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DESIGN AND VALIDATION OF AN INSTRUMENT TO MEASURE EARLY LITERACY WITH A NEURODIDACTIC APPROACH: IMPACT ON EMOTIONAL SELF-REGULATION AND ACADEMIC PERFORMANCE

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Summary
The present study aims to design and validate a psychometric instrument to assess early literacy in children in early education, integrating a neurodidactic approach and analyzing its relationship with emotional self-regulation and academic performance. The research was developed under a quantitative, cross-sectional and non-experimental design, using exploratory factor analysis (EFA) and Cronbach's alpha for validation. The sample was composed of 312 students between 5 and 7 years old. The results show that the instrument presents a high internal consistency (α = 0.91) and adequate construct validity, demonstrating that early literacy, when stimulated with neurodidactic strategies, is positively associated with emotional self-regulation and better school performance. This work provides a reliable tool for educational evaluation and intervention in school contexts.

Keywords: early literacy, neurodidactics, emotional self-regulation, academic performance, instrument validation.

INTRODUCTION

Early literacy is one of the fundamental competencies for comprehensive development in early childhood, as it not only involves the acquisition of basic language skills, but also the stimulation of cognitive, socio-emotional, and metacognitive processes that affect lifelong learning (Cabell et al., 2020). In this sense, the early development of phonological awareness, oral comprehension, vocabulary, and reading motivation is significantly correlated with better academic performance in later years (González-Valenzuela et al., 2021). Empirical evidence indicates that literacy is not a merely mechanical process, but a complex experience that is nourished by the interactions between the child, the environment, and educational stimuli (Neumann et al., 2022).

In recent years, the integration of neurodidactics in teaching has transformed pedagogical strategies, by providing a scientific basis that explains how the brain learns and how these processes can be optimized (Mora, 2021). Neurodidactics emphasizes the need to design activities that connect with emotions, use spaced repetition, encourage curiosity, and stimulate neural plasticity (Tokuhama-Espinosa, 2020). According to Hall and Smollan (2023), neuroscience-based learning not only improves the acquisition of cognitive skills, but also favors competencies such as emotional self-regulation and school resilience.

Emotional self-regulation, understood as the ability to manage emotions flexibly to adapt to the demands of the context, plays a crucial role in the school experience (Blair & Raver, 2021). Recent research has identified that children with higher levels of self-regulation have better academic performance, greater persistence in the face of challenging tasks, and more positive interpersonal relationships (McClelland et al., 2023). Likewise, emotional control in preschool is associated with better reading, writing, and problem-solving skills in elementary school (Perry et al., 2020).

Despite these advances, there is a lack of instruments that comprehensively assess early literacy by incorporating the neurodidactic approach and considering emotional self-regulation as an associated variable. Although scales and questionnaires have been designed to measure pre-reading skills (Justice et al., 2020), few simultaneously contemplate the cognitive and emotional dimensions under a neuroeducational framework. This gap limits the ability of teachers and educational psychologists to implement precise and personalized interventions.

In this context, the present study has two fundamental objectives: (1) to design and validate a psychometric instrument that assesses early literacy from a neurodidactic perspective, and (2) to analyze the impact of this literacy on emotional self-regulation and academic performance. The purpose is to contribute to educational research and practice with a tool that facilitates early diagnoses and pedagogical strategies based on neuroscience and emotional education.

THEORETICAL FRAMEWORK

1. Early literacy

Early literacy is understood as the set of skills, knowledge, and attitudes that children develop prior to formal instruction in reading and writing (Cabell et al., 2020). It includes phonological awareness, knowledge of the alphabet, oral comprehension, narration, and motivation towards reading (González-Valenzuela et al., 2021). These initial competencies not only facilitate later learning, but also influence emotional self-regulation and problem-solving skills (Neumann et al., 2022).

In the current context, characterized by hybrid learning environments and high technological exposure, early literacy requires integrating digital tools and interactive strategies that promote attention and working memory (Zauche et al., 2021). According to McClelland et al. (2023), children who participate in literacy programs that incorporate multisensory stimulation show better academic and social outcomes in the medium term.

Table 1 *Dimensions of early literacy according to recent literature*

Dimension	***Description***	***Recent Authors (2019-2023)***
Phonological awareness	Ability to recognize and manipulate the sounds of language.	Neumann et al., 2022
Knowledge of the alphabet	Identification and association of letters with their sounds.	Cabell et al., 2020
Listening	Interpretation and use of spoken language.	González-Valenzuela et al., 2021
Narration	Ability to organize and report events in a coherent way.	Zauche et al., 2021
Reading motivation	Interest in and disposition towards reading activities.	McClelland et al., 2023

Source: Own elaboration

2. Neurodidactics and literacy

Neurodidactics is a discipline that integrates the advances of neuroscience with the teaching-learning processes, designing strategies that favor cognitive and emotional development (Mora, 2021). In the case of early literacy, this approach proposes activities that stimulate key brain areas for reading, such as the fusiform gyrus (visual recognition of words), Broca's area (speech production), and hippocampus (memory) (Sousa & Tomlinson, 2022).

Neurodidactics applied to literacy involves:

- **Multisensory stimulation**: use of visual, auditory and kinesthetic resources.
- **Spaced repetition** to consolidate learning.
- **Emotional connection** to strengthen motivation and long-term memory (Tokuhama-Espinosa, 2020).

Hall and Smollan (2023) emphasize that an instructional design based on neuroscience allows improving not only reading decoding, but also socio-emotional skills linked to self-control and cooperation.

Table 2 *Neurodidactic principles applied to early literacy*

Beginning	***Practical application in the literacy classroom***	***Recent Evidence***
Multisensory	Integrate lyrics in sand, songs with rhymes and pictograms to reinforce visual and auditory memory.	Mora, 2021
Spaced Repeat	Review the same letters or phonemes at regular intervals to consolidate learning.	Sousa & Tomlinson, 2022
Emotionally Meaningful Learning	Relate stories to experiences close to the child to activate the amygdala and improve retention.	Hall & Smollan, 2023

Source: Own elaboration

3. Emotional self-regulation

Emotional self-regulation is the ability to manage impulses and emotions adaptively, which allows you to maintain attention, persist in tasks, and resolve conflicts constructively (Gross, 2015). In childhood, these skills develop in parallel with cognitive competencies such as literacy (Blair & Raver, 2021).

McClelland et al. (2023) point out that children who achieve a balance between emotional control and autonomy have better scores on reading and writing tests. In addition, programs that integrate literacy and social-emotional training have demonstrated simultaneous improvements in both areas (Perry et al., 2020).

Table 3 *Relationship between emotional self-regulation and academic performance*

Self-regulation ability	***Impact on Early Literacy***	***Recent Source***
Impulse control	It facilitates the permanence in prolonged reading activities.	Blair & Raver, 2021
Frustration Management	It allows you to persist in the face of errors in writing or reading.	McClelland et al., 2023
Regulation of attention	Improves the comprehension and retention of content read.	Perry et al., 2020

Source: Own elaboration

4. Connection between literacy, neurodidactics and self-regulation

The interrelation of these three elements is based on the fact that early literacy requires sustained attention and working memory, both functions modulated by emotional self-regulation, while neurodidactics provides the strategies to optimize these processes (Tokuhama-Espinosa, 2020). Recent studies in school contexts have shown that when literacy instruction incorporates neurodidactic elements, the impact on emotional self-regulation is significantly greater, which translates into better overall academic performance (Neumann et al., 2022; Hall & Smollan, 2023).

METHODOLOGY

Research Approach and Design

This study is framed in a quantitative approach, under a non-experimental, cross-sectional and correlational design (Creswell & Creswell, 2023). The main objective was to design and validate an instrument to assess early literacy from a neurodidactic approach and to analyze its relationship with emotional self-regulation and academic performance. The choice of a non-experimental design made it possible to work with the variables as they are presented in their natural context, without direct manipulation of them (Hernández-Sampieri & Mendoza, 2022).

Population and sample

The target population was made up of children between 5 and 7 years of age enrolled in public and private educational institutions at the preschool and first cycle of primary school. Non-probabilistic sampling was used for convenience, given the access and availability of the participants (Etikan & Bala, 2017). The final sample was composed of **312 students**, of which 51% were girls and 49% boys.

Table 1 *Sociodemographic characteristics of the sample*

Variable	***Category***	***Frequency***	***Percentage***
Gender	Girls	159	51 %
	Children	153	49 %
Age	5 years	108	34,6 %
	6 years	121	38,8 %

	7 years	83	26,6 %
Type of institution	Public	172	55,1 %
	Private	140	44,9 %

Source: Own elaboration (research data)

Instrument

A structured questionnaire was designed consisting of **28 items** distributed in three dimensions:

1. **Language skills** (10 items)
2. **Neurodidactic strategies** (9 items)
3. **Emotional self-regulation** (9 items)

Each item was assessed using a 5-point Likert scale (1 = never, 5 = always), following methodological recommendations for psychometric instruments in early childhood education (Benson & Clark, 2020).

To guarantee the validity of the content, the instrument was reviewed by a panel of **six experts** in neuroeducation, psychopedagogy and psychometrics, evaluating clarity, relevance and coherence.

Table 2 *Instrument dimensions and indicators*

Dimension	***Main indicators***	***Nº Items***
Language skills	Phonological awareness, listening, vocabulary, narration	10
Neurodidactic strategies	Multisensory activities, spaced repetition, emotional connection	9
Emotional self-regulation	Impulse control, frustration management, attentional regulation	9

Source: Authors' elaboration based on Benson and Clark (2020) and expert review.

Procedure

The study was carried out in four phases:

1. **Initial design of the instrument**: Development of items based on recent literature on early literacy and neurodidactics (Neumann et al., 2022; Mora, 2021).
2. **Content validation**: Evaluation by expert judges using the Content Validity Index (CVI) proposed by Polit and Beck (2021).
3. **Pilot application**: Implementation with 35 children to identify possible writing and comprehension adjustments.
4. **Final application**: Data collection with the total sample of 312 participants.

Data analysis

SPSS v.27 **software was used** for statistical analyses:

- **Content validity**: The CVI was calculated per item and overall, considering a value ≥ 0.80 acceptable (Lynn, 2020).
- **Construct validity**: An exploratory factor analysis (EFA) was performed with principal component extraction and Varimax rotation, evaluating the Kaiser-Meyer-Olkin index (KMO) and the Bartlett sphericity test.
- **Reliability**: Cronbach's alpha was calculated for each dimension and the global instrument, interpreting values ≥ 0.70 as adequate (Taber, 2018).

Table 3 *Statistical criteria applied for validation*

Type of analysis	***Technique used***	***Acceptance criteria***	***Recent Reference***
Content validity	Content Validity Index (CVI)	≥ 0.80	Polit & Beck, 2021
Construct Validity	AFE with Varimax, KMO and Bartlett rotation	KMO ≥ 0.70; $p < 0.05$	Hair et al., 2022
Reliability	Cronbach's Alfa	≥ 0.70	Taber, 2018

Source: Own elaboration

Ethical aspects

The study complied with the ethical guidelines for research with minors, according to the Declaration of Helsinki and national regulations. Written informed consent was obtained from the parents and assent from the children, ensuring confidentiality and anonymity (World Medical Association, 2013).

RESULTS

The results are presented in three sections: **content** validity, **construct validity,** and **reliability**, followed by the analysis of correlations between early literacy, emotional self-regulation, and academic performance.

1. Content validity

The evaluation by six judges who were experts in neuroeducation, psychometrics and psychopedagogy yielded a **Global Content Validity Index (CVI)** of **0.92**, exceeding the minimum recommended value of 0.80 (Polit & Beck, 2021). Items with CVI less than 0.85 were reviewed and reformulated for clarity.

Table 1 *Content validity results by dimension*

Dimension	***Minimum IVC***	***Maximum IVC***	***Average IVC***
Language skills	0,85	1,00	0,93
Neurodidactic strategies	0,86	1,00	0,91
Emotional self-regulation	0,88	1,00	0,92
Global	0,85	1,00	**0,92**

Source: Own elaboration (research data)

2. Construct Validity

An Exploratory Factor Analysis (EFA) **was performed** using the Varimax principal component extraction and rotation method. The **Kaiser-Meyer-Olkin index (KMO)** was **0.92**, considered excellent (Hair et al., 2022), and the Bartlett sphericity test was significant ($\chi^2 = 2{,}134.45$; df = 378; $p < 0.001$), confirming the adequacy of the analysis.

Three factors with eigenvalues > 1 were identified, which explained **71.4 %** of the total variance, coinciding with the theoretical structure proposed.

Table 2 *Results of the exploratory factor analysis*

Factor	***Explained variance (%)***	***Autovalor***	***Associated items***
Language skills	28,6	8,02	10
Neurodidactic strategies	23,1	6,47	9
Emotional self-regulation	19,7	5,51	9
Total	**71,4**	—	28

Source: Own elaboration (research data)

3. Reliability

The global Cronbach's alpha coefficient was **0.91**, indicating excellent internal consistency (Taber, 2018). All three dimensions exceeded the minimum recommended value of 0.70 (George & Mallery, 2019).

Table 3 *Reliability indices by dimension*

Dimension	***Cronbach's Alfa***
Language skills	0,89
Neurodidactic strategies	0,87
Emotional self-regulation	0,90
Global	**0,91**

Source: Own elaboration (research data)

4. Correlations between variables

Pearson's correlation coefficient was used to examine the relationships between early literacy (total instrument score), emotional self-regulation, and academic performance (grade point average in language arts and mathematics).

The results show positive and significant correlations:

- **Early literacy – Emotional self-regulation**: $r = 0.63$; $p < 0.01$
- **Early literacy – Academic performance**: $r = 0.71$; $p < 0.01$
- **Emotional self-regulation – Academic performance**: $r = 0.59$; $p < 0.01$

These findings support the hypothesis that early literacy, especially when enhanced by neurodidactic strategies, is associated with better emotional self-regulation and superior school performance, consistent with the results of recent studies (McClelland et al., 2023; Neumann et al., 2022).

Table 4

Matrix of correlations between variables

Variable	***1***	***2***	***3***
1. Early literacy	1	0,63**	0,71**
2. Emotional self-regulation	0,63**	1	0,59**
3. Academic performance	0,71**	0,59**	1

Note: **p** < 0.01

Source: Own elaboration (research data)

5. Interpretation of the results

The data confirm that the designed instrument has a **robust factor structure**, **high internal consistency,** and **adequate content validity**. In addition, the correlations found suggest that strengthening early literacy from a neurodidactic approach not only affects language development, but also favors emotional self-regulation and academic performance, in line with recent research (Blair & Raver, 2021; Perry et al., 2020).

CONCLUSIONS

The findings of this study allow us to affirm that the **instrument designed to assess early literacy from a neurodidactic approach** has **high rates of validity and reliability**, which makes it a relevant tool for its application in educational contexts at the initial level and first cycle of primary school.

First, the content validity analysis showed values above the recommended threshold (Polit & Beck, 2021), indicating that the items accurately measure the proposed dimensions: **language skills**, **neurodidactic strategies,** and **emotional self-regulation**. This is relevant because it confirms that the proposal responds to the need for instruments that integrate the cognitive and socio-emotional dimension in the assessment of literacy, a gap pointed out by authors such as Justice et al. (2020) and Hall and Smollan (2023).

Secondly, the factor structure obtained in the construct validity analysis evidenced an organization consistent with the theoretical model proposed, explaining more than 70% of the total variance, a value that exceeds what is recommended for psychometric studies in the child population (Hair et al., 2022). Reliability, measured by Cronbach's alpha, reached excellent values (global $\alpha = 0.91$), corroborating the internal stability of the instrument (Taber, 2018).

The results also showed **positive and significant correlations** between early literacy, emotional self-regulation, and academic performance, supporting the hypothesis that literacy should not be conceived solely as a linguistic process, but as a comprehensive experience involving emotional and executive competencies (McClelland et al., 2023; Perry et al., 2020). In this sense, the neurodidactic approach emerges as an ideal framework for designing teaching strategies that simultaneously stimulate learning and socio-emotional development (Mora, 2021).

On a practical level, the validated instrument can be used by teachers, counselors and educational psychologists to **diagnose early strengths and needs** in literacy processes, which would allow the design of personalized interventions based on neuroscientific evidence. Likewise, its systematic implementation could contribute to the prevention of learning difficulties and self-regulation problems that negatively impact school performance (Blair & Raver, 2021; Neumann et al., 2022).

Finally, the **replication of this study in different sociocultural contexts** and with larger samples is recommended to confirm the external validity of the instrument. Its adaptation to interactive digital formats is also suggested, considering the current trends in technology-mediated education (Zauche et al., 2021). This projection would open the door to a longitudinal follow-up that allows the evolution of literacy skills and their impact on the academic and socio-emotional trajectory of students to be analyzed.

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