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Preliminary Validation of a Student Digital Literacy Questionnaire Based on the UNESCO Digital Literacy Global Framework and DigComp 2.2

Rubilyn G Barrios [1], Mailah Grace Dosol-Demonteverde [2], Nova Kurnia[3], Sergii Sharov[4]*

[1] Mathematics Department, Monkayo College of Arts, Sciences and Technology, Monkayo, Philippines
[2] Physics Department, Ateneo de Davao University, Davao City, Philippines
[3] Science Education Department, Mandalika University of Education, Mataram, Indonesia
[4] Department of Computer Science, Dmytro Motornyi Tavria State Agrotechnological University, Zaporizhzhia, Ukraine

*Correspondence: sergii.sharov@tsatu.edu.ua

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Abstract

This study aims to examine the preliminary validation of a Student Digital Literacy Questionnaire based on the UNESCO Digital Literacy Global Framework and DigComp 2.2. The instrument was developed to measure seven dimensions of digital literacy: device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. This study employed a quantitative approach involving 350 respondents. Data were analyzed using descriptive statistics, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy, Bartlett's Test of Sphericity, exploratory factor analysis, corrected item-total correlation, Cronbach's Alpha, and a specified CFA measurement model. The results showed that the mean student digital literacy score was 116.18, indicating a moderate-to-high tendency. The KMO value of 0.951 and significant Bartlett's Test at $p < 0.001$ indicated that the data were suitable for factor analysis. Factor extraction produced seven factors with a cumulative variance of 47.04%. All items were valid, with corrected item-total correlations ranging from 0.412 to 0.548. The overall reliability was very high, with a Cronbach's Alpha of 0.924, while dimensional reliability ranged from 0.638 to 0.690. The CFA model was specified as a higher-order measurement model with seven first-order latent factors. The instrument is considered suitable as a preliminary measure of students' overall digital literacy in the context of school-based digital learning.

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INTRODUCTION

Digital transformation has changed the ways students access information, communicate, complete assignments, and construct learning experiences. Learning activities are no longer limited to printed books and face-to-face interaction, but increasingly involve digital devices, online learning platforms, search engines, social media, collaborative

applications, and open learning resources. These changes expand students' learning opportunities, but they also create new challenges because students must be able to select information, protect personal data, communicate ethically, and use technology productively. In this context, digital literacy has become an essential competence that students need in order to participate effectively, critically, and responsibly in digital learning environments.

Digital literacy should not be narrowly understood as the ability to operate devices or use particular applications. Such an understanding is insufficient because students who are skilled in using digital devices are not necessarily able to evaluate the credibility of information, understand the risks of digital footprints, create content ethically, or solve technical problems that arise during learning. Eshet-Alkalai (2004) emphasizes that digital literacy consists of a set of complex thinking and action skills in digital environments. Ng (2012) also explains that digital literacy involves technical, cognitive, and socio-emotional dimensions. Therefore, digital literacy needs to be positioned as a multidimensional construct that includes technical, critical, communicative, creative, ethical, and reflective aspects.

The need to understand digital literacy as a multidimensional competence has become increasingly important as global attention to students' ability to use technology and digital information continues to grow. The International Computer and Information Literacy Study shows that students' readiness to engage with digital environments is related to their ability to use computers and digital information responsibly, safely, and effectively (Fraillon, 2025). This type of finding indicates that education should not merely provide access to digital devices. Schools must also ensure that students have the competence to use technology as a means of learning, decision-making, communication, and self-development.

The UNESCO Digital Literacy Global Framework provides an important foundation for understanding digital literacy in a broad scope. The UNESCO Institute for Statistics (2018) developed this framework to support the measurement of digital literacy skills, including in relation to Sustainable Development Goal indicator 4.4.2. The framework positions digital literacy as a competence related to the use of devices, information management, communication, content creation, safety, problem solving, and the use of technology in everyday life. Within this scope, digital literacy is understood not only as a technical skill but also as the ability to use digital technology meaningfully across various contexts.

In addition to the UNESCO Digital Literacy Global Framework, DigComp 2.2 is also widely used as a framework for defining digital competence. DigComp 2.2 organizes digital competence into five main areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving (Vuorikari et al., 2022). This framework also enriches the description of digital competence by providing examples of knowledge, skills, and attitudes relevant to developments in digital technology, including new technologies based on artificial intelligence. Thus, DigComp 2.2 can serve as a conceptual basis for designing instruments that measure not only device use but also critical, ethical, creative, and problem-solving aspects in digital environments.

Although digital literacy has become an important issue in education, its measurement still requires careful attention. Digital literacy instruments that are not developed based on a clear conceptual framework may produce partial information. For example, instruments that overemphasize device use may overlook students' ability to evaluate information, maintain digital safety, or create content responsibly. Conversely, instruments that cover broad dimensions but are not psychometrically tested may create another problem, namely uncertainty about whether the items actually measure the intended construct. Therefore, the development of digital literacy instruments needs to be supported by adequate evidence of validity and reliability.

Instrument development and validation are important stages in educational research because data quality depends strongly on the quality of the measurement tool used. The Standards for Educational and Psychological Testing place validity as a primary consideration in interpreting test or instrument scores, while reliability concerns the consistency of measurement results (American Educational Research Association et al., 2014). Boateng et al. (2018) also emphasize that scale development should be carried out through a systematic process, beginning with item construction, followed by structural testing and reliability evaluation. Thus, a student digital literacy questionnaire should not only be developed based on theoretical indicators but also tested through empirical analysis so that it can be used more responsibly.

Several studies have attempted to develop and validate instruments for measuring digital competence or digital literacy. Tzafilkou et al. (2022), for example, developed the Students' Digital Competence Scale to measure students' digital competence by considering online learning skills, collaboration, social media, mobile devices, safety, and data protection. Chang and Kuo (2025) also developed and validated a digital literacy questionnaire to evaluate students' digital literacy. These studies show that the validation of digital literacy instruments is an important agenda in digital education research. However, in the context of measuring students' digital literacy, there remains a need for an instrument that explicitly integrates the UNESCO Digital Literacy Global Framework and DigComp 2.2 while presenting preliminary validation evidence at the levels of construct structure, item validity, and internal consistency reliability.

Based on this need, this study developed a Student Digital Literacy Questionnaire consisting of seven dimensions: device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. These seven dimensions were designed by adapting the scope of competencies in the UNESCO Digital Literacy Global Framework and DigComp 2.2, while also aligning them with students' learning contexts. The instrument consists of 35 statement items, with each dimension represented by five items.

The main focus of this study is to conduct a preliminary validation of the Student Digital Literacy Questionnaire. The preliminary validation is directed toward analyzing the preliminary construct structure, item validity, internal consistency reliability, and measurement model specification. The preliminary construct structure is analyzed to examine the suitability of the factor pattern with the seven developed dimensions. Item validity is analyzed to determine the contribution of each item to the measured construct. Internal consistency reliability is analyzed to assess the consistency of the instrument, both at the overall level and within each dimension. In addition, the CFA measurement model is specified to provide a conceptual representation of the relationship among the student digital literacy construct, the seven latent dimensions, and the observed indicators.

Thus, this study aims to analyze the preliminary construct structure, item validity, internal consistency reliability, and measurement model specification of the Student Digital Literacy Questionnaire based on the UNESCO Digital Literacy Global Framework and DigComp 2.2. The findings are expected to contribute to the development of a student digital literacy instrument that has a strong conceptual foundation and preliminary psychometric evidence. This instrument may also serve as a basis for further research examining students' digital literacy in relation to other educational variables, such as academic achievement, self-regulated learning, critical thinking skills, or technology-based learning readiness.

METHODS

Research Type and Design

This study employed a quantitative approach with a preliminary instrument validation design. The focus of the study was directed toward examining the preliminary construct structure, item validity, internal consistency reliability, and measurement model specification of the Student Digital Literacy Questionnaire. This design was selected because the main objective of the study was to obtain preliminary evidence regarding the psychometric adequacy of an instrument developed based on the UNESCO Digital Literacy Global Framework and DigComp 2.2.

Preliminary validation was conducted to determine whether the developed instrument had a construct structure aligned with the dimensions of digital literacy, whether each item made an adequate contribution to the measured construct, and whether the instrument demonstrated acceptable internal consistency. Thus, this study did not merely assess students' digital literacy scores but placed greater emphasis on the quality of the instrument as a measurement tool.

Research Respondents

The research data were obtained from 350 respondents who completed the Student Digital Literacy Questionnaire. Each respondent answered 35 statement items using a five-point Likert scale. The data analyzed in this study included item response scores, dimensional scores, total digital literacy scores, achievement percentages, and digital literacy categories.

The sample size of 350 respondents was considered adequate for item validity analysis, internal consistency reliability analysis, and exploratory factor analysis. This number also met the preliminary requirements for testing an instrument consisting of 35 items, as the respondent-to-item ratio was at an adequate level for preliminary psychometric analysis.

Research Instrument

The instrument used in this study was the Student Digital Literacy Questionnaire. This instrument was developed by adapting the UNESCO Digital Literacy Global Framework and DigComp 2.2. Both frameworks view digital literacy as a multidimensional construct that is not only related to the ability to use digital devices but also includes the ability to manage information, communicate ethically, create digital content, maintain digital safety, solve technical problems, and use digital technology for learning.

The questionnaire consisted of 35 statement items divided into seven dimensions. Each dimension consisted of five statement items. The seven dimensions included device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning.

The response scale used was a five-point Likert scale, consisting of Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree. For positive items, scores ranged from 5 to 1, with a score of 5 assigned to Strongly Agree and a score of 1 assigned to Strongly Disagree. For negative items, the scores were reversed so that the direction of measurement remained consistent with the digital literacy construct. The negative items in this instrument were Q4, Q9, Q14, Q19, Q24, Q29, and Q34.

Scoring Procedure

Scoring was carried out by considering the direction of each statement item. Positive items were scored according to the respondent's level of agreement, with 5 for Strongly Agree, 4 for Agree, 3 for Undecided, 2 for Disagree, and 1 for Strongly Disagree. Conversely, negative

items were reverse-scored, with 1 for Strongly Agree, 2 for Agree, 3 for Undecided, 4 for Disagree, and 5 for Strongly Disagree.

Reverse scoring for negative items was conducted before the analysis of validity, reliability, and construct structure. This step was important because negative items have a measurement direction that is opposite to the digital literacy construct. If reverse scoring is not performed, the total score, item-total correlations, and internal consistency reliability may become inaccurate.

After all scores were aligned in the same direction, the score for each dimension was calculated by summing the five items included in that dimension. The total digital literacy score was obtained by summing all scores from the 35 items. Since the instrument consisted of 35 items with a score range of 1 to 5, the minimum total score was 35 and the maximum total score was 175.

Data Analysis Technique

Data were analyzed quantitatively through several stages, namely descriptive analysis, preliminary construct structure analysis, CFA measurement model specification, item validity analysis, and internal consistency reliability analysis.

First, descriptive analysis was conducted to describe the characteristics of students' digital literacy scores. This analysis included minimum score, maximum score, mean, standard deviation, category distribution, and mean score for each dimension. Descriptive analysis was used as an initial overview of the data pattern and respondents' score achievement before conducting psychometric analysis of the instrument.

Second, the preliminary construct structure was analyzed using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy, Bartlett's Test of Sphericity, and Exploratory Factor Analysis. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was used to determine sample adequacy and the suitability of the data for factor analysis. Bartlett's Test of Sphericity was used to determine whether the inter-item correlation matrix met the requirements for factor analysis. The data were considered suitable for further analysis if the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was greater than 0.50 and Bartlett's Test of Sphericity showed a significance value of less than 0.05.

Exploratory Factor Analysis was used to obtain a preliminary overview of the instrument's factor structure and to examine its alignment with the seven developed dimensions of digital literacy. The preliminary number of factors was determined by considering eigenvalues greater than 1, the scree plot pattern, and the alignment of the factors with the theoretical framework of the instrument. Factor loadings were used to examine the strength of the relationship between each item and the extracted factors, as well as to identify possible cross-loadings across dimensions.

Third, the CFA measurement model was specified based on the seven-dimensional structure of digital literacy. This model positioned students' digital literacy as a second-order latent construct underlying seven first-order latent factors: device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. Each first-order latent factor was represented by five observed indicators according to the instrument blueprint.

The CFA measurement model specification in this study was used to clarify the structural relationship among the main construct, dimensions, indicators, and error terms. The model was presented as a measurement diagram to serve as a basis for further CFA testing. Because this study focused on preliminary validation, the CFA model was not used

to make statistical decisions regarding model fit. Therefore, model fit indices such as chi-square/df, Comparative Fit Index, Tucker-Lewis Index, Root Mean Square Error of Approximation, and Standardized Root Mean Square Residual were not used as decision-making criteria in this study.

Fourth, item validity was analyzed using corrected item-total correlation. This technique was used to determine the relationship between each item score and the total instrument score after the item was excluded from the total score calculation. An item was considered valid if its corrected item-total correlation value was greater than the critical r value at the 0.05 significance level. In addition, this study used a practical criterion that items with corrected item-total correlation values of ≥ 0.30 were considered to have an adequate contribution to the measured construct.

Fifth, internal consistency reliability was analyzed using Cronbach's Alpha. Reliability analysis was conducted for the overall instrument and for each dimension. Overall reliability was used to determine the internal consistency of the 35 items as a single digital literacy instrument. Dimensional reliability was used to determine the internal consistency of the five items within each dimension. A higher Cronbach's Alpha value indicated better internal consistency, although its interpretation still considered the number of items, the characteristics of the construct, and the stage of instrument development.

Interpretation Criteria

The interpretation criteria in this study referred to the suitability of factor analysis, preliminary construct structure, item validity, and internal consistency reliability. The data were considered suitable for factor analysis if the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was above 0.50 and Bartlett's Test of Sphericity was significant at the 0.05 level. The preliminary construct structure was interpreted based on the number of extracted factors, eigenvalues, scree plot pattern, factor loadings, and the alignment of the factors with the seven developed dimensions of digital literacy.

Factor loading was interpreted as an indicator of the strength of the relationship between an item and a factor. Items with adequate loadings indicated sufficient association with the measured factor. However, if an item had closely related loadings on more than one factor, the item was interpreted as showing an indication of cross-loading. Cross-loading was not used as an immediate basis for item deletion in this preliminary validation, but rather as a note for further instrument refinement.

The CFA measurement model was interpreted as a specification of the measurement structure, not as final evidence of model fit. The CFA diagram was used to show the conceptual relationship among the second-order latent construct, the seven first-order latent factors, the observed indicators, and the error terms. Statistical decisions regarding CFA model fit require further testing by reporting model fit indices and standardized factor loadings.

Item validity was interpreted based on corrected item-total correlation values. An item was considered valid if its correlation value was greater than the critical r value and met the practical minimum criterion of 0.30. Internal consistency reliability was interpreted based on Cronbach's Alpha values, both for the overall instrument and for each dimension. Adequate alpha values indicated that the items in the instrument had internal consistency in measuring students' digital literacy.

Study Limitations

This study was limited to the preliminary validation of the Student Digital Literacy Questionnaire based on the UNESCO Digital Literacy Global Framework and DigComp 2.2.

The analysis focused on score description, preliminary construct structure, item validity, internal consistency reliability, and CFA measurement model specification. Therefore, this study did not examine the relationship between digital literacy and other variables, such as academic achievement, learning motivation, critical thinking skills, or students' demographic characteristics.

Another limitation is that the CFA model in this study was presented as a measurement model specified based on the theoretical structure and the results of exploratory factor analysis. The model was not used to make statistical decisions regarding model fit. For stronger testing, future research should conduct a full Confirmatory Factor Analysis by reporting standardized factor loadings, parameter significance values, Composite Reliability, Average Variance Extracted, and model fit indices such as chi-square/df, Comparative Fit Index, Tucker-Lewis Index, Root Mean Square Error of Approximation, and Standardized Root Mean Square Residual.

RESULTS AND DISCUSSION

Results

The analysis of the research results was directed toward obtaining preliminary evidence regarding the psychometric quality of the Student Digital Literacy Questionnaire. This instrument consists of 35 statement items developed based on seven dimensions of digital literacy, namely device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. Each dimension consists of five statement items, giving the instrument a balanced structure in representing the construct of students' digital literacy.

The data were analyzed through several stages. The first stage was descriptive analysis to describe the total scores, category distribution, and score achievement for each dimension. The second stage was preliminary construct structure analysis using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy, Bartlett's Test of Sphericity, eigenvalues, scree plot, and factor loadings from exploratory factor analysis. The third stage was the presentation of a specified CFA measurement model based on the seven dimensions of digital literacy. The fourth stage was item validity analysis using corrected item-total correlation. The fifth stage was internal consistency reliability analysis using Cronbach's Alpha, both for the overall instrument and for each dimension.

Description of Students' Total Digital Literacy Scores

The first result presented is the descriptive statistics of students' total digital literacy scores. Descriptive statistics are needed to provide an initial overview of the data characteristics before conducting validity, reliability, and preliminary construct structure analyses. A summary of the descriptive statistics of students' total digital literacy scores is presented in Table 1.

Table 1. Descriptive summary of students' digital literacy scores

Component	Value
Number of respondents	350
Number of items	35
Number of dimensions	7
Theoretical minimum score	35
Theoretical maximum score	175
Empirical minimum score	83

Component	Value
Empirical maximum score	164
Mean total score	116.18
Standard deviation	13.61

Based on Table 1, students' total digital literacy scores ranged from 83 to 164. This range indicates that the empirical scores of the respondents did not fall at either the theoretical minimum or maximum limits. Thus, the data showed sufficient variation to be further analyzed in testing the characteristics of the instrument.

The mean total score of 116.18 indicates that students' overall digital literacy achievement tended to fall between the moderate and high levels. When compared with the theoretical maximum score of 175, this mean suggests that the respondents had a sufficient level of digital literacy, although their overall achievement had not generally reached the very high category.

The standard deviation of 13.61 indicates variation in scores among students. This variation is important in the context of instrument validation because a good instrument should be able to distinguish among respondents' levels of ability. If respondents' scores are too homogeneous, validity and reliability analyses become less informative because the instrument does not demonstrate adequate discriminating capacity.

Distribution of Students' Digital Literacy Categories

In addition to the total score, the distribution of students' digital literacy categories was analyzed to examine the spread of respondents across each category. The results of the category distribution are presented in Table 2 and visualized in Figure 1.

Table 2. Distribution of students' digital literacy categories

Category	Frequency	Percentage
Very Low	0	0.00
Low	13	3.71
Moderate	199	56.86
High	135	38.57
Very High	3	0.86
Total	350	100.00

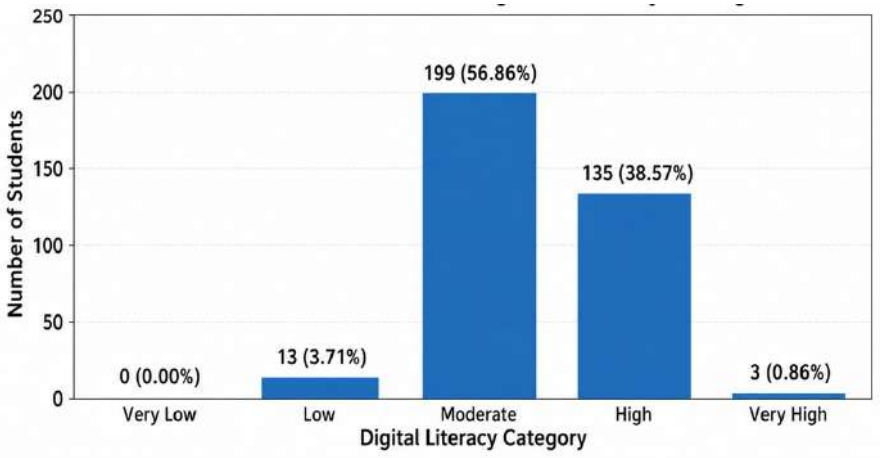

Figure 1. Distribution of Students' Digital Literacy Categories

Based on Table 2 and Figure 1, most respondents were in the moderate category. The number of respondents in this category reached 199 students, or 56.86% of the total

respondents. This finding indicates that more than half of the respondents had a moderate level of digital literacy.

The high category included 135 respondents, or 38.57%. This percentage is relatively large and indicates that a considerable proportion of respondents already had relatively good digital literacy skills. Meanwhile, only 13 respondents, or 3.71%, were in the low category, and no respondents were in the very low category.

Only three respondents, or 0.86%, were in the very high category. This pattern indicates that students' digital literacy was not yet concentrated at the very high level. Thus, although most respondents were in the moderate and high categories, there remains room for improvement, especially in the more complex dimensions of digital literacy.

Description of Digital Literacy Scores by Dimension

The next analysis examined the scores for each dimension of digital literacy. Dimensional analysis is important because digital literacy is a multidimensional construct. Students may have strong abilities in certain aspects but weaker abilities in others. The descriptive statistics for each dimension are presented in Table 3 and visualized in Figure 2.

Table 3. Descriptive statistics of dimensional scores

Dimension	Number of Items	Mean	Standard Deviation	Percentage of Maximum Score
- Device and digital application operation	5	19.37	2.43	77.46
- Information and data literacy	5	15.50	2.44	62.00
- Digital communication and collaboration	5	17.63	2.31	70.51
- Digital content creation	5	15.63	2.48	62.50
- Digital safety and ethics	5	15.19	2.47	60.78
- Digital problem solving	5	15.65	2.40	62.59
- Digital use for learning	5	17.22	2.40	68.87

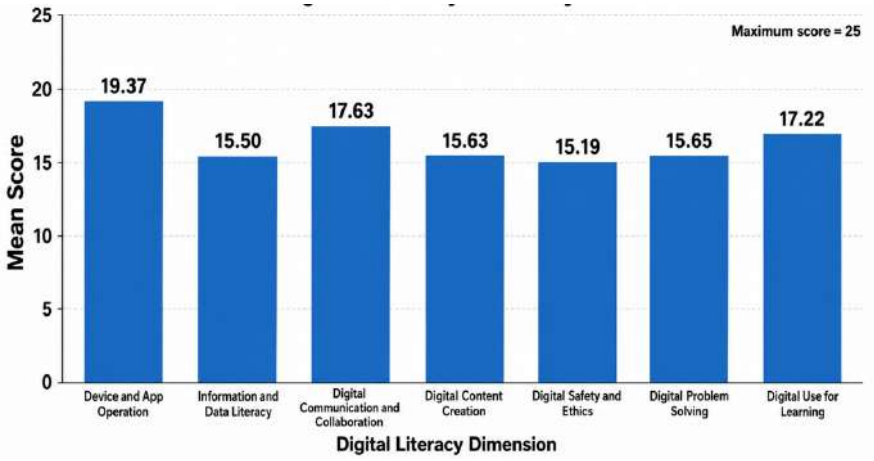

Figure 2. Mean Digital Literacy Score by Dimension

Based on Table 3 and Figure 2, the dimension with the highest mean was device and digital application operation, with a score of 19.37 out of a maximum score of 25. When converted into a percentage, the achievement in this dimension reached 77.46%. This finding indicates that the basic technical aspect of using digital devices and applications was the relatively strongest ability among the respondents.

The digital communication and collaboration dimension ranked second, with a mean score of 17.63 or 70.51% of the maximum score. The digital use for learning dimension also showed a relatively good achievement, with a mean score of 17.22 or 68.87%. These two dimensions indicate that students did not only use digital devices technically but also used them to interact and support learning activities.

In contrast, the digital safety and ethics dimension obtained the lowest mean score, namely 15.19 or 60.78% of the maximum score. The dimensions of information and data literacy, digital content creation, and digital problem solving were also at around 62%. This pattern indicates that abilities related to critical, ethical, productive, and problem-oriented engagement in digital environments remained lower than basic operational abilities.

Data Suitability for Factor Analysis

Before further analysis of the preliminary construct structure, data suitability was tested using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. This test was conducted to determine whether the inter-item correlation matrix met the requirements for factor analysis. The results of the factor analysis suitability test are presented in Table 4.

Table 4. Results of the KMO and Bartlett's Test

Indicator	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.951
Bartlett's Test of Sphericity, chi-square	3211.524
Degrees of freedom	595
Significance	< 0.001

Based on Table 4, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was 0.951. This value was far above the minimum threshold of 0.50. Thus, the data had very good sample adequacy and correlation patterns for factor analysis.

The results of Bartlett's Test of Sphericity showed a chi-square value of 3211.524 with 595 degrees of freedom and a significance level of < 0.001. This result indicates that the inter-item correlation matrix differed significantly from an identity matrix. In other words, the items in the instrument had sufficient correlations to form a factor structure.

The findings in Table 4 provide a basis for continuing the factor analysis. In the context of preliminary instrument validation, these results indicate that the data met the prerequisites for examining the preliminary construct structure of the Student Digital Literacy Questionnaire.

Preliminary Construct Structure Based on Eigenvalues and Scree Plot

After the data were considered suitable for factor analysis, preliminary factor extraction was performed. The extraction results were used to examine the number of factors formed based on the criterion of eigenvalues greater than 1. The eigenvalues and percentage of variance explained by the seven preliminary factors are presented in Table 5, while the eigenvalue decline pattern is visualized in Figure 3.

Table 5. Eigenvalues and variance explained by the seven preliminary factors

Factor	Eigenvalue	Explained Variance	Cumulative Variance
1	9.825	28.07	28.07
2	1.241	3.55	31.62
3	1.186	3.39	35.00
4	1.102	3.15	38.15

Factor	Eigenvalue	Explained Variance	Cumulative Variance
5	1.072	3.06	41.21
6	1.028	2.94	44.15
7	1.012	2.89	47.04

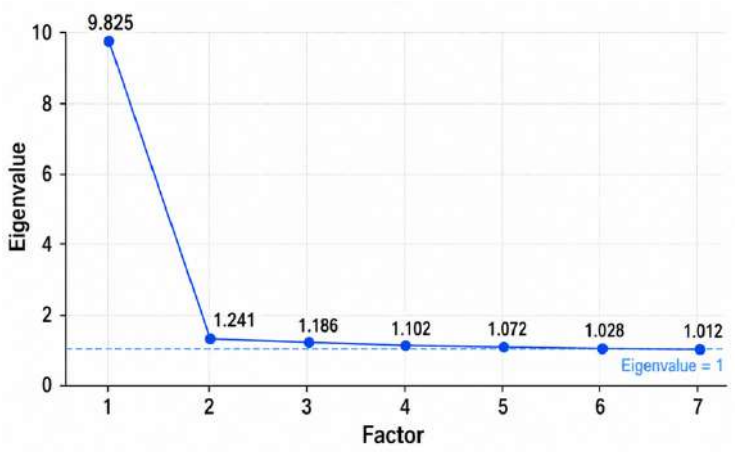

Figure 3. Scree Plot of the Initial Construct Structure

Based on Table 5, seven factors had eigenvalues greater than 1. This number of factors was consistent with the theoretical design of the instrument, which consisted of seven dimensions of digital literacy. The seven factors explained a cumulative variance of 47.04%.

The first factor had the largest eigenvalue, namely 9.825, and explained 28.07% of the variance. The second to seventh factors had smaller eigenvalues, ranging from 1.012 to 1.241, with each factor contributing between 2.89% and 3.55% of the variance. This pattern indicates that the instrument had a strong general factor while still showing a multidimensional tendency through the formation of seven preliminary factors.

Figure 3 shows a sharp decline in eigenvalues at the first factor, followed by a more gradual decline in the subsequent factors. This pattern can be interpreted as an indication that students' digital literacy has a dominant general construct, while still being composed of several more specific dimensions. Thus, the preliminary factor extraction results support the use of seven dimensions as the basis for instrument development.

Factor Loadings from Exploratory Factor Analysis

To further clarify the preliminary construct structure, the results of exploratory factor analysis are also presented through a summary of factor loadings. Table 6 presents the range of factor loadings on the theoretical dimensions, the range of dominant loadings, and notes on the loading pattern for each dimension. This presentation is important because eigenvalues and the scree plot only indicate the preliminary number of factors, whereas factor loadings provide information about the strength of the relationship between items and the extracted factors.

Table 6. Summary of factor loadings by dimension

Dimension	Items	Loading Range on Theoretical Dimension	Dominant Loading Range	Notes
- Device and digital application operation	Q1-Q5	0.300-0.701	0.371-0.701	Most items loaded on the theoretical dimension.

Dimension	Items	Loading Range on Theoretical Dimension	Dominant Loading Range	Notes
- Information and data literacy	Q6-Q10	0.063-0.500	0.352-0.500	Loading variation was found, and several items showed proximity to other factors.
- Digital communication and collaboration	Q11-Q15	0.156-0.522	0.462-0.674	Several items showed indications of cross-loading.
- Digital content creation	Q16-Q20	0.320-0.623	0.380-0.623	Most items loaded fairly well on the theoretical dimension.
- Digital safety and ethics	Q21-Q25	0.177-0.562	0.346-0.608	Several items had dominant loadings on other factors.
- Digital problem solving	Q26-Q30	0.172-0.688	0.392-0.688	Loading variation was found across items.
- Digital use for learning	Q31-Q35	0.155-0.636	0.366-0.636	Some items loaded on the theoretical dimension, but several showed proximity to other factors.

Based on Table 6, factor loadings on the theoretical dimensions showed varied ranges. The device and digital application operation dimension had a loading range on the theoretical dimension from 0.300 to 0.701. The digital content creation dimension also showed a fairly good pattern, with a loading range on the theoretical dimension from 0.320 to 0.623. These two dimensions demonstrated a relatively clearer relationship between the items and the intended dimensions.

Several dimensions showed greater loading variation. In the information and data literacy dimension, loadings on the theoretical dimension ranged from 0.063 to 0.500. In the digital communication and collaboration dimension, loadings on the theoretical dimension ranged from 0.156 to 0.522. This pattern indicates that not all items loaded most strongly on their theoretical dimensions, suggesting indications of cross-loading in several items.

These factor loading findings need to be interpreted carefully. On the one hand, the eigenvalue results supported the formation of seven preliminary factors according to the instrument design. On the other hand, the factor loading pattern indicated that the structure across dimensions was not yet fully distinct. This is understandable in the preliminary validation of a digital literacy instrument because several dimensions are conceptually related, such as information literacy, digital communication, digital safety, and digital use for learning.

Specified CFA Measurement Model

Based on the instrument structure and the results of exploratory factor analysis, a CFA measurement model was developed to represent the relationship among the student digital literacy construct, the seven latent dimensions, and the 35 observed indicators. This model is

presented as a measurement specification that can be used as a basis for further CFA testing. The CFA measurement model diagram is presented in Figure 4.

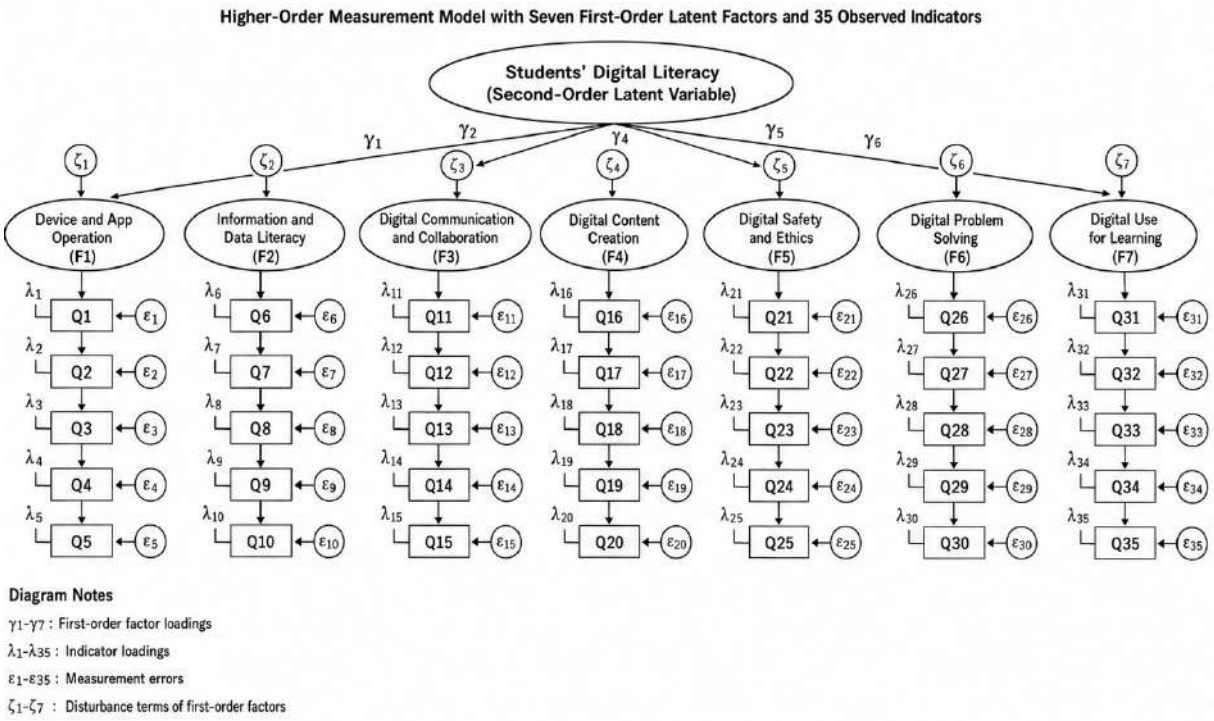

Figure 4. Confirmatory Factor Analysis Model of Students' Digital Literacy

Figure 4 shows a CFA measurement model with student digital literacy as a second-order latent construct. This construct underlies seven first-order latent factors: device and app operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. Each first-order latent factor is represented by five observed indicators, from Q1 to Q35.

In the CFA diagram, ellipses represent latent variables, rectangles represent observed indicators, small circles represent measurement errors, and disturbance symbols for the first-order factors represent disturbance terms. Arrows from the second-order construct to the seven latent factors represent higher-order factor loadings, while arrows from each latent factor to the indicators represent indicator loadings. Thus, this model illustrates a more complete measurement structure than a simple mapping of dimensions and items.

Although Figure 4 was constructed according to the standard presentation of CFA diagrams, its interpretation in this study is limited to a specified measurement model. Standardized factor loadings, p-values, chi-square/df, Comparative Fit Index, Tucker-Lewis Index, Root Mean Square Error of Approximation, and Standardized Root Mean Square Residual were not reported at this stage. Therefore, Figure 4 is not used to claim that the model is statistically fit, but rather to clarify the model structure that can be further tested through CFA.

Item Validity Based on Corrected Item-Total Correlation

Item validity was analyzed using corrected item-total correlation. This analysis was used to determine the extent to which each item was associated with the total instrument score after the item was excluded from the total score calculation. A summary of item validity by dimension is presented in Table 7.

Table 7. Summary of item validity by dimension

Dimension	Items	Corrected Item-Total Correlation Range	Status
- Device and digital application operation	Q1-Q5	0.475-0.488	Valid
- Information and data literacy	Q6-Q10	0.472-0.548	Valid
- Digital communication and collaboration	Q11-Q15	0.412-0.506	Valid
- Digital content creation	Q16-Q20	0.465-0.536	Valid
- Digital safety and ethics	Q21-Q25	0.479-0.539	Valid
- Digital problem solving	Q26-Q30	0.447-0.547	Valid
- Digital use for learning	Q31-Q35	0.464-0.538	Valid

Based on Table 7, all dimensions had corrected item-total correlation ranges above 0.30. This indicates that the items in each dimension had an adequate contribution to measuring the student digital literacy construct. No dimension had an item-total correlation range below the practical criterion used in this study.

The digital communication and collaboration dimension had the lowest corrected item-total correlation value, namely 0.412. Although this was the lowest value, it remained above the 0.30 threshold and therefore still met the item validity criterion. Meanwhile, the highest value was found in the information and data literacy dimension, namely 0.548.

These findings indicate that all items in the instrument can be retained. In other words, no item needed to be eliminated based on the item-total correlation results. However, variation in item values remains important to discuss, particularly for items with the lowest correlations, as these may require attention in future instrument refinement.

Detailed Item Validity and Alpha if Item Deleted

To provide a more detailed picture, the validity results for each item are presented in Table 8. This table contains the corrected item-total correlation value, alpha if item deleted value, and item validity decision for each item.

Table 8. Detailed item validity results

Item	Dimension	Corrected Item-Total Correlation	Alpha if Item Deleted	Status
Q1	Device and digital application operation	0.488	0.922	Valid
Q2	Device and digital application operation	0.488	0.922	Valid
Q3	Device and digital application operation	0.475	0.922	Valid
Q4	Device and digital application operation	0.484	0.922	Valid
Q5	Device and digital application operation	0.484	0.922	Valid
Q6	Information and data literacy	0.481	0.922	Valid
Q7	Information and data literacy	0.544	0.922	Valid
Q8	Information and data literacy	0.548	0.922	Valid
Q9	Information and data literacy	0.472	0.922	Valid

Item	Dimension	Corrected Item-Total Correlation	Alpha if Item Deleted	Status
Q10	Information and data literacy	0.512	0.922	Valid
Q11	Digital communication and collaboration	0.494	0.922	Valid
Q12	Digital communication and collaboration	0.444	0.923	Valid
Q13	Digital communication and collaboration	0.426	0.923	Valid
Q14	Digital communication and collaboration	0.412	0.923	Valid
Q15	Digital communication and collaboration	0.506	0.922	Valid
Q16	Digital content creation	0.465	0.923	Valid
Q17	Digital content creation	0.476	0.922	Valid
Q18	Digital content creation	0.536	0.922	Valid
Q19	Digital content creation	0.505	0.922	Valid
Q20	Digital content creation	0.476	0.922	Valid
Q21	Digital safety and ethics	0.539	0.922	Valid
Q22	Digital safety and ethics	0.485	0.922	Valid
Q23	Digital safety and ethics	0.505	0.922	Valid
Q24	Digital safety and ethics	0.499	0.922	Valid
Q25	Digital safety and ethics	0.479	0.922	Valid
Q26	Digital problem solving	0.474	0.922	Valid
Q27	Digital problem solving	0.456	0.923	Valid
Q28	Digital problem solving	0.547	0.922	Valid
Q29	Digital problem solving	0.447	0.923	Valid
Q30	Digital problem solving	0.471	0.922	Valid
Q31	Digital use for learning	0.488	0.922	Valid
Q32	Digital use for learning	0.464	0.923	Valid
Q33	Digital use for learning	0.484	0.922	Valid
Q34	Digital use for learning	0.538	0.922	Valid
Q35	Digital use for learning	0.498	0.922	Valid

Based on Table 8, all items had corrected item-total correlation values ranging from 0.412 to 0.548. All of these values were above the minimum criterion of 0.30. Thus, each item had an adequate relationship with the total instrument score. The item with the highest corrected item-total correlation was Q8, with a value of 0.548. This item belonged to the information and data literacy dimension. This value indicates that Q8 had the strongest contribution to the total digital literacy score compared with the other items. The item with the lowest corrected item-total correlation was Q14, with a value of 0.412. Although it had the lowest value, it still met the validity criterion. In addition, the alpha if item deleted values for all items ranged from 0.922 to 0.923, indicating that no item deletion would increase the total alpha beyond 0.924. Therefore, all items could be retained in the instrument.

Internal Consistency Reliability of the Instrument

Internal consistency reliability was analyzed using Cronbach's Alpha. The analysis was conducted at two levels: the overall instrument and each dimension. The results of internal consistency reliability are presented in Table 9.

Table 9. Internal consistency reliability of the instrument and each dimension

Instrument Component	Number of Items	Cronbach's Alpha	Interpretation
- Overall instrument	35	0.924	Very high
- Device and digital application operation	5	0.685	Adequate
- Information and data literacy	5	0.690	Adequate
- Digital communication and collaboration	5	0.638	Adequate
- Digital content creation	5	0.682	Adequate
- Digital safety and ethics	5	0.686	Adequate
- Digital problem solving	5	0.673	Adequate
- Digital use for learning	5	0.659	Adequate

Based on Table 9, the Cronbach's Alpha value for the overall instrument was 0.924. This value indicates that the Student Digital Literacy Questionnaire had very high internal consistency when used as an overall measurement instrument. Thus, the 35 items composing the instrument had strong internal relationships in measuring students' digital literacy.

Dimensional reliability ranged from 0.638 to 0.690. The dimension with the highest alpha value was information and data literacy, namely 0.690. The dimension with the lowest alpha value was digital communication and collaboration, namely 0.638. These values remain acceptable in the context of preliminary validation, especially because each dimension consisted of only five items.

The difference between the total alpha and dimensional alpha values requires attention. The very high total alpha indicates that the instrument is strong as a measure of overall digital literacy. However, the dimensional alpha values, which were at an adequate level, indicate that the use of dimensional scores should be interpreted carefully. This finding is important because it shows that the instrument has strong internal consistency at the total score level but still has room for refinement at the dimensional level.

Summary of Preliminary Validation Results

To clarify the overall findings, the main results of the preliminary validation of the Student Digital Literacy Questionnaire are summarized in Table 10. This table presents the analyzed aspects, main findings, and decisions based on the criteria used in this study.

Table 10. Summary of the main findings of the preliminary validation

Analyzed Aspect	Main Findings	Decision
- Suitability for factor analysis	KMO = 0.951; Bartlett p < 0.001	Suitable for factor analysis.
- Preliminary construct structure	Seven factors had eigenvalues > 1	Supports the seven-dimensional design.
- Cumulative variance of the seven factors	47.04%	Adequate for preliminary validation.
- Factor loadings	Most items showed adequate loadings, although several items indicated cross-loading	Preliminary construct structure was supported but still requires strengthening.
- CFA model	The measurement model was specified as a higher-order	Suitable as a basis for further CFA testing.

Analyzed Aspect	Main Findings	Decision
	measurement model with seven first-order latent factors and 35 indicators	
- Item validity	Corrected item-total correlation = 0.412-0.548	All items were valid.
- Total reliability	Cronbach's Alpha = 0.924	Very high
- Dimensional reliability	Cronbach's Alpha = 0.638-0.690	Adequate.
- Item deletion	Alpha if item deleted = 0.922-0.923	No item needed to be deleted.

Based on Table 10, the Student Digital Literacy Questionnaire had adequate preliminary validity evidence. Suitability for factor analysis was indicated by the very high KMO value and significant Bartlett's Test. The preliminary construct structure also supported the seven-dimensional design because seven factors had eigenvalues greater than 1.

The factor loading results showed that the preliminary construct structure tended to support the seven-dimensional model, but the structure was not yet fully distinct across items and dimensions. Several items showed indications of proximity to other factors, suggesting that the instrument still has room for refinement if used in further testing. This finding does not invalidate the seven-dimensional structure, but it indicates that further validation is needed to test the model more rigorously.

The presented CFA model clarifies that students' digital literacy can be positioned as a second-order construct underlying seven first-order latent factors. The presentation of this model strengthens the conceptual basis of the instrument and provides direction for testing the measurement model in the next stage. However, because model fit indices were not reported, the CFA model in this study was not used to conclude statistical model fit.

Item validity showed consistent results. All items had corrected item-total correlations above the minimum criterion; therefore, no item was declared invalid. The alpha if item deleted results also showed that deleting any item did not increase the overall reliability of the instrument.

The internal consistency reliability of the overall instrument was in the very high category. However, dimensional reliability was in the adequate category. Therefore, this instrument has its main strength as a measure of overall digital literacy, while interpretation at the dimensional level should be conducted more carefully and may become a focus for further instrument development.

Discussion

The findings of this study show that the Student Digital Literacy Questionnaire has sufficiently strong preliminary validation evidence as an instrument for measuring digital literacy based on the UNESCO Digital Literacy Global Framework and DigComp 2.2. Overall, the analysis supports the view that students' digital literacy can be understood as a multidimensional construct that is not only related to the ability to use digital devices but also includes information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and the use of digital technology for learning. This finding is consistent with the view of the UNESCO Institute for Statistics (2018), which positions digital literacy as a broad competence that includes technical, cognitive, communicative, creative, and problem-solving abilities. A similar perspective is also reflected in DigComp 2.2, which maps digital competence into the areas of information

and data literacy, communication and collaboration, digital content creation, safety, and problem solving (Vuorikari et al., 2022).

These findings strengthen the view that digital literacy cannot be reduced to technical ability alone. Students who are able to use digital devices do not necessarily have adequate ability to evaluate the credibility of information, maintain data security, understand the ethics of digital communication, or create content responsibly. Eshet-Alkalai (2004) emphasizes that digital literacy is a combination of thinking and action skills in digital environments, while Ng (2012) distinguishes digital literacy into technical, cognitive, and socio-emotional dimensions. Therefore, the structure of the instrument, which includes seven dimensions, can be viewed as an effort to capture digital literacy more comprehensively rather than merely as a skill in using technology.

From a descriptive perspective, the mean total digital literacy score of 116.18 indicates that the respondents tended to be at a moderate-to-high level. The category distribution showed that most respondents were in the moderate and high categories, while only a small proportion were in the very high category. This finding indicates that students' digital literacy has developed but has not yet fully reached an optimal level. This condition is consistent with international evidence showing that students' ability to engage in digital environments is not determined solely by access to devices, but also by their ability to use information, technology, and digital media effectively, safely, and responsibly (Fraillon, 2025; Livingstone et al., 2023).

The dimensional analysis provides a more detailed picture. The device and digital application operation dimension obtained the highest mean score, whereas the digital safety and ethics dimension obtained the lowest mean score. This pattern indicates that students' operational ability is relatively more developed than abilities requiring ethical awareness, data security, and critical decision-making in digital spaces. This is consistent with Ng's (2012) argument that a generation familiar with digital devices is not automatically digitally literate. Students may appear fluent in using gadgets or applications, yet they still need strengthening in information evaluation, safety, ethics, and digital responsibility. Vissenberg et al. (2022) also show that digital literacy and online resilience play an important role in the wellbeing of children and adolescents, particularly when they encounter digital risks, misinformation, and unsafe communication practices.

The finding that digital safety and ethics had the lowest mean score deserves particular attention. This dimension is not only related to knowledge about passwords or privacy settings but also concerns awareness of digital footprints, protection of personal data, and the ability to avoid risky behavior in digital spaces. Vissenberg et al. (2023) explain that digital skills and digital knowledge can serve as buffers against misinformation and disinformation. Therefore, the relatively low achievement in the digital safety and ethics dimension suggests that digital literacy education needs to move beyond technical training. Schools need to integrate learning about privacy, communication ethics, information credibility, and digital responsibility into everyday learning practices.

The results of the factor analysis suitability test showed a Kaiser-Meyer-Olkin Measure of Sampling Adequacy value of 0.951 and a significant Bartlett's Test of Sphericity at $p < 0.001$. These values indicate that the data had very adequate sample adequacy and inter-item correlation structure for factor analysis. Kaiser (1974) states that the KMO index is used to assess the adequacy of partial correlations in factor analysis, while Hair et al. (2019) and Tabachnick and Fidell (2019) emphasize that a high KMO value and a significant Bartlett's Test are important prerequisites before researchers interpret factor structures. Thus, the results of this study provide a strong statistical basis that the items in the questionnaire are sufficiently interrelated to be analyzed as a construct structure of digital literacy.

Preliminary factor extraction showed that seven factors had eigenvalues greater than 1 and explained a cumulative variance of 47.04%. This number of factors corresponds to the theoretical design of the instrument, which consists of seven dimensions of digital literacy. This finding supports the argument that students' digital literacy in this instrument has a multidimensional structure. However, the first factor explained the largest proportion of variance, namely 28.07%, whereas the subsequent factors contributed smaller proportions of variance. This pattern indicates the presence of a relatively strong general digital literacy factor while still showing specific dimensions within the construct. In other words, the instrument can be understood as a measure of digital literacy that has a general tendency while still retaining a multidimensional structure.

Although the eigenvalue results support seven factors, interpretation of the number of factors should be conducted carefully. Costello and Osborne (2005) caution that decisions regarding the number of factors in Exploratory Factor Analysis should not rely solely on eigenvalues greater than 1. Horn (1965) and Hayton et al. (2004) recommend parallel analysis as a stronger approach for determining the number of factors to retain. Therefore, the seven-factor result in this study should be understood as preliminary evidence rather than final evidence of the construct structure. In the next stage, testing can be strengthened through parallel analysis and Confirmatory Factor Analysis so that the seven-dimensional structure can be examined more rigorously.

The factor loading results showed that most items had adequate loadings, although indications of cross-loading were found in several dimensions. This pattern is not entirely unexpected because digital literacy is an interrelated construct. For example, the ability to evaluate digital information may be related to digital safety, digital communication, and the use of technology for learning. Van Laar et al. (2017) explain that 21st-century digital skills are closely related to information skills, communication, collaboration, critical thinking, creativity, and problem solving. Therefore, cross-loading in several items may indicate conceptual proximity among dimensions rather than merely a weakness of the instrument. Nevertheless, this finding should still serve as a basis for refining items so that the boundaries among dimensions become clearer.

The specified CFA measurement model in this study positioned students' digital literacy as a second-order latent construct underlying seven first-order latent factors. This specification is consistent with the nature of digital literacy, which has both a general construct and specific dimensions. Brown (2015) and Kline (2023) explain that a higher-order model can be used when several first-order factors are viewed as representations of a more general construct. In the context of this study, the seven dimensions of digital literacy can be viewed as first-order factors, while students' digital literacy serves as the second-order construct. However, because the CFA model in this study was not tested using fit indices such as CFI, TLI, RMSEA, and SRMR, the model cannot yet be declared statistically fit. The model is more appropriately positioned as a measurement specification that can be tested in future research.

Item validity showed consistent results. All items had corrected item-total correlation values ranging from 0.412 to 0.548, meaning that all items met the practical threshold of 0.30. This finding indicates that each item had an adequate relationship with the total instrument score. In instrument development, an adequate item-total correlation indicates that an item contributes to the construct being measured (DeVellis & Thorpe, 2021; Field, 2018). Boateng et al. (2018) also emphasize that item evaluation is an important part of the scale validation process because weak items can reduce measurement accuracy. Based on the findings of this study, no item needed to be removed based on corrected item-total correlation.

The item with the highest corrected item-total correlation was Q8, which belongs to the information and data literacy dimension. This indicates that the item made the strongest contribution to the total digital literacy score. Conceptually, information and data literacy is indeed one of the core components of digital literacy because students need to search for, evaluate, select, and use digital information critically. This is consistent with DigComp 2.2, which positions information and data literacy as one of the main areas of digital competence (Vuorikari et al., 2022). Conversely, the item with the lowest value was Q14 in the digital communication and collaboration dimension. Although its value remained valid, this item should be considered in future instrument revision because its correlation value was the lowest among all items. Revision may focus on the clarity of wording, the context of digital behavior being asked, or the alignment of the item with the dimensional indicator.

The internal consistency reliability of the overall instrument showed a Cronbach's Alpha value of 0.924. This value indicates very high internal consistency at the total instrument level. In general, a high alpha value indicates that the items in an instrument are strongly interrelated in measuring the same construct (Cronbach, 1951). However, the interpretation of alpha values needs to be proportionate. Tavakol and Dennick (2011) emphasize that Cronbach's Alpha is influenced by the number of items, inter-item correlations, and the dimensionality of the instrument. Because this instrument consists of 35 items, the high total alpha value may also be influenced by the number of items. Therefore, total alpha should not be the sole basis for claiming that the instrument is psychometrically established.

Dimensional reliability ranged from 0.638 to 0.690. These values were lower than the total reliability but remain understandable in the context of preliminary validation because each dimension consisted of only five items. DeVellis and Thorpe (2021) explain that scale reliability is influenced by the number of items and the homogeneity of the construct. If the number of items in a subscale is small, the alpha value may be lower even when the items still make an adequate contribution. Therefore, the dimensional reliability results in this study do not necessarily indicate that the dimensions are unsuitable for use. However, these values suggest that dimensional scores should be used cautiously and may be strengthened through the addition or refinement of items in future research.

The difference between the very high total alpha and the adequate dimensional alpha values indicates that this instrument is stronger for measuring overall digital literacy than for drawing highly specific conclusions for each dimension. This finding is methodologically important. If researchers or practitioners intend to use dimensional scores separately, each subscale needs to have adequate reliability and a clear factor structure. Worthington and Whittaker (2006) state that scale development requires continuous evaluation of factor structure, item quality, and subscale reliability. Thus, this instrument is appropriate as a preliminary measurement tool, but further testing is still needed to strengthen interpretation at the dimensional level.

Compared with previous studies, the findings of this study are consistent with the direction of instrument development in digital literacy and digital competence, which emphasizes the importance of empirical validation. Tzafilkou et al. (2022) developed the Students' Digital Competence Scale by considering the validity and reliability of digital competence dimensions. Chang and Kuo (2025) also developed a digital literacy questionnaire to evaluate students' digital literacy through a validation process. Avinç and Doğan (2024) used the Rasch approach to test the validity and reliability of a digital literacy scale. The main similarity between this study and those previous studies lies in the importance of ensuring

that digital literacy instruments are not only theoretically developed but also empirically tested before being used for broader interpretation.

However, this study has its own distinctive feature because it integrates the UNESCO Digital Literacy Global Framework and DigComp 2.2 into seven dimensions adapted to students' contexts. This integration produced an instrument that includes device operation, information and data, digital communication, content creation, digital safety, problem solving, and digital use for learning. This structure provides a more comprehensive scope than instruments that emphasize only technical skills or technology use in learning. Therefore, the contribution of this study lies in providing a preliminary model of a student digital literacy instrument that is based on global frameworks and supported by preliminary psychometric evidence.

The practical implication of this study is that the developed questionnaire can be used as an initial diagnostic tool for students' digital literacy. Teachers, schools, or researchers can use the measurement results to identify which aspects are relatively strong and which aspects require improvement. Based on the descriptive results, device and digital application operation appeared to be relatively strong, while digital safety and ethics emerged as an area requiring particular attention. This means that digital literacy strengthening programs should not only include training in application use but also learning about information verification, privacy, data security, digital communication ethics, and responsibility in creating or sharing content.

Methodologically, the findings of this study show that preliminary validation of an instrument should not stop at total reliability. Although the total Cronbach's Alpha was high, the factor loading results and dimensional reliability values indicate that the instrument can still be refined. AERA et al. (2014) emphasize that validity is not a fixed property of an instrument but is related to score interpretation and instrument use in a particular context. Therefore, the use of the Student Digital Literacy Questionnaire should be accompanied by the understanding that validity evidence can continue to be strengthened through testing with different samples, full CFA analysis, invariance testing, and evaluation of relationships with other relevant variables.

This study also has several limitations that need to be considered when interpreting the findings. First, the CFA model presented in this study remains a specified measurement model and not the result of statistical model fit testing. Therefore, future research should test the model using standardized factor loadings, Composite Reliability, Average Variance Extracted, CFI, TLI, RMSEA, and SRMR. Second, the decision regarding the number of factors still relied on eigenvalues, scree plot, and theoretical alignment. The use of parallel analysis, as recommended by Horn (1965) and Hayton et al. (2004), can strengthen factor retention decisions. Third, dimensional reliability remained in the adequate category, indicating that item refinement within each dimension is needed to improve subscale internal consistency.

Overall, the findings of this study show that the Student Digital Literacy Questionnaire has an adequate preliminary conceptual and psychometric foundation. This instrument supports the understanding of digital literacy as a multidimensional construct that includes technical, informational, communicative, creative, ethical, problem-solving, and learning-related aspects. The empirical evidence shows that all items were valid, total reliability was very high, and the preliminary construct structure supported the seven-dimensional design, although indications of cross-loading were still found. Therefore, this instrument is suitable as a preliminary measurement tool for students' digital literacy, with the note that further testing is still needed to strengthen construct validity and dimensional-level reliability.

CONCLUSION

This study shows that the Student Digital Literacy Questionnaire based on the UNESCO Digital Literacy Global Framework and DigComp 2.2 has adequate preliminary validation evidence as an instrument for measuring students' digital literacy. The instrument, consisting of 35 items and seven dimensions, is able to represent digital literacy as a multidimensional construct that includes device and digital application operation, information and data literacy, digital communication and collaboration, digital content creation, digital safety and ethics, digital problem solving, and digital use for learning. The descriptive results indicate that students' digital literacy tended to be at a moderate-to-high level, with the highest achievement found in the device and digital application operation dimension, while the lowest achievement was found in the digital safety and ethics dimension.

The results of the preliminary construct structure analysis show that the data were suitable for factor analysis, as indicated by the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value of 0.951 and a significant Bartlett's Test of Sphericity. Preliminary factor extraction produced seven factors with eigenvalues greater than 1 and a cumulative variance of 47.04%, thereby supporting the initial design of the instrument, which consists of seven dimensions. However, the factor loading results also indicated cross-loading in several items, suggesting that the construct structure of the instrument still needs to be strengthened through further testing. The specified CFA measurement model in this study shows that students' digital literacy can be positioned as a second-order latent construct underlying seven first-order latent factors, but the model has not yet been used to conclude statistical model fit because fit indices were not reported.

The item validity results show that all items had corrected item-total correlation values ranging from 0.412 to 0.548; therefore, all 35 items in the instrument were declared valid and could be retained. The internal consistency reliability of the overall instrument was in the very high category, with a Cronbach's Alpha of 0.924, while dimensional reliability ranged from 0.638 to 0.690. Thus, the Student Digital Literacy Questionnaire is suitable as a preliminary instrument for measuring students' overall digital literacy, although the use of dimensional scores should be interpreted carefully. Further research is needed through Confirmatory Factor Analysis, parallel analysis, Composite Reliability, Average Variance Extracted, and testing with more diverse samples in order to strengthen the instrument's validity and reliability evidence.

RECOMMENDATIONS

Based on the findings of this study, the Student Digital Literacy Questionnaire can be used as a preliminary instrument to map students' overall digital literacy, particularly in the contexts of learning evaluation, diagnosis of digital literacy development needs, and technology-based educational research. However, the use of scores for each dimension should be conducted carefully because dimensional reliability remained at an adequate level and several items showed indications of cross-loading. Future research is recommended to conduct stronger psychometric testing through Confirmatory Factor Analysis, parallel analysis, Composite Reliability, Average Variance Extracted, and invariance testing across more diverse respondent groups. In addition, items in dimensions with lower reliability, particularly digital communication and collaboration as well as digital use for learning, need to be reviewed so that the structure across dimensions becomes more distinct and the internal consistency of the instrument improves.

Author Contributions
The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

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Declaration of Interest
The author declares no conflict of interest.

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