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Instruments for measuring the digital environment and motivation in Ibero-American regular basic education: Psychometric evidence

Instrumentos de medición del entorno digital y motivación en educación básica regular Iberoamericana: evidencias psicométricas

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Abstract

This study analyzed the psychometric evidence of instruments used to measure virtual environments and motivation in students and teachers of regular basic education (EBR) in Latin America and the Iberian Peninsula. The PRISMA information flow diagram was used to select and examine 13 articles from the Scopus, Web of Science, and SciELO databases. The results reveal that the leading instruments exhibit excellent psychometric properties, with robust samples and solid factor analyses. For virtual environments, the WVDE-CIS-28 scale stands out; for motivation, the EMMA achieves a CFI of .970 and RMSEA of .079, indicators of high validity and reliability. These attributes are crucial for instrument adaptation, as they guarantee the accurate measurement of the construct, as well as its consistency and internal coherence. In conclusion, these findings provide a solid scientific basis for adapting and applying these instruments in other Latin American educational contexts. This research underscores the need to develop or adapt tools that link motivation with the use of virtual environments, helping to reduce the digital divide and preventing it from becoming an obstacle to the development of digital skills in students and teachers.

Keywords: virtual environments, psychometric instruments, motivation, psychometric validity.

Resumen

El presente estudio analizó las evidencias psicométricas de los instrumentos utilizados para medir entornos virtuales y motivación en estudiantes y docentes de educación básica regular (EBR) en Iberoamérica. Se empleó el flujo de información del diagrama PRISMA para seleccionar y examinar 13 artículos de las bases de datos Scopus, Web of Science y SciELO. Los resultados revelan que los instrumentos destacados presentan excelentes propiedades psicométricas, con muestras robustas y análisis factoriales sólidos. Para entornos virtuales, sobresale la escala WVDE-CIS-28; en motivación, la EMMA alcanza un CFI = .970 y RMSEA = .079, indicadores de alta validez y confiabilidad. Estos atributos son cruciales para la adaptación de instrumentos, ya que garantizan la medición precisa del constructo, así como su consistencia y coherencia interna. En conclusión, estos hallazgos ofrecen una base científica sólida para adaptar y aplicar estos instrumentos en otros contextos educativos iberoamericanos. La investigación subraya la necesidad de desarrollar o adaptar herramientas que vinculen la motivación con el uso de entornos virtuales, contribuyendo a reducir la brecha tecnológica y evitando que se convierta en un obstáculo para el logro de competencias digitales en estudiantes y docentes.

Palabras clave: entornos virtuales, instrumentos psicométricos, motivación, validez psicométrica.

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Introduction

In recent years, the use of psychometric instruments to assess virtual learning environments and academic motivation has become a cornerstone of educational research, particularly within regular basic education (Crisol-Moya et al., 2020). This trend intensified markedly with the COVID-19 pandemic, which not only accelerated the forced transition to virtual formats but also laid bare the urgent need for robust, valid, and reliable measurement tools. Such instruments enable researchers to disentangle precisely how digital environments reshape teaching and learning processes, revealing patterns that vary widely across educational realities, from well-equipped urban classrooms with high connectivity to remote communities where even basic internet access remains a daily challenge.

The current educational landscape thus demands a strategic emphasis on Information and Communication Technologies (ICT), with particular attention to virtual learning environments (VLEs) and collaborative networks that should guide student experiences toward the competencies expected at the basic education level. These digital spaces cannot merely replicate face-to-face practices; rather, they must be intentionally designed to foster meaningful and deep learning, encourage student autonomy in discovery processes, facilitate critical and ethical information management with equitable access to diverse and multidisciplinary content, and support effective time management that balances study, rest, and personal life. True internalization of these environments, however, requires deep technical empowerment for both teachers and students, accompanied by optimal implementation conditions such as stable connectivity, accessible devices, and continuous technical support. Consequently, sustained and reflective use of VLEs not only advances equity in universal access to quality information but also positions digital inclusion as an essential catalyst for thoroughly renewing the educational process in the digital age. Moreover, effectively integrating technology into teaching and learning demands the parallel development of innovative pedagogical strategies and ongoing, personalized training programs tailored to both instructors and learners, ensuring that these tools become authentic allies in learning rather than mere superficial substitutes for traditional face-to-face interaction (Castellanos et al., 2018).

Nevertheless, various international studies warn of persistent barriers that constrain this transformative potential. Vargas-Montoya et al. (2023) and Bos (2019), for instance, offer exhaustive analyses of PISA (Programme for International Student Assessment) results and highlight a widespread low disposition, coupled with predominantly negative attitudes toward the relevant and creative use of ICT, trends that translate into consistently limited academic performance, with greater prevalence and depth in Latin American countries. This concerning educational reality stems from multiple interconnected factors: insufficient teacher preparation that falls short of hybrid teaching demands, scarce material resources that hinder equitable provision, obsolete technological infrastructure that breeds constant frustration, and inadequate handling of digital tools that prioritizes technical over pedagogical concerns. Such obstacles not only obstruct the immediate achievement of specific learning goals but also structurally compromise the comprehensive development of essential competencies such as digital critical thinking, collaborative problem-solving, and media literacy in real-world contexts.

Previous international research further underscores that the real impact of virtual environments and digital technologies is neither uniform nor guaranteed, but depends largely on three fundamental pillars: effective pedagogical integration aligning technological tools with curricular objectives, material accessibility conditions that remove physical barriers, and the level of empowerment achieved in digital competencies by the entire educational community. UNESCO (2023), in this regard, emphatically warns that the absence of clear, regulated methodological articulation in the use of technological equipment frequently generates chronic distractions, progressively erodes self-regulation in autonomous learning, and systematically jeopardizes the achievement of long-term educational goals. Along similar lines, the ICILS (International Computer and Information Literacy Study, 2018) report reveals concrete and alarming data: 33% of teachers perceive ICT predominantly negatively, viewing them as a disruptive element that systematically distracts and reduces students' sustained attention and deep concentration, rather than enhancing their genuine and productive engagement with content.

These inherent limitations were exponentially magnified during the 2019–2020 pandemic, a critical period that exposed deep systemic vulnerabilities in global education systems. According to compelling data from international organizations, approximately 826 million students worldwide were unable to participate actively and effectively in their schoolwork, while nearly 43% faced severe and prolonged restrictions in accessing basic technological devices and reliable internet, with disproportionately greater impact in socioeconomically vulnerable contexts such as marginalized neighborhoods, isolated rural areas, and low-income single-parent households (UNESCO, 2020). This digital inequality did not merely represent a temporary interruption in educational continuity but generated an urgent and multifaceted challenge: to move decisively toward more equitable, resilient, and culturally relevant educational environments that close gaps accumulated over decades and promote genuine technological inclusion.

Recent comparative studies across Latin America and Asia confirm these disparities at both

international and country-specific local levels. In Venezuela, for example, digital gaps are dramatically aggravated by geographic factors such as the extreme dispersion of rural populations, structural poverty conditions, and fragmented educational policy frameworks that do not prioritize sustained technological investment (Laura, 2024). Similarly, though with its own nuances, rural areas in Costa Rica suffer chronic and persistent deficits in broadband connectivity, access to updated hardware, and large-scale digital literacy programs, perpetuating vicious cycles of educational exclusion that affect entire generations. Addressing these complex realities thus demands deeply contextualized pedagogical and policy interventions that consider not only basic material infrastructure but also the unique social, cultural, and human capital of each geographic region and specific community. Systematic assessment of digital competencies (DC) in both developed and developing nations empirically demonstrates that persistent inequalities are shaped by complex intersectional variables such as race/ethnicity, prior professional training, gender, and socioeconomic status, imperatively reinforcing the need for reliable, culturally validated, context-sensitive psychometric instruments to inform strategic and transformative educational decisions (Silva & Lázaro-Cantabrana, 2020). Likewise, intentionally strengthening teachers' digital competencies is inextricably linked to the quality of their everyday pedagogical practice in virtual environments, encompassing everything from creative planning of interactive and multimedia classes to rigorous implementation of ongoing formative assessment, personalized real-time accompaniment, and constructive, timely feedback that fosters metacognition (Carranza et al., 2024).

Finally, within this complex and interdependent framework, academic motivation emerges as an absolutely pivotal and cross-cutting construct, given its decisive role in sustaining long-term persistence, deep emotional engagement, and resilience in the face of obstacles inherent to digital learning. Precise, multidimensional measurement of motivation demands psychometric tools with solid, accumulated evidence, capable of faithfully capturing both intrinsic dimensions (autonomy, competence) and extrinsic ones (external recognition) in contemporary digital contexts (Ryan & Deci, 2000; Laura, 2024). This organic connection between motivation, digital environments, and pedagogical competencies fully justifies rigorous, systematic, and critical scrutiny of the measurement instruments available in the current literature.

Ruiz (2002) emphasizes that every psychometric instrument must be firmly anchored in a solid theoretical and operational definition of the target construct, followed by systematic, reflective, and iterative development of individual items. Moreover, this foundational process logically culminates in formal expert judgment, which grants essential content validity to the complete scale and ensures its precise conceptual alignment with the underlying theory. Lloret-Segura et al. (2014) therefore explicitly recommend applying direct oblique rotation in exploratory factor analysis (EFA), establishing clear interpretation thresholds: individual items should never load below .40; in such specific cases, their selective removal permits iteration of the analysis until a clean, interpretable, and theoretically coherent factor structure emerges. This concretely illustrates how validity must be proactively integrated from the earliest stages of instrument development, precisely through rigorous expert evaluation of each item during the very construction of the psychometric tool.

In this specific research, the central variables of digital environments and motivation are approached from an integrative perspective that combines social, academic, and critical dimensions, recognizing them as dynamic, interrelated factors that effectively propel the achievement of meaningful, contextualized learning while simultaneously erecting subtle but real obstacles to generating authentic, reflective, and transferable actions in students. Another absolutely crucial element resides in the teacher's strategic function as technological mediator, whose personal limitations in advanced use of digital platforms, such as limited familiarity with gamification tools, design of collaborative virtual activities, or learning analytics, decisively modulate the real transformative potential of VLEs in the classroom. Therefore, identifying and validating existing instruments, such as standardized questionnaires and already-created or culturally adapted multidimensional scales, proves absolutely indispensable for measuring these constructs with the scientific precision required in complex educational contexts. This imperatively demands that each tool respond to a robust and replicable EFA, clearly determining significant factor correlations among latent dimensions and optimally and evenly distributing items, ideally achieving factor loadings above 0.70 per individual item, while strictly avoiding problematic cross-loadings that seriously compromise theoretical and practical interpretation (Hair et al., 2019).

Furthermore, implementing exhaustive, sequential validation systems proves essential not only to guarantee a high level of internal and temporal reliability but also to facilitate valid replication of the instrument across diverse cultural, geographic, and educational contexts. Critical analyses of existing articles in the literature reveal a concerning pattern: many instruments fail spectacularly to comprehensively evaluate fundamental psychometric properties, frequently omitting critical validity types such as discriminant, convergent, or ecological validity. Consequently, before proceeding to any advanced statistical analysis or structural modeling, rigorous reliability tests, such as Cronbach's alpha for internal consistency or test-retest for temporal stability, must be systematically prioritized. Nevertheless, this practice reveals a common and problematic methodological tendency in educational research: authors disproportionately emphasize general descriptive methodology and superficial statistical results while systematically neglecting the intrinsic,

foundational properties of the new instruments they propose. Hence, greater technical rigor is urgently required in the sequential execution of EFA, multivariate confirmatory factor analysis (CFA), and transparent presentation of detailed statistical evidence, including fit indices such as CFI, TLI, RMSEA, and SRMR, with the explicit purpose of substantially elevating the robust and replicable scientific contribution of future educational research (Atashzadeh-Shoorideh & Yaghmaei, 2016).

In the preliminary and exploratory review conducted as the basis for this study, one key representative instrumental study was identified that develops specific scales for measuring digital environments applicable to both basic education students and their direct teachers. From this solid foundation, the investigation proceeded to exhaustively examine psychometric scales already validated in the literature that systematically measure digital environments and academic motivation, deliberately adopting a comprehensive pedagogical lens that organically integrates the student's concrete actions in daily interaction, the teacher's facilitating and mediating role, the technological resources available in each specific context, and the broader socio-structural level of the Ibero-American context characterized by its linguistic, cultural, and economic diversity. Preliminary findings from this review clearly conclude that these existing scales exhibit significant structural shortcomings in their validity, particularly in theoretical construct validity and operational content validity, drastically restricting their uncritical, universal replication across heterogeneous contexts; likewise, internal and external reliability emerges as another critical factor demanding exhaustive scrutiny during any cultural adaptation process or creation of new versions, aggravated precisely by the persistent lack of solid multidimensional construct or representative content evidence, as well as the limited and biased representativeness of the originally studied sample contexts.

From this comprehensive and critical analytical panorama emerges naturally the central research question guiding this work: What specific and accumulated psychometric evidence exists for instruments that reliably measure digital environments and academic motivation in the particular context of regular basic education in Ibero-America?

The main general objective was therefore established: to systematically and exhaustively review the psychometric evidence of available instruments measuring digital environments and motivation in regular basic education in Ibero-America. As complementary and operational specific objectives, the following were proposed: to thoroughly review the content validity of instruments measuring digital environments and motivation; to technically evaluate the construct validity of said instruments through exploratory and confirmatory factor analysis; and to precisely identify the principal methodological, technical, and psychometric limitations inherent to existing instruments for digital environments and motivation in the Ibero-American literature.

This rigorous methodological approach not only fills a significant and persistent gap in the regional Ibero-American scientific literature but also concretely paves the way for the development of culturally adapted, empirically validated, context-sensitive psychometric instruments, thus promoting truly inclusive, equitable, and effectively transformative digital education in the region's educational systems.

Methodology

This study rigorously applied the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method, an internationally recognized standard that ensures transparency and reproducibility in systematic reviews. Through this structured methodological flow, 13 highly relevant articles were ultimately identified, selected following exhaustive and meticulous analysis of the existing scientific literature. This process not only permitted filtering quality sources but also ensured that each publication incorporated sound psychometric evidence related to the constructs of interest.

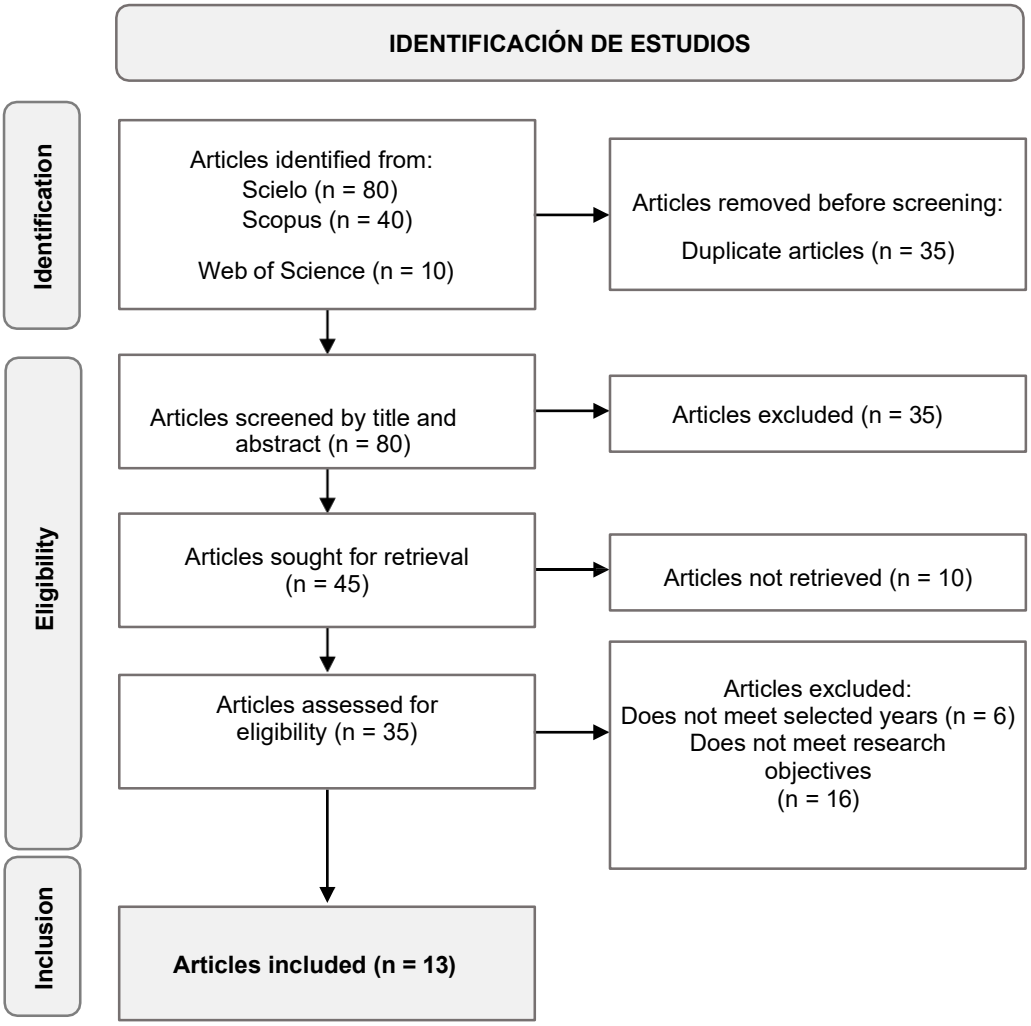
Additionally, to underpin a truly solid and well-founded scientific contribution, an exhaustive, systematic search was executed in prestigious academic databases: Scopus, SciELO, and Web of Science. These platforms, by virtue of their inherent characteristics of methodological rigor, diverse geographic coverage, and editorial quality standards, confer irrefutable scientific validity upon the entire selection and analysis process. The publications scrutinized revolved around strategically defined keywords such as "digital environments," "academic motivation," "psychometric instruments," "basic education," and "Ibero-America," combined using Boolean operators (AND, OR, NOT) to maximize precision in identifying pertinent and contextualized studies.

Consequently, during the theoretical and empirical construction of the central constructs —digital environments and motivation— studies meeting explicit, hierarchical inclusion criteria were strictly prioritized, all related to the simultaneous or complementary use of these two principal variables in regular basic education contexts. Specifically, studies were required to present measurement instruments with reported psychometric evidence (validity, reliability, factor analysis), representative samples of Ibero-American students and teachers, and a post-pandemic focus relevant to educational digital transformation. In this meticulous manner, a corpus of information was compiled that contributed directly, precisely, and without overlap to the central objective of the systematic review: evaluating the psychometric quality of available tools for measuring these phenomena in the region.

To execute this systematic review with maximum methodological rigor, four fundamental and sequential phases were adopted, exhaustive search, critical eligibility evaluation, in-depth evidence analysis, and integrative synthesis of findings, as proposed by Codina (2018).

Figure 1

PRISMA method flow diagram



Results

From the exhaustive review of diverse scientific sources informing the object of study —digital environments and motivation in regular basic education— it becomes evident that these works focus on concrete evidence obtained from both students and teachers. Evaluating this educational stage therefore acquires strategic relevance in the Ibero-American context, where technological and pedagogical realities vary enormously between privileged urban settings and marginalized rural areas. Furthermore, this analysis not only permits mapping the strengths of available instruments but also illuminates opportunities for adapting them to local realities, considering cultural and socioeconomic factors that influence their effectiveness.

In this regard, one notable study was conducted in the state of Sonora, Mexico, focusing on the validation of digital competencies for primary education (Vargas et al., 2024). This work incorporated expert judgment to establish face validity, with an initial sample of 30 students from three educational institutions. Subsequently, to deepen construct validity, 280 sixth-grade students from eight schools participated, using an instrument composed of 38 questions distributed across eight dimensions. The results obtained were robust: a KMO of .80, confirming ideal sample adequacy due to its good score; in the exploratory factor analysis (EFA), an average Cronbach's alpha of .74 was recorded, although one specific dimension showed levels below the general average, suggesting careful review of its items to balance the structure. Additionally, the average

explained variance reached 46.64%, an indicator demonstrating a satisfactory level of overall reliability. Consequently, analysis concludes that this represents a robust and adequate tool, with potential to serve as a reference in similar evaluations, provided these minor adjustments are addressed to enhance its precision across diverse contexts.

Following this line of Mexican validations, research conducted in Yucatán aimed to validate a digital literacy instrument for secondary school students (Reyes & Pinto, 2024). This study involved subject-matter experts and mobilized 491 students from 19 schools, structuring the document into 39 questions organized across eight dimensions. Psychometric indicators stood out for their excellence: an internal consistency of .958, a KMO of .974, and Bartlett's sphericity test with p=.000, validating sample adequacy and underlying structure. In EFA, five factors emerged with 24 questions explaining 58% of the variance, while confirmatory factor analysis (CFA) yielded a CFI of .996 and an RMSEA of .017, evidencing exceptional global model fit. Even through structural equation modeling, good fit was observed in each individual dimension. It can therefore be concluded that this instrument possesses a high level of robustness for replication in the Ibero-American context, especially given it was constructed considering the diversity of post-pandemic educational realities, making it adaptable to heterogeneous student profiles.

In the same Yucatecan setting, another instrument was applied with the participation of three experts and prior evaluation with 143 students, structured into five sections with 96 items and taking the European Digital Competence Framework as a key reference (Bastarrachea et al., 2023). This international approach enriched its conceptual design, resulting in excellent internal consistency of .946, supported by expert observations regarding the precise adequacy of each item. Furthermore, a KMO of .803 was obtained, and EFA results revealed explained variance of 74.74% distributed across five dimensions. Meanwhile, CFA —conducted on four dimensions— showed good comparative fit with a CFI of .920 and TLI of .918, confirming the instrument's overall consistency. Consequently, this tool positions itself as a reliable foundation for future research, particularly in settings seeking to align local competencies with global standards, facilitating cross-cultural comparisons and continuous pedagogical improvements.

Moving toward the Southern Cone, the study conducted in the Biobío region of Chile focused on adaptation and validation of the WVDE-CIS-28 scale to assess perceptions of pedagogical practices aimed at fostering 21st-century skills (Sepúlveda et al., 2023). A total of 3,432 students from 26 schools participated, with a scale comprising eight dimensions and 47 items. EFA proved appropriate, registering an RMSEA of .034 and TLI of .951, along with Cronbach's alphas between .780 and .854, and omegas between .784 and .855 reinforcing reliability. Upon conducting CFA, the data fully confirmed the EFA, maintaining an RMSEA of .034, SRMR of .031, CFI of .946, and TLI of .941, results that far surpass established thresholds in the psychometric literature. These excellent factor analysis indicators thus support the internal consistency of the items, while good convergent validity and solid correlations among factors demonstrate the unity of dimensions as a coherent and robust construct. In summary, this proposal offers an adequate and validated foundation for measuring perceptions in educational digital environments at large scale, highlighting its applicability in contexts with massive and representative samples.

In Santiago, Chile, Herrera et al. (2022) developed and validated a questionnaire specifically designed to explore teaching-learning in remote education contexts. A total of 202 teachers participated, and the instrument was structured into six dimensions with 38 items, complemented by two open-ended questions enriching the capture of qualitative perceptions. For content validation, five experts issued their judgment, strengthening conceptual pertinence from early stages. Overall reliability reached an impressive .943 according to Cronbach's alpha, while in exploratory factor analysis (EFA) a KMO of .920 was recorded, indicating excellent sample adequacy, along with significant Bartlett's test (p=.000) and total explained variance of 61.6%. It is therefore concluded that items exhibit a high level of internal consistency and logical dimensional grouping, supported by higher-order factor analyses. This instrument positions itself as a valuable foundation for future research, particularly relevant given the scarcity in recent years of studies focused on regular basic education teachers. However, to achieve even greater robustness, complementing with confirmatory factor analysis (CFA) is recommended, which would elevate its credibility in practical applications and regional replications.

Continuing with experiences in virtual environments, Fernández-Bringas et al. (2023) analyzed the Interaction in Virtual Contexts scale, developed in Lima with fourth- and fifth-year secondary students. Following the validation process, the instrument comprised 24 items distributed across three dimensions, with 321 students from four institutions, two public and two private, contributing socioeconomic diversity to the sample. A KMO above 0.7 was obtained, along with significant Bartlett's test ($p<0.01$), and explained variance of 93.1% after eliminating problematic ítems, indicators confirming a solid factor structure. In confirmatory factor analysis (CFA), indices were very good, with Cronbach's alpha of .901 and omega of .904, validating its capacity to assess interactions in distance education. Consequently, results permit concluding that the instrument presents adequate fit and confirms the factorial validity of the construct. Nevertheless, to endow it with greater scientific robustness, expanding the sample toward more diverse contexts proves essential, since

one identified limitation lies in the NFI of .818 and the study group size, below recommendations for this type of psychometric research. This suggestion opens doors to methodological expansions that potentiate its Ibero-American generalization.

In parallel, research conducted in Tacna, Peru, was explicitly designed to validate a questionnaire aimed at measuring student satisfaction with virtual teaching (SEV), a key aspect of the post-pandemic transition (García et al., 2022). A total of 572 secondary-level learners from seven educational institutions participated, complemented by five experts who endorsed content validation. The instrument's initial version consisted of 27 items, but through exploratory factor analysis (EFA) a seven-factor model emerged coherently grouping 22 items. Subsequently, CFA refined this structure to six factors with 19 items, yielding outstanding results: a CFI of .952, TLI of .939, and RMSEA of .073, all within optimal ranges evidencing good model fit. Furthermore, average coefficients obtained with ordinal alpha ranged between .88 and .926 per dimension, reinforcing internal reliability. Consequently, this instrument stands as an effective and reliable tool for measuring student satisfaction in virtual environments, fully supported by solid factor analysis results. Its design contextualized to Peruvian realities makes it especially promising for adaptations in other Ibero-American countries facing similar technological implementation challenges.

Another fundamental aspect considered in this study is academic motivation, a decisive factor in regular basic education where students find themselves in a critical stage of comprehensive formation that shapes their long-term learning habits. Analyzing specific instruments to measure this construct therefore proves essential, as it enables identification of how motivation influences interaction with digital environments and pedagogical engagement in post-pandemic contexts.

In this regard, the Intrinsic Motivation Profiles Scale (EPMI) was examined, developed in Alicante, Spain, and validated for children aged 6 to 11 (Moreno-Murcia et al., 2021). The first study involved a sample of 132 participants, focused on assessing sports motivation, with subject-matter experts endorsing content validation from initial stages. Exploratory factor analysis (EFA) allowed structuring the instrument into three clear dimensions, intrinsic motivation, extrinsic motivation, and amotivation, retaining only nine items with minimum saturations of .40, explaining total variance of 51.98%. Additionally, an average internal consistency of .703 was obtained, a solid indicator for scales in child populations. Subsequently, confirmatory factor analysis (CFA) yielded promising results: CFI of .94, NFI of .90, TLI of .92, SRMR of .06, and RMSEA of .06, all within acceptable ranges confirming model fit. In a second complementary study, with 156 students assessing motor competence, internal consistency of .87 was recorded in one dimension with 22 items, along with significant positive correlations between intrinsic/extrinsic motivation and motor competence. Consequently, this instrument positions itself as valid, reliable, and temporally stable, with potential for educational applications integrating physical activity and motivational digital environments.

Among the specific motivation scales, one developed in Mexico for primary school students stands out particularly, with 527 children participating and five experts providing judgment ensuring content validation (CVR=.93), guaranteeing a high level of reliability in individual items (Durán & Acle, 2022). Upon completion of the entire process, the instrument comprised three dimensions and 16 final questions, showing a Cronbach's alpha of .90 evidencing excellent overall internal consistency. Furthermore, EFA yielded satisfactory results, explaining 55% of the variance with a KMO of .92, confirming sample and structural adequacy. Findings reveal good criterion validity evidence, while the good construct validity level was endorsed by CFA results demonstrating optimal overall fit of the evaluated model. Thus, this scale proves not only useful for measuring school motivation across different educational contexts but also lends itself to intervention programs specifically designed to elevate motivational levels in students, encouraging its application in pedagogical initiatives combining digital environments with personalized engagement strategies.

Continuing this systematic analysis, in the Dominican Republic the Academic Motivation Scale (EMAA) was validated, with 1,712 secondary-level adolescents from two representative educational districts participating (Reyes et al., 2022). In exploratory factor analysis (EFA), a KMO of .74 was obtained, accompanied by good results in the evaluation of inter-item correlations, validating the underlying structure. CFA averages were optimal, notably a CFI of .970 evidencing excellent model fit levels, along with an RMSEA of .079, an adequate value despite the 90% confidence interval (.061, .097) suggesting a high probability of stable positive results. Additionally, the SRMR of .024 indicates excellent fit between observed data and the proposed model. Logistic models with two parameters were incorporated, highlighting the versatility of items to capture relevant information for the study. Finally, structural equation modeling showed excellent fit levels, granting structural and predictive validity to the instrument and to the measured construct. Consequently, this scale demonstrates robustness and coherence that make it highly replicable in other Ibero-American contexts, positioning it as a strategic tool for future research exploring the intersection between motivation and digital environments in vulnerable adolescent populations.

In Uruguay, Cuevasanta et al. (2023) conducted the validation process of an instrument designed to measure intrinsic versus extrinsic motivational orientation in primary school children. A total of 912 students from ten educational institutions, both public and private, participated, ensuring a broad and diverse sample

reflecting varied socioeconomic realities. The original instrument comprised five dimensions and 30 items, although four were eliminated due to low factor loadings, optimizing its internal structure. Three specialists participated in the adaptation phase, ensuring cultural and conceptual relevance. Confirmatory factor analysis (CFA) results proved particularly adequate in model 2b, with solid fit indices: CFI of .91, TLI of .90, RMSEA of .06 —acceptable levels indicating model precision— and an SRMR of .05, evidencing good relationship between observed data and what the construct intends to measure. Among dimensions, "challenge" stood out with an omega of .83, while "curiosity" showed the lowest level (.62), suggesting possible focused refinements. Consequently, the analyses fully support the instrument's validity and reveal robust psychometric properties, ideal for replication in other Ibero-American contexts, especially considering the large and heterogeneous sample that strengthens its generalizability.

Continuing with adaptations in the specific motivation domain, in Lima, Peru, Dammert et al. (2025) analyzed the SRQ-Reading Motivation, resulting from the integration of several previous instruments with collaboration from psychologists, bilingual educators, and a special education specialist. Work was conducted with 235 students from a single primary-level educational institution, structuring the document into two main factors, autonomous and controlled motivation, with 17 items capturing these dynamics according to self-determination theory. Confirmatory factor analysis (CFA) yielded a well-defined bifactorial model, with data confirming an SRMR of .082 —regular and acceptable levels for this type of scale— a CFI of .96 showing excellent results, and an AIC of 386.38 evidencing adequate and efficient model fit. Regarding factor loadings, autonomous motivation registered correlations between .69 and .89, while controlled motivation ranged between .37 and .73, with some questions exhibiting low loadings and suggesting careful revision to adjust them to the specific analysis context. Consequently, it can be determined that the instrument faithfully responds to what is predicted by self-determination theory, positioning itself as a valuable tool for evaluating reading processes in bilingual educational settings, though with opportunities for refinement that would enhance its precision in practical applications.

Meanwhile, in the Huancavelica region of Peru, Canales et al. (2025) executed the validation process of a questionnaire focused on motivation toward learning, with 192 students from a representative school participating. The instrument is organized into two fundamental dimensions, extrinsic and intrinsic motivation, and comprises 23 items addressing these orientations in a balanced manner. Five experts intervened to validate content, obtaining a content validity coefficient (CVC) of .920, a very good value establishing a solid foundation from initial stages. Additionally, kurtosis and skewness indices remained within acceptable ranges, granting initial validity to the scale and paving the way toward confirmatory factor analysis (CFA). In the latter, a correlation between factors of .69 was identified, along with a CFI of .996, excellent model fit, an equally outstanding TLI of .996, an SRMR of .062 adequately measuring discrepancy between observed and theoretical data, and an RMSEA of .036 confirming good global fit levels. Complementarily, average Cronbach's alpha reached .861, indicating that reliability falls within permissible parameters and provides valid, reliable, and actionable data. Therefore, these indicators not only demonstrate the robustness and solidity of the questionnaire's factor structure but also render it a practical tool for continuously improving educational processes, inviting teachers to actively promote these motivational factors in challenging rural classroom contexts.

Discussion

Upon systematically reviewing the 13 selected studies, the findings reveal that the various scales and questionnaires analyzed present significant psychometric results for precisely measuring the construct of digital competencies, as well as academic motivation in regular basic education contexts. When these validations are executed appropriately and rigorously, they not only generate solid evidence but also lay the groundwork for designing precise support mechanisms and informed educational policies directly anchored in the psychometric properties of available instruments. These resources enable reliable evaluation of how digital environments and motivation interact in the Ibero-American region, contributing to contextualized and effective pedagogical interventions (Silva & Lázaro-Cantabrana, 2020).

First, when examining content validation —an indispensable requirement in the creation or adaptation of any instrument— of the seven studies on digital environments, five explicitly incorporate expert judgment, thus fulfilling this foundational step ensuring conceptual pertinence from the initial stages. Similarly, of the six questionnaires measuring motivation, self-determination theory emerges as a determining factor in their theoretical construction, and five of them satisfy this criterion robustly. Overall, most instruments exhibit a good level of content validity, a crucial element that responds to the mandate of Ruiz (2002) to ground each scale in a solid theoretical definition of the construct, followed by systematic item development and, finally, expert endorsement providing coherence, relevance, and alignment with measured objectives. This practice not only elevates the initial credibility of the tools but also prevents conceptual biases that could compromise subsequent interpretations.

Furthermore, regarding construct validity and the internal structure of psychometric instruments, the

vast majority perform exploratory factor analysis (EFA) with encouraging results. In digital environments, Cronbach's alphas range between .74 and .946, with an average of .882; for motivation, the average reaches .796. Notably, two instruments do not include EFA because they merely adapt pre-existing methodological structures to the local context, faithfully responding to the original version without need for initial exploration. Nonetheless, all seek scientific robustness permitting precise measurement of the subjective aspects inherent to these constructs. As Hair et al. (2019) underscore, the importance of EFA lies in clearly determining correlations among factors and correctly distributing items, ideally obtaining factor loadings above 0.70 per item while strictly avoiding cross-loadings that distort interpretation. Consequently, these analyses not only validate internal dimensionality but also generate tools more sensitive to the real dynamics of digital teaching and learning.

Moreover, it is imperative to highlight the levels of explained variance, ranging from 46% to 75% in most scales. Several instruments purged items and dimensions with factor loadings below the established average, a methodologically sound practice that optimizes structure without sacrificing essential content. The ideal in such cases consists of eliminating items with low saturations to refine overall precision. These observed weaknesses should not be viewed as insurmountable failures but rather as valuable opportunities to improve the instruments: by structuring them more cleanly and aligned with diverse educational realities, future investigations with truly robust and replicable scientific contributions are enabled (Atashzadeh-Shoorideh & Yaghmaei, 2016). This transformative perspective converts specific limitations into catalysts for regional psychometric progress.

Concerning confirmatory factor analysis (CFA), which confers final construct validity, four of the seven instruments on digital competencies incorporate it, with impressive averages of CFI=.94 and TLI=.930 confirming excellent fit. Two additional scales show solid CFA, with the WVDE-CIS-28 particularly standing out for its combination of robust construct validity and a massive sample evaluating pedagogical practices oriented toward 21st-century skills. Another relevant finding is the multidimensional nature of all scales, allowing disaggregation of technology use in teaching-learning processes and facilitating the design of specific training strategies for teachers and students (Castellanos et al., 2018). Therefore, integrating complete factor analyses into each instrument proves highly practically useful, generating cumulative evidence that underpins informed and scalable pedagogical decisions.

Similarly, in the evidence on motivation scales, all six studies incorporate CFA with CFI levels consistently above .90, accompanied by elevated TLI and RMSEA in optimal ranges supporting the stability of proposed models. Two exceptional instruments stand out: one developed in Huancavelica, Peru, with outstanding construct results reflecting rural realities; and another in the Dominican Republic, with solid internal/external validity supported by a robust and broad sample of 1,712 participants. Most of these scales are multidimensional, capturing nuances such as intrinsic motivation, extrinsic motivation, and amotivation, while one instrument with pictographic items for early primary grades evidences good validity in child populations. Consequently, pertinently evaluating academic motivation acquires critical relevance, given its direct impact on learning persistence, sustained engagement, and educational resilience, demanding precise measurements through tools with solid psychometric evidence (Ryan & Deci, 2000; Laura, 2024).

Finally, among identified limitations, most studies lack convergent and discriminant validity evidence, preventing precise differentiation of constructs related to digital environments and motivation from adjacent variables. Another critical methodological aspect lies in frequently inadequate simples —predominantly non-probabilistic— the absence of factorial invariance analyses in several cases, and the lack of norming in most scales, elements that severely limit generalization of results to broader populations. Faced with these shortcomings, adequately measuring the real impact of virtual environments and digital technologies proves challenging, since without psychometrically sound instruments it will be difficult to rigorously assess the level of empowerment in digital competencies and its pedagogical influence (UNESCO, 2023). Nevertheless, recognizing these weaknesses opens pathways for future research incorporating more inclusive designs, representative samples, and exhaustive validations, thus strengthening the methodological arsenal available for Ibero-American education.

Conclusions

The systematic review of psychometric instruments measuring digital environments and motivation in regular basic education proves fully pertinent to the Ibero-American reality, revealing both their strengths and opportunities for improvement in diverse and challenging educational contexts. These findings not only consolidate a scientific foundation for future adaptations but also underscore the need for validated tools responsive to regional particularities, from connected urban zones to rural communities with technological limitations.

Regarding content validity, results determine that in the digital environment domain, not all instruments strictly meet this indispensable criterion, evidencing inconsistencies in the initial theoretical grounding of some items. Conversely, regarding motivation scales, findings yield adequate and consistent content validation,

although the need persists to strengthen theoretical constructs through more exhaustive and systematic expert judgment. This practice, as Ruiz (2002) emphasizes, ensures that each item coherently aligns with the conceptual definition of the construct, elevating measurement relevance and credibility from its foundational stages.

Furthermore, the scales analyzed exhibit adequate levels of internal reliability, supported by expert participation conferring content validity, alongside solid construct validity evidence derived from exploratory and confirmatory factor analyses. Two exemplary instruments stand out here: the WVDE-CIS-28 scale for virtual environments, with its multidimensional structure and massive sample evaluating innovative pedagogical practices; and the EMAA for motivation, combining excellent psychometric properties with a robust sample size. These characteristics render them ideal candidates for replication across heterogeneous Ibero-American contexts, facilitating application in varied educational realities without compromising interpretive precision.

Another key finding lies in the recurrent limitations, where sample size emerges as a determining factor directly influencing the internal and external validity of instruments. Many scales present poorly representative simples, frequently non-probabilistic and concentrated in specific institutions, restricting their generalizability. Likewise, a widespread lack of convergent and discriminant validity evidence is observed, as well as factorial invariance analyses, elements essential for differentiating adjacent constructs and ensuring structural stability across cultural contexts. These weaknesses do not invalidate existing contributions but highlight the urgency of methodological refinements to enhance their practical impact.

Consequently, to overcome these limitations and maximize the potential of instruments, deepening confirmatory factor analysis (CFA) across all scales is recommended, incorporating fit indices such as CFI, TLI, and RMSEA to definitively validate their multidimensional structures and guarantee statistical stability. Furthermore, when constructing or adapting new psychometric scales, it is essential to follow a rigorous sequential process: begin with detailed expert judgment to achieve optimal content validity, followed by exhaustive pilot tests identifying early difficulties, permitting precise item adjustments, and perfecting the instrument before its mass application with the target population. Finally, systematic work with representative and heterogeneous samples is suggested, collected from diverse educational institutions across different socioeconomic and geographic contexts, which would generate truly robust tools replicable in any Ibero-American reality and capable of informing inclusive and transformative pedagogical policies.

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