Journal of Ecohumanism
2025
Volume: 4, No: 2, pp. 1766 – 1774
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i2.6560

Validation of a Tool to Measure the Digital Competence of Students from Universidad Latina

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Abstract

Digital competence (DC) is essential in higher education, supporting academic, professional, and cultural development. This study aimed to validate the COMPDIG-PED instrument for assessing digital competence among students at Universidad Latina. Data were collected using non-probabilistic convenience sampling during the second quarter of 2024. Reliability analysis revealed satisfactory internal consistency, with Cronbach´s alpha (a = .70). However, the distribution of item difficulty highlighted a significant imbalance, as 36.51% of items were classified as very difficult, while only 12.70% fell into the medium-difficulty range. Participants scored between 12 and 41 (M = 31.52, SD = 5.05) out of a maximum of 63 points. These results highlighted the need to recalibrate item difficulty to enhance the instrument´s diagnostic value. Confirmatory factor analysis further raised concerns regarding the instrument´s unidimensionality. The Kaiser-Meyer-Olkin (KMO) value was low (2.0), and Bartlett´s test was significant (p< .001), indicating weak inter-item correlations. Additionally, low alpha values (0.13 – 0.55) within specific factors suggested issues with item alignment and clarity. These findings emphasize the need for refinements to the COMPDIG-PEG instrument to improve its design, structure, and reliability, ensuring it provides a comprehensive assessment of digital competences in higher education contexts.

Keywords: *Digital Competence, Questionnaire Validation, Higher Education, Reliability, Technological Education.*

Introduction

Digital competence (DC) plays a fundamental role in higher education, shaping students 'academic and professional development at both undergraduate and graduate levels. As Revuelta-Domínguez (2023) asserts, digital competence is not only a key factor in education but also an essential component of human development. In today´s world, digital competence encompasses more than basic technical skills: it includes the ability to critically evaluate, create, and effectively use digital tools to enhance learning and problem-solving. When higher education institutions assess students 'digital competence, they go beyond measuring simple access to network infrastructure. They also evaluate students 'ability to integrate technology into academic and professional activities, thus considering a broader range of usage factors through digital governance.

To address this need, various instruments have been developed to assess university students 'digital competence. Among the most recognized are the INCOTIC 2.0 questionnaire (González-Martínez et al., 2017), SDICoS (Tzafilkou et al., 2022), the Ikanos Test (Paños-Castro et al., 2022), and COMPDIG-PED (Silva-Quiroz et al., 2022b), among others. These tools provide valuable insights into students 'proficiency levels and inform institutional strategies for digital literacy development. The findings derived from these instruments highlight the growing significance of digital competence, reinforcing its importance within the global academic, professional, and cultural landscape (Marrero-Sánchez et al.; 2023).

Given the increasing reliance on digital technologies in education, higher education institutions implement effective assessment tools and training programs to foster digital competence. These initiatives enable institutions to design evidence-based pedagogical strategies that integrate technology into curricula and enhance student engagement (Silva-Quiroz et al., 2022b); Cabero-Almenara et al., 2020). A key consideration in this process in the validity of the assessment instrument. Ensuring internal consistency and

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DOI: https://doi.org/10.62754/joe.v4i2.6560

reliability is crucial, as it determines the accuracy of measurements regarding students 'knowledge, digital toll usage, and attitudes toward technology (Cabezas et al.; 2017).

However, despite the widespread use of digital technologies, research findings on students 'digital competence remain mixed. Dávila (2021) concluded that students frequently use digital tools for non-educational purposes, such as social media and entertainment, rather than for academic growth. This suggests that having access to technology does not guarantee the development of essential digital competencies. Ruiz-Zamora (2020) highlights that student acquire some digital competencies informally, through personal experiences. While many students demonstrate proficiency in basic information management, communication, and the use of digital tools for everyday tasks, their skills in more technical and specialized areas, such as data analysis, coding, and cybersecurity, tend to be underdeveloped (García et al., 2022).

Several studies have examined digital competence using different assessment models. For example, Tzafilkou et al., (2022) applied the SDICoS model, which demonstrated high validity and reliability across both undergraduate and graduate student populations. Similarly, Cabero-Almenara et al., (2023) implemented an alternative questionnaire, reporting satisfactory reliability and strong dimensional consistency. Notably, research suggests that students who have not repeated a course tend to exhibit higher levels of digital competence than those who have (Lorca et al., 2024; Silva-Quiroz et al., 2023). These findings indicate that academic success and digital competence may be closely linked, with students who navigate their academic journey without delays likely having stronger digital literacy skills.

The assessment of digital competence in students is not only necessary but also imperative for ensuring that higher educations institutions can design targeted interventions to address skill gaps. The implementation of robust evaluation instruments allows educators to accurately measure student´s competence levels, identify weaknesses, and apply corrective measures to enhance digital literacy (Silva-Quiroz et al., 2022). The growing global interest in digital competencies has led to an increased use of assessment tools across various educational contexts. For these tools to be effective, they must meet psychometric standards of reliability and validity (Fan & Wang, 2022). According to Touron et al., (2018) construct validity offers a comprehensive framework for integrating different validity measures, providing a detailed comprehension of digital competence as a multi-dimensional construct that ranges from abstract conceptualization to concrete application.

This article presents the validation process for an instrument designed to objectively assess students 'digital competence using the COMPDIG-PED tool. The study focuses on validating the instrument specifically for students at Universidad Latina, ensuring its effectiveness in measuring digital skills withing this academic context. By establishing the reliability and validity of the instruments, this research aims to contribute to the broader discourse on digital competence assessment, ultimately supporting the integration of digital literacy frameworks in higher education curricula.

Objective

The primary objective of this study is to validate the COMPDIG-PED instrument for assessing digital competences among higher education students at Universidad Latina of Costa Rica. To achieve this, the instrument was administered to students enrolled in English courses from various disciplines during the second academic quarter of 2024. The main research questions guiding this study are:

Does the COMPDIG-PED instrument effectively assess higher education students' digital competencies?

Does the COMPDIG-PED instrument provide an appropriate distribution of item difficulty to enhance its diagnostic value and meet psychometric standards?

Are the dimensions of the COMPDIG-PED instrument appropriately aligned to evaluate students´ digital competencies?

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Research Methodology

Research Design

The purpose of the study is to validate the COMPDIG-PED instrument in order to measure students´ digital competence at Universidad Latina. Data collection was conducted using a non-probabilistic convenience sampling method during second quarter of the 2024 academic year.

Participation in the study was voluntary, with no reward points of incentives provided. The research team explained the study´s purpose to participants and obtained signed consent forms from the students. Data collection was administered online and involved students enrolled in English courses (level 3,4 and 5) across various disciplines over a four-week period. Once collected, the data was downloaded from platform and saved in a spreadsheet. SPSS software was used to perform the validation and reliability analyses.

Instrument

The applied instrument was the COMPDIG-PED, developed in Chile using the DIGCOMP framework as a reference for understanding and fostering digital competences in Europe (Redecker & Punie, 2017, as cited by Silva-Quiros et al., 2022b). The instrument was based on DIGCOMP 2.1, which includes 21 indicators distributed across five dimensions (Carretero et al., 2017, as cited by Silva-Quiros et al, 2022b).

COMPDIG-PED was designed as a test comprising 84 items, with four items corresponding to each indicator. The instrument was reviewed and analyzed by five experts from Chile and Spain, who completed a validation matrix to ensure reliability.

The final version of COMPDIG-PED achieved a Cronbach´s alpha of $\alpha = .702$, indicating acceptable reliability. The instrument includes 63 items, with three items addressing each of the 21 competencies. It presents different situations with correct and incorrect answers, assigning 1 and 0 respectively. The possible range for each indicator ranges from 0 to 3, while the overall instrument score ranges from 0 to 63 (Silva-Quiroz et al., 2022b).

The following are the dimensions:

Table 1. Dimensions Evaluated By COMPDIG-PED

Competency	Quantity of items	Specific number
1. Information and digital literacy	9 items	1 – 9
2. Online communication and collaboration	18 items	10 – 27
3. Digital content creation	12 items	28 – 39
4. Network security	12 items	40 – 51
5. Problem solving	12 items	52 – 63

In order to evaluate the validity of the instrument, its reliability was tested through two analyses: an internal consistency using Cronbach´s Alpha and factorial analysis using Confirmatory Factor Analysis (CFA). For the CFA, a five-factor model was examined, corresponding to the dimensions outlined in the construct.

Participants

The study population consisted of 213 students, with a sample of 69 students selected through a voluntary participation process. These students were invited to complete the COMPDIG-PED instrument and were enrolled in English courses across various disciplines during the second academic quarter of 2024. The sample exhibited the following characteristics:

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Table 2. Sample Characterization

Variable	N	%
Gender		
Female	45	66%
Male	24	35%
Age started using technology		
less than 5 years old	4	6%
6 – 10	30	43%
11 – 15	31	44%
16 – 20	4	6%
University Faculty		
Art, Design and Communication	30	43%
Health Sciences	23	33%
Business and Hospitality	2	3%
Social Sciences	5	7%
Engineering and Information Technology	9	13%
Sample Total N=69		

66% of students are female and 35% are male, with an average age of 24 years old. The majority (44%) started using digital technology, including personal computer, laptop, tablet or smartphones, when they were between ages 11 and 15, 43% between 6 and 10, the 6% started before age 5, and 6% at age 16 or older. The 43% are students from the Faculty of Art, Design and Communication, 33% from Health Sciences, 13% from Technologies and IT, 7% from Social Sciences and 3% from Management and Hospitality.

Results

Evidence of Empirical Validation

The study findings offer valid evidence based on the application of the instrument and its outcomes The psychometric performance of the test, as assessed through reliability analysis using Cronbach´s alpha (α), shows a (α = .70), which is an acceptable level of self-consistency for an instrument (Taber, 2018).

The following section addresses the objectives of this work, providing references for the COMPDIG-PED questionnaire used to evaluate students´ digital competencies.

A digital competence test was conducted, exhibiting a difficulty level of 50% which falls within the acceptable range (50%-60%). However, the distribution of item difficulty was not appropriate. The test comprised 36.51% of very difficult items (GD < 0.32), 23.81% of moderately difficult items (0.33 < 0.52), 12.70% of medium difficulty items (0.53 < GD < 0.73), 12.70% of moderately easy items (0.74 < GD < 0.86), and 14.29% of easy items (GD > 0.87). According to Backhoff et al (2000) the ideal distribution should consist of 5% very difficult items, 20% moderately difficult items, 50% medium-difficulty items, 20% moderately easy items, and 5% very easy items.

In this test, participants demonstrated ordinary performance, with final scores ranging between 12 and 41 (M = 31.52, SD = 5.05) on an assessment with a maximum possible score of 63. This low performance persisted across the different dimensions of the test, as shown in table 3.

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Table 3. Results in Subtests of the Digital Competence Test

	Maximum posible score	Mean	SD	Min	Max
Information and digital literacy	9	3.99	1.29	0	6
Online communication and collaboration	18	9.39	2.15	2	13
Digital content creation	12	5.59	1.47	2	9
Network security	12	7.10	2.08	1	10
Problem solving	12	5.26	1.67	2	9
Total test	63	31.52	6.05	12	41

Reliability Analysis

The overall reliability of the test yielded an acceptable value (α = .70). Therefore, a confirmatory factor analysis was conducted to test the existence of a single factor. However, the fit indices were not satisfactory, as evidenced in table 4. This is indicated by a very low KMO value (.20), despite a significant Bartlett´s test of sphericity ($\chi 2=2583.99$, gl=1953, p<.001).

Table 4. Model Fit Indices for one factor CFA in the Digital Competence Test

CFI	TLI	SRMR	RMSEA
0.118	0.089	0.113	0.114

Additionally, a confirmatory factor analysis was attempted for the digital competence test using its original distribution of five factors. However, the five-factor model failed to converge due to the presence of "negative variances", a problem commonly referred to as Heywood case (Kolenikov & Bollen, 2012). This issue may indicate minimal differences in variances or variances approaching zero, a common occurrence when working with binary variables. For instance, in the digital context, there can be more than one correct answer and there may be some better options, which are not necessarily incorrect (Silva-Quiros et al., 2022). Alternatively, it could point to a flaw in the model structure.

The psychometric performance of the test can be confirmed through its reliability analyses, which yielded α values ranging between .13 and .55, as shown in table 5.

Table 5. Reliability of Subscales in the Digital Competence Test

Subescale	α de Cronbach
Information and digital literacy	.13
Online communication and collaboration	.37
Digital content creation	.19
Network security	.55
Problem solving	.27
Total test	.70

From table 5 the Information and Digital Literacy subscale (α = .13), Digital Content Creation (α = .19), and Problem Solving (α = .27) all exhibit very low reliability, suggesting that the items within these subscales do not consistently measure the intended constructs. Similarly, the Online Communication and Collaboration subscale (α = .37) falls below the acceptable threshold, indicating poor item cohesion.

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The Network Security (α = .55) shows relatively higher internal consistency compared to the other subscales, but it is still below the recommended standard of 0.70. This suggests that while some consistency exists, further refinement is necessary to improve reliability. The overall instrument achieves a Cronbach´s alpha of .70, which meet the minimum acceptable threshold for reliability in educational and psychological assessments. This suggests that while individual subscale may have weak internal consistency, the test as a whole provides a more reliable measure of digital competence.

Discussion

The findings of this study provide strong evidence for the validity and effectiveness of the instrument used. Reliability analysis performed using Cronbach´s alpha (α), revealed a score of α = .70, indicating a satisfactory level of internal consistency. The instrument´s reliability in measuring the target construct and highlight its suitability for future research applications, reinforcing its contribution to psychometric assessments and related studies.

While the reliability analysis confirmed an acceptable level of internal consistency, the item difficulty distribution presents areas for improvement. The digital competence test exhibited an overall difficulty level of 50%, falling within the acceptable range of 50%-60%. However, the item distribution deviated from the ideal balance. Specifically, the test contained a disproportionately high percentage of very difficult items (36.51%) and fewer medium-difficulty items (12.70%), which may affect the test´s overall effectiveness in providing a balanced assessment of digital competences. The high percentage of very difficult items (36.51%) means the test could be too challenging for most participants, which might frustrate them of fail to properly measure their abilities. Similarly, the low percentages of medium and moderately easy items (12.70% each) suggest that the instrument lacks sufficient questions accessible to a broader range of participants, as also noted by Silva-Quiros et al. (2022).

Despite the challenges, participant performance on the test was moderate, with scores ranging from 12 to 41 (M = 31.52, SD = 5.05) out of a maximum of 63 points. These finding underscore the need to refine the test´s items distribution to enhance its diagnostic value and align more closely with psychometric standards. Future efforts should focus on recalibrating items difficulty levels to achieve a more representative distributions, ultimately ensuring that the instrument provides a comprehensive and equitable assessment of digital competences across varying skill levels.

The confirmatory factor analysis (CFA), conducted to verify the existence of a single underlying factor, yielded unsatisfactory results, raising concerns about the dimensionality of the instrument. In particular, the fit indices demonstrated poor performance, as evidenced by the very low KMO value (2.0), which indicated inadequate inter-item correlations for reliable factor analysis. Meanwhile, Bartlett´s test of sphericity was significant ($p < .001$), suggesting that the correlation matrix is not an identity matrix, the low KMO value highlights the need for further refinement of the questionnaire items.

The test items within each factor may not be measuring the same underlying construct effectively. The α values ranged between 0.13 and 0.55, which are far below and might indicates almost no correlation between items within that factor. These low values undermine the test´s ability to reliable measure digital competence across its factors. It suggests that participants' responses to items within the same factor may be inconsistent or unrelated. This may be due; to poorly written or ambiguous items, items that do not appropriately align with the intended factor, or heterogeneity in the constructs being measured within each factor.

Cronbach´s alpha values for most subscales suggest that individual items within dimensions may need revision. This could involve removing redundant or unclear items, improving wording for clarity, or ensuring better alignment with the construct being measured. The low internal consistency for individual subscales might indicate that the instrument is not effectively capturing separate, distinct factors for digital competence.

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Conclusion

These findings propose that the COMPDIG-PED instrument, in its current form, does not adequately support a unidimensional structure. This discrepancy may be attributed to the presence of multiple latent dimensions that were not accounted for or to potential weaknesses in item design, such as redundancy, lack of clarity, or uneven difficulty levels. As a result, the instrument may not fully capture the intended construct of digital competence, limiting its diagnostic utility and validity.

The first research question examines whether the COMPDIG-PED instrument effectively assesses digital competences in higher education students. Addressing this question requires further investigation into the instrument's theoretical framework and its alignment with contemporary models of digital competence. Digital competencies are dynamic and multifaceted, and their assessment should accurately measure competence levels (Silva-Quiroz et al., 2022). Therefore, the assessment tool must be flexible and adaptable to reflect these changes accurately. Future research should explore alternative factor structures, such as multidimensional models, to better represent the construct. Additionally, refining the item pool to enhance clarity, improve inter-item correlations, and balance item difficulty distributions will be critical steps in strengthening the psychometric properties of the instrument. These refinements will contribute to developing a more robust and precise tool for evaluating digital competencies, with applications in both research and educational practice. A well-calibrated instrument will not only improve diagnostic precision but also enhance its utility for educators and policymakers seeking to implement digital competence frameworks effectively.

The second question investigates whether the COMPDIG-PED instrument ensures an appropriate distribution of item difficulty to enhance its diagnostic value and meet psychometric standards. Analyzing item difficulty levels and their impact on measurement accuracy will be vital in determining how well the instrument differentiates between varying levels of digital competence. If the items are too easy or too difficult for the majority of respondents, the tool may fail to provide meaningful distinctions in competence levels, thereby reducing its effectiveness as an assessment mechanism. The instrument COMPDIG-PED requires an appropriate balance in item difficulty to make it more valuable in identifying specific areas of strength and weakness among students, thereby guiding targeted interventions. Furthermore, ongoing statistical analyses, such as item response theory modeling, could offer deeper insights into item performance and ensure that each item contributes meaningfully to the overall assessment.

The last research question raises an important concern whether the dimensions of the COMPDIG-PED instrument are appropriately aligned to evaluate students' digital competencies. If the current dimensions do not fully capture the multifaceted nature of digital competence, then a reconsideration of the instrument's structure will be necessary to ensure a comprehensive assessment. Digital competence encompasses a wide range of skills, including technical proficiency, information literacy, communication skills, and ethical considerations in digital environments. If the instrument lacks coverage in any of these areas, it may provide an incomplete picture of students' competencies. Consequently, a rigorous review of the theoretical framework foundation of the instrument should be conducted to ensure its alignment with contemporary models of digital competence. This review may involve expert panel consultations, comparative analyses with existing validated instruments, and pilot testing in diverse educational settings.

Regarding the limitations of the study, a primary concern is the use of convenience sampling, which naturally leads to low representativeness of the findings. Convenience sampling can introduce biases, as it may not accurately capture the diversity of digital competence levels across different student populations. Additionally, the study faces potential biases related to the sample's composition, which may not accurately reflect the range of digital competencies in higher education settings. For future research, it is recommended to explore alternative randomization methods to enhance reliability and obtain a larger, more diverse sample to improve generalizability. Employing stratified random sampling or mixed-method approaches may help achieve a more representative participant pool, ensuring that findings are applicable across various academic disciplines and institutions. Following the validation of the current questionnaire, the goal is to evaluate digital competencies across a broader spectrum of participant profiles and varied contextual settings.

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Expanding the sample size and incorporating longitudinal studies could provide richer data on how digital competence evolves over time and how educational interventions influence skill development.

Finally, the implications of this study can be considered at various levels and within different decision-making contexts. For university students, the findings provide valuable insights into their current standing in terms of digital competence, enabling them to reflect and develop tailored actions for improvement through continuous learning. Self-assessment is a crucial aspect of digital competence development, as it fosters metacognition and proactive learning strategies. By using the instrument as a diagnostic tool, students can identify specific areas that require further development and seek out targeted resources, such as workshops, online courses, or mentoring programs.

For faculty, the tool offers an opportunity to assess students' digital competence at different stages and use the results to design or adapt methodological strategies that offer diverse and effective ways for acquiring digital skills. Digital competence is not a static skill set; rather, it evolves as technology advances and as educational contexts shift. Therefore, integrating digital competence assessment into curriculum design will help faculty ensure that students receive continuous and relevant digital skills training. Faculty members can leverage the instrument's findings to implement more interactive and technology-enhanced learning experiences that align with students' needs and expectations. Additionally, faculty development programs can use these insights to design targeted training sessions, equipping educators with the necessary skills to support students effectively.

Academic authorities could also leverage the findings to identify the training needs of new professors and collaborate with academic units to establish coordinated efforts and innovative approaches to better align teacher training with the evolving demands of the higher education sector. Digital transformation in education requires a strategic approach to faculty development, ensuring that educators are equipped with the skills and knowledge needed to integrate digital tools effectively into their teaching practices. Institutional policies should support ongoing digital literacy initiatives, creating a culture of continuous learning and innovation. By incorporating digital competence assessment into institutional strategies, universities can enhance their overall educational quality and ensure that graduates are well-prepared for the digital demands of the workforce.

By addressing the questions posed in this study will contribute to the continued refinement of the COMPDIG-PED instrument, ultimately enhancing its validity and utility in assessing digital competencies in higher education. Future studies should aim to refine the instrument further, ensuring that it remains relevant and adaptable to the ever-changing digital landscape. The integration of feedback from students, faculty, and educational researchers will be essential in creating a comprehensive and effective assessment tool. Moreover, collaboration with international institutions may provide opportunities for cross-cultural validation, enhancing the instrument's applicability across different educational contexts.

The findings highlight the need for a more refined approach to digital competence assessment, emphasizing the importance of multidimensionality, item refinement, and theoretical alignment. Addressing these issues through rigorous research and methodological improvements will strengthen the COMPDIG-PED instrument, making it a valuable resource for students, educators, and academic staff. As digital competence continues to gain significance in higher education and beyond, ensuring the accuracy and effectiveness of assessment tools will be crucial in fostering a digitally literate and capable workforce for the future.

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