primary education and the first grade of basic education in the department of Intibucá, thus facilitating an accurate and well-founded interpretation of the data in the educational situations studied.

Keywords: Cronbach's Alpha; Exploratory Factor Analysis; Language Development Theories; Methodological Processes.

RESUMEN

Un adecuado desarrollo del lenguaje en tercer grado de educación prebásica y primer grado de educación básica es fundamental, pues sienta las bases para futuros aprendizajes y para la comunicación efectiva. La investigación sobre la relación entre las teorías del lenguaje y los procesos metodológicos en el ámbito educativo resulta crucial para reducir la brecha entre el conocimiento científico del desarrollo del lenguaje y los procedimientos pedagógicos aplicados. Se aplicó el análisis factorial exploratorio (AFE) iniciando con la prueba de elementos excluidos, los resultados mostraron un Alfa de Cronbach de 0,921, un Kaiser-Meyer-Olkin KMO de 0,580 y una prueba de Bartlett con valor de 682 856 y significancia de 0,000, así como un gráfico de sedimentación que permitió rechazar la hipótesis nula de la prueba. Esta validación estadística garantiza que el instrumento es confiable y válido, para la investigación orientada a encontrar la relación entre las teorías del desarrollo del lenguaje y procedimientos pedagógicos en el tercer grado de educación prebásica

y primer grado de educación básica del departamento de Intibucá, facilitando así una interpretación precisa y fundamentada de los datos en situaciones educativas estudiadas.

Palabras clave: Alpha de Cronbach; Análisis Factorial Exploratorio; Teorías del Desarrollo del Lenguaje; Procesos Metodológicos.

INTRODUCTION

Adequate language development in the third grade of preschool and first grade of elementary school is essential, as it lays the foundation for future learning and communication. Through language, children discover, socialize, express themselves, learn about their environment, develop critical thinking, imagination, and problem-solving skills. In addition, language proficiency is essential for the development of literacy and academic success in all areas.[1]

Establishing a relationship between language development theories and methodological processes in education will bridge the gap between scientific knowledge of language development and methodological procedures. By understanding how various theories of language development (behaviorist, cognitive, sociocultural, and neurolinguistic) are postulated, teachers can base their decisions on which strategies, activities, and resources to apply in the classroom.

In order for the findings of the test to have true scientific rigor and for the conclusions about the theoretical-methodological relationship to be reliable, it is essential to ensure the metric quality of the research instrument applied. Therefore, statistical validation was carried out, first using Cronbach's Alpha calculation to establish its reliability or internal consistency and Exploratory Factor Analysis (EFA) to verify the validity of the construct and confirm the underlying dimensional structure of variables that measure theories and pedagogical practices.

The instrument validation process was rigorously executed to ensure that it accurately and consistently measured the relationship between language development theories and teaching methodological practices. First, content validity was established by a panel of technicians and experts who reviewed the relevance and clarity of each item.

Second, reliability was calculated using Cronbach's Alpha. Subsequently, construct validity was verified through Exploratory Factor Analysis (EFA), allowing the underlying dimensions of the theoretical construct to be identified and confirmed, ensuring that the items were logically grouped into coherent factors.

METHOD

Type of study

This is a correlational study to determine the relationship between language development theories and pedagogical practices used in the third grade of pre-primary education and first grade of primary education in the department of Intibucá in 2025.

Population and sample

Population

To carry out this research, deliberate or critical judgment sampling was used. In this regard, the following inclusion criteria were established for participants:

The population consisted of third-grade pre-primary education teachers and first-grade primary education teachers from the departments of La Paz, Lempira, and Comayagua.

Inclusion criteria: teachers working in third grade pre-primary education and first grade primary education were selected, as established in Chapter II, Article 12, paragraph d, of the Fundamental Law of Education in Honduras.

Exclusion criteria: teachers without a degree and university degrees not related to teaching and learning at the pre-basic and basic levels, as well as teachers who did not work in the department of Intibucá.

Variables analyzed

V1 Language development theories: refers to the degree to which teachers base their practices on theoretical models (behaviorist, cognitive, sociocultural, and neurolinguistic).

V2 Pedagogical practices: refers to the strategies, activities, and methods that teachers apply for language development.

The research analyzed the variables of language development theories and pedagogical practices. Neurolinguistics is considered a dimension rarely addressed in previous studies in the Honduran context, which allows for an assessment of the degree of correspondence between the theoretical foundations and the pedagogical actions of teachers.

Dimensions: for variable one, these are theories of language development: behaviorist, sociocultural, cognitive, and neurolinguistic. For variable two, these were named: imitation and repetition strategies, social interaction strategies, cognitive strategies for thought construction, and strategies for stimulating mental processes.

Indicators are specific and measurable variables that represent the broader concept, allowing numerical data to be obtained on the study, in this case four theories of language development.

Table 1. Variables and dimensions

Variable	Dimensions	Indicators
V1 Theories of language development	Behaviorist	Language shaping. Positive reinforcement. Learning by imitation. Stimulus-response association. Systematic repetition. Immediate language correction. Use of social reinforcement. Assessment through behavioral observation.
	Sociocultural	Learning mediation Social interaction as a driver of learning Language as a tool for thinking Symbolic play and learning. Internalization of language. Social scaffolding Interaction with cultural materials Development of the regulatory function of language Dialogues and open-ended questions.
	Cognitive	Use of symbolic games. Encouraging imitation of sounds and words through songs and rhymes. Assimilation and accommodation. Balance: Encouraging the resolution of communication problems. Interaction with the environment. Egocentrism Development of symbolic thinking. Development of logic and classification.
	neurolinguistics	Brain plasticity and early stimulation. Activation of Broca's area. Activation of Wernicke's area. Interhemispheric connection Verbal and associative memory reinforcement. Repetition and positive feedback. Development of auditory attention.
V2 Methodological strategies	Imitation and repetition	The teacher uses repetition games to expand vocabulary. The student repeats words and phrases in response to verbal and visual stimuli. The teacher positively reinforces pronunciation and correct use of vocabulary. Students respond to oral instructions.
	Social interaction	The teacher organizes dialogue activities. The student participates in role-playing games. The teacher encourages collaboration in activities. The student asks and answers questions during group activities.
	Thought construction	The teacher promotes the classification of objects, images, or words according to categories. The student organizes ideas when recounting personal experiences. The teacher encourages inference and prediction in readings or narratives. The student constructs sentences and short texts.
	Stimulation of mental processes.	The teacher designs listening activities. The student relates graphemes to phonemes. The teacher incorporates tracing, copying, and dictation. The student maintains attention during storytelling or reading.
	Organization and recording of progress	Class planning Class evaluation

Table 1 shows the operationalization of variables.[1,2,3]

The table shows the operationalization of variables, where abstract concepts from language development theories and methodological strategies were transformed into variables that can be measured and observed in a concrete and systematic way, bringing clarity and precision to the research, which allowed for the collection of concrete data from third-grade preschool teachers and first-grade elementary school teachers.

Instrument, techniques, and procedures

Instrument design

Item drafting**:** the questions were organized into blocks according to two variables to avoid confusing the interviewee by jumping from one topic to another, ensuring the reliability of the scale.[4] This also ensures ease of analysis when analyzing results.

The length of the questions ranges from 17 to 25 words, making it easier for respondents to understand the statements. Together with a moderate number of questions, this contributes to more accurate responses, reducing fatigue and abandonment of the questionnaire when answering digitally.

The instrument was organized using a Likert scale, a psychometric assessment tool that quantifies individuals' opinions, perceptions, and attitudes on a specific topic.[5] In this research, the questions were written based on variables, dimensions, and indicators defined for the study, where respondents indicated their degree of agreement or disagreement with the questions posed with five options:

- 1 = Never
- 2 = Rarely
- 3 = Occasionally
- 4 = Frequently
- 5 = Always

Analysis of the Likert scale order: arranged in ascending order of measured perception frequency, where 1 is the total absence of behavior (never) and 5 is constant presence (always), the intermediate numbers mark progressive degrees of occurrence 2 (rarely) indicates low frequency and 4 (frequently) indicates a high level, but not total.

Position 3 is located at the midpoint of the scale, making it a neutral or moderate value. The questions were written using clear and specific statements focused on the study to obtain more accurate results. It is neither rare nor frequent, but occurs intermittently.

Structure of the instrument

Title: relationship between language development theories and methodological processes in the third grade of pre-primary education and first grade of primary education in the department of Intibucá in 2025.

Instructions: answer the thirty items by selecting the alternative that reflects your experience. Do not leave any questions unanswered.

Likert scale: with five options listed.

General data: level at which you work, last degree obtained, grade taught, age, gender, years of experience. This data allowed us to characterize the population according to the interests of the study.

Items: thirty questions.

Instrument validation procedure by technicians and experts

Technicians: two specialists with master's degrees in language teaching and one teacher with a master's degree in emerging literacy.

Experts: teachers working in the third grade of pre-primary education and the first grade of primary education, with a university degree.

Technicians and experts evaluated the items of the instrument considering the following criteria:

- Clarity: it is written in an understandable and precise manner.
- Coherence: it is logically related to the objectives of the instrument and the study.
- Relevance: it is relevant for measuring what it is intended to measure.
- Sufficiency: the content adequately covers the aspect to be evaluated.
- Language: appropriate to the informant's level.

Technicians and experts stated

The questions were aligned with the research objectives and responded to the issues raised, so they were written in a coherent and clear manner. In relation to the comprehension analysis, they reviewed the vocabulary and appropriateness, and found that they were written at the level of the teachers surveyed. Likewise, in terms of content validation, they determined that each question was clear and essential for measuring the

variables. With regard to language assessment, they suggested changing some very technical terms to ensure comprehension of the questions.

Data collection procedure

To conduct the pilot study, the research objective was written in the Google Forms document and informed consent was added, requesting voluntary participation in the survey.

The pilot test is part of the methodological framework and serves to make real approximations of research studies before establishing the final test.[6]

To conduct a pilot study in a quantitative study, it is recommended to have between thirty and fifty people, as this is a sufficient size to evaluate the feasibility of the study, comprehension of questions, and detect possible errors in the design without the need for a sample as large as that of the main study.[7] In this regard, this research conducted a pilot test with thirty-seven respondents.

Data analysis procedure

This refers to the consistency and stability of results obtained when applying a survey repeatedly under the same conditions.[8] To ensure methodological rigor and transparency in the research process.

To begin the rigorous scientific research process, Cronbach's alpha was calculated, which requires a single administration of the measurement instrument and produces values ranging from 0 to 1. Its advantage is that it is not necessary to divide the items of the instrument in half; it is simply applied and the coefficient is calculated.[9] This value shows the internal consistency, that is, it shows the correlation between each of the questions.

Based on data obtained from the survey, a database was created in IBM SPSS 24 statistical software, and the internal consistency of the instrument was determined using Cronbach's alpha coefficient, evaluating how related and consistent the items in the questionnaire are.

First, listwise deletion was applied prior to calculating Cronbach's alpha to ensure that the internal consistency of the instrument was accurate. Of the thirty-seven cases, one was excluded because it had at least one missing value in one of the variables analyzed.

Table 2. Excluded cases

	N	%
Valid	36	97,3
Excluded[a]	1	2,7
Total	37	100,0

Note: a. Listwise deletion based on all variables in the procedure * Shows the excluded case and the percentage.

Excluded case (2,7 %) implies that if a case has missing data, it is completely excluded from the analysis. The sample size is reduced from thirty-seven to thirty-six. A validity percentage of 97,3 % is high, suggesting that most of the data is complete and that a single case has no significant impact on the overall results of the analysis.

Table 3. Cronbach's Alpha Calculation

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0,921	0,926	30

Note: *Cronbach's Alpha calculation results.

Cronbach's alpha of 0,921 indicates very high internal reliability according to general criteria between 0,80 and 0,90 → Very good. The thirty-item instrument has an excellent level of reliability (α = 0,921), meaning that it consistently measures the construct it assesses. The items are highly reliable in terms of the responses obtained.

The results will be consistent and representative, which is crucial when conducting research on complex topics such as language development and methodological strategies, since the items are aligned and consistent with each other. This level of reliability ensures that, when applying the questionnaire to a large sample, the results will be stable, reproducible, and representative of the reality being studied.

Factor analysis

It is important to mention that factor analysis tests were applied to the research instrument in a pilot test to evaluate its internal structure and confirm that the items measure the proposed theoretical dimensions or constructs. This technique allows for the identification of latent factors that group related items, facilitating data reduction and improving the reliability and validity of the instrument.

Factor analysis detects items that do not contribute adequately to dimensions, allowing them to be adjusted or eliminated before final application.[10] Exploratory factor analysis (EFA) is a statistical technique used to discover latent factors hidden in data, revealing how observed variables are grouped into underlying factors.

Bartlett's sphericity test: with the aim of assessing whether the variables are correlated with each other, the test determines whether the correlation matrix is significant.[11]

Table 4. Bartlett's sphericity test and KMO

Kaiser-Meyer-Olkin measure of sampling adequacy		0,479
Bartlett's sphericity test	Approx. Chi-square	789,531
	gl	435
	Sig.	0,000

Note: * Test results with all items.

Bartlett's test results showed an approximate chi-square value of 789,531 with 435 degrees of freedom and a p-value of $6{,}86x10^{-23}$ significantly lower than the established significance level of 0,05, the null hypothesis (H0) is rejected. This means that there is a correlation between the variables, suggesting that factor analysis is justified, as it not only validates and improves the quality of the instrument, but also enriches our understanding of the phenomenon under study.

Table 5. Bartlett's sphericity test and KMO

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,651
Bartlett's Test of Sphericity	Approx. Chi-Square	492,120
	df	231
	Sig.	0,000

Note: *Test result excluding items 23 to 30.

After removing questions 23 to 30, the KMO test was recalculated, obtaining a value of 0,651 according to the Kaiser scale. This result is considered acceptable. Despite the increase in KMO, it was decided to keep the items removed, because their fundamental purpose is to collect specific data on planning and evaluation across all factors under study.

Sedimentation graph

The sedimentation graph was used to analyze the principal components (ACP) that should be retained in an exploratory study.[12]

Sedimentation graph

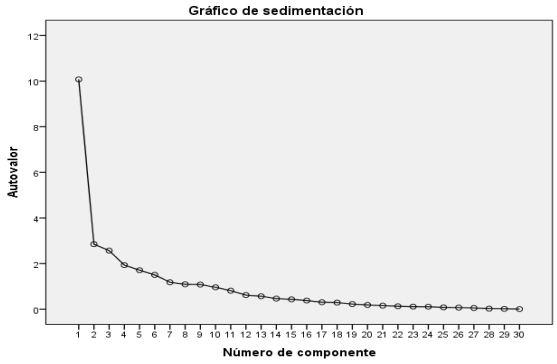

Figure 1. Factor or principal component analysis to decide how many components to retain

Graph analysis

The x-axis represents components 1 to 30. The y-axis shows eigenvalues that indicate the amount of variance explained by each component. The common rule is to retain all components with an eigenvalue greater than 1. The first component has a very high eigenvalue, which means that it explains a large part of the variance in the data.

Cognitive factor 1: according to the graph, this is the strongest factor with high loadings (70, 80), representing cognitive strategies for constructing thought. Second component: groups components with loadings around 40 to 53, showing a pattern more closely linked to social interaction, linked to sociocultural theory and social interaction strategies. Third component: items with relevant loadings, related to neurolinguistic theory and mental process stimulation strategies.

Component 4 onwards, although values appear, their representation is lower and they seem scattered, which may reflect the influence of behaviorist theory, but without a dominant weight like the first three factors.

The instrument is structured mainly around three factors that correspond to theories of language development (cognitive, neurolinguistic, and sociocultural theory), while behaviorist theory appears to have less weight but contributes relevant items in the secondary components. This is consistent with the current perspective on language development, where cognitive, social, and neurological theories tend to have greater influence than current behaviorist approaches.

The fourth component consists of items that address planning and evaluation. This factor is vital because it facilitates understanding of the mechanisms teachers use to organize and regulate their teaching methods. The information obtained will enrich the interpretation of research data and results.

The Varimax method was applied to redistribute variance across the components. The graphical representation of the rotated factor matrix was used to facilitate interpretation, as it indicates the relationship between factors and variables.[13]

The rotated space component graph is a visualization that shows the relationship between variables and factors extracted in factor analysis, after applying a rotation to the factorial matrix to improve interpretation. The test results are detailed below.

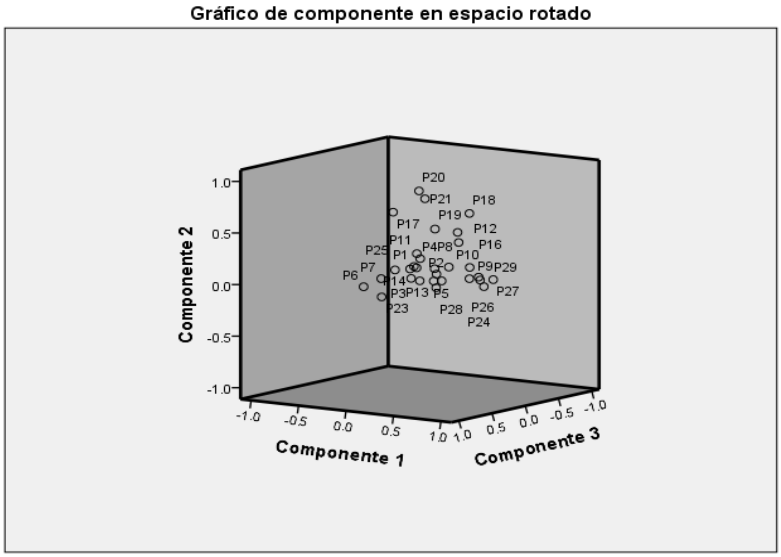

Figure 2. Shows the three axes corresponding to the components

Each point in the graph represents an item from the questionnaire analyzed, and the position of each one indicates its loading on rotated components.

Analysis of the graph

Axes: the graph shows the first three components, each axis represents an extracted factor or dimension, and the position of items (p1, p2, p3, etc.) indicates their degree of association with each component.

Grouping of items: clusters of items that are close to a specific component can be observed, for example:

- Items: p18, p19, p20, p21 are more oriented towards component 2.
- Items: p27, p28, p29, p9 lean towards component 3.
- Items: p5, p10, p12, p13, are concentrated around component 1.

Theoretical interpretation: the distribution indicates that the items are not randomly dispersed, but rather form logical groupings that reinforce the existence of three main dimensions in the instrument. This supports

the findings in the sedimentation graph, which explains that the instrument measures three relevant factors (neurolinguistic, sociocultural, and cognitive theories of language development).

DISCUSSION

The research results are based on exploratory factor analyses as a guarantee of scientific reliability, generating improvements for subsequent application.[14] This strengthens the quality of the findings and their applicability in future research.

This instrument identifies language development theories and teaching practices in the classroom, since language is a fundamental component of child development, facilitating communication, thinking, and social interaction.[15] Likewise, it makes it possible to scientifically demonstrate teaching practices in the classroom, which contributes to substantiating proposals for improvement aimed at strengthening the study and teaching of language.

Behaviorism is excluded from Bartlett's test groupings, as it is one of the theories that focuses on stimulus response rather than the development of higher human capacities. However, the aim is not to rank any of the theories as better or worse, but to make teachers aware of how internalized pedagogical practices are and how to improve results.[16]

One of the weaknesses of the study is the variables not considered, such as teaching resources and teacher training, since they also have an impact on theory and practice.

CONCLUSIONS

The AFE showed that the scale is consistently grouped into three components, and this simplified factor solution will significantly facilitate data analysis and instrument management in subsequent research.

Researchers in their field of expertise determine whether to retain or eliminate items that have a low correlation with the factor.

Considering the characteristics of the data, this exploratory factor analysis made it possible to obtain an appropriate instrument and allowed for better decisions to be made regarding its content.

The application of the instrument will facilitate analysis of the relationship between language development theories and pedagogical practices in the third grade of pre-primary education and the first grade of primary education, thus strengthening the language teaching and learning processes in the grades under study.

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FINANCING

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CONFLICT OF INTEREST

None.

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