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Statistical Validation of the "ECODIES" Questionnaire to Measure the Digital Competence of Colombian High School Students in the Subject of Mathematics

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Abstract: Education in the 21st century faces the challenge of digitalization; therefore, the acquisition and development of digital skills in students is indispensable, not only for their learning processes but also for their lives. This study aims to validate the test "ECODIES", which was used to assess the level of development of digital competence in students in a public high school in Bogotá (Colombia). The test is based on the DigCom model and was administered to a sample of 777 students aged between 11 and 18. The results obtained in the exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and reliability analysis show the quality of the test. Therefore, in this study it is concluded that "ECODIES" is a test with the reliability and validity to assess digital competence in the Colombian context; in this way, we hope to gain enough research about this topic to contribute to the development of digital competence in Colombian students. We conducted an instrumental study for the analysis of the psychometric properties of the questionnaire.

Keywords: digital competence; assessment; validation; high school

MSC: 97U10

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1. Introduction

In 2020, the global education system faced the challenge of virtual classes due to the emergence of COVID-19. Educational institutions were forced to close their doors to prevent the spread of the virus [1,2]. However, the teaching–learning process had to continue. The pandemic accentuated the gaps already existing in most countries, among which technology was one of the most obvious [3]. A lack of connectivity and resources excluded at least a third of students from continuing to learn [4], partly breaking the relationship between information and communication technologies (ICT) and learning and teaching, which had already been identified as a digital divide. Moving teaching and learning to the virtual environment due to confinement meant a change in the roles of students, teachers, and families [5]. Changes occurred, also, in the paradigms regarding both classroom practices and work outside the classroom. Digital skills became vitally important for both students and teachers [6].

These new modalities shone a spotlight on the work of teachers, demanding that they deal with and shift to a virtual form of education based on digital tools that are both synchronous and asynchronous. Technology has thus been the "great ally" of all the social restructuring that has taken place up until now [7].

Certainly, the COVID-19 crisis marked a before-and-after in the teaching–learning process. It was, and still is, the time to implement new methodologies in the process. ICTs are constantly evolving, and education must adapt to these changes [8]. Teachers believed that the teaching–learning process in a digital environment would be easy, since current students are often referred to as digital natives [9] who, in theory, have the necessary skills to use ICT appropriately, with their high level of digital skills [10]. However, being born in this digitalized era does not mean, per se, that students will properly use ICTs as learning tools or that they themselves have acquired the necessary skills to do so. In neuroscientific research and its neuroeducation embodiment, this has been revealed as a neuromyth, or false myth about the functioning of the brain and the denomination of digital natives and immigrants. While it is true that today's young people have grown up among a multitude of digital options and present skills and abilities that older generations do not have, this does not imply, as mentioned above, that they are digitally competent. This supposes, in the long term, a generation more educated and aware of the benefits, applicability, and usefulness of ICT, but the need to improve these skills is a current issue.

Digital competence in teachers and students is not a recent issue. Research has increased due to the continuous use of digital technologies, and educational systems have seen the need to promote the acquisition and development of these skills, especially in students, not only to improve their learning process, but also for performance in their future, personal, and professional lives [11]. Likewise, the development of these competences is closely linked to the success, creativity, and employability of each individual [12], so much so, that there are numerous studies focused on analyzing the digital competence of teachers [13–17] and students of all educational stages (infant, primary, secondary, and higher) [18–20] and in a diversity of different contexts. Attention has even been paid to digital training in working with people with functional diversity, both university students [21,22] and current educators [23,24]. Given the conceptual variety around this competence, it is complex and difficult to define a universal, valid, and accepted definition of digital competence [25]. This has an impact on the difficulty and lack of instruments that allow for the measurement of the level of digital competence in the school environment [26]. This competence, also known by other terms such as "digital literacy", "digital competence", "digital skills", or "information literacy" [6], was included by the European Commission [14] as one of the eight core competences for lifelong learning. Therefore, it is necessary and indispensable that educational institutions promote and guarantee training in digital competence in the educational community. This contributes to social inclusion, the participation of all individuals regardless of their conditions, and the use of the opportunities associated with digital technologies that our new knowledge society offers [27–29].

Thus, digital competence is key to consolidating these dimensions in a pedagogical way in the classroom [30]. Indeed, there are many education systems and national legislation that include it among their objectives and competences. Specifically, its relevance has been escalating in the Colombian context from various national programs promoted by the Ministry of ICT such as MisiónTic 2022, Digital Citizenship, Digital School and Redvolución, whose purpose is to ensure that both students and teachers, and the community in general, are competent in the digital field.

Therefore, training in digital competence must be present in the educational process at all levels [31], regardless of the disciplinary field. It is transversal and transferable to any context and field of knowledge (hence its denominations as basic, key, transversal competence, etc.), since it helps in the acquisition of other specific competences, given its importance in contemporary digitalization [32–34]. This training should not be reduced to the simple development of instrumental skills for the management of hardware and software [35,36]; on the contrary, digital competence is understood as the ability not only to use ICT, but also to search, understand, evaluate, create, and communicate digital information, transform it into knowledge, and share it. It requires both cognitive and technical skills, but also involves the conscious, safe, and critical use of digital resources [37–39].

Along the same lines, Ferrari [40] defines digital competence as the set of skills and attitudes (also strategies, values, and awareness) that any citizen requires when using ICT or other digital media to perform tasks, solve problems, communicate, manage information, collaborate, create, share content, and build knowledge in a creative, effective, critical, appropriate way that is reflective, ethical, autonomous, and flexible. These definitions coincide with that of Area and Ribeiro [41], confirming that digital competence not only requires instrumental knowledge, but also axiological and emotional components since, being immersed in a digital society, we are interacting constantly and emotional states associated with the use of ICTs are generated, whether positive or negative [42].

Therefore, the purpose of this work is to validate the "ECODIES" instrument in the Colombian context and determine whether it can be used to evaluate digital competence in secondary school students in the territory. The study results will serve as a starting point for research on digital competence in Colombian students so that plans can be drawn up for studies that contribute to the acquisition and development of these competences from all areas of the curriculum of educational institutions.

Assessing Digital Competence

Assessing digital competence in students has become challenging; however, we have found some current models and standards of digital competence that are adjustable to the school environment (Table 1).

Table 1. Frameworks and benchmarks on the conceptualization and assessment of DC.

Frame/Standard	Context	Conceptualization	Reference
ISTE (Standard for Students)	International	7Areas: 1. Empowered learners 2. Digital citizenship 3. Knowledge-building 4. Innovative design 5. Computational thinking 6. Creative communication 7. Global collaboration	International Society for Technology in Education —ISTE (2016)
DigCom 2.1 The Digital Competence Framework for Citizens	European	21 competences defined in 8 levels of development and grouped in 5 areas: 1. Information 2. Communication and Collaboration 3. Content creation 4. Safety 5. Problem-solving	Carretero et al. (2017)

Table 1. *Cont.*

Frame/Standard	Context	Conceptualization	Reference
DQ Framework. Digital Standard for Digital Literacy	International	24 competences defined in 3 levels of development and grouped in 8 areas: 1. Identity 2. Use 3. Safety 4. Security 5. Emotional intelligence 6. Literacy 7. Communication 8. Rights	DQ Institute (2019)
Digital Kids Asia Pacific (DKAP) Framework	International	16 competences grouped into 5 domains: 1. Digital literacy 2. Online security and resilience 3. Online participation and citizenship 4. Digital emotional intelligence 5. Digital creativity and innovation	UNESCO (2019)

Researchers such as García-Valcárcel et al. [43] and Paredes-Labra et al. [44] have established differences in research approaches for the evaluation of digital competency in students: (a) students' own assessment tests, and (b) execution tests. In the first approach, the assessment of digital competence is carried out by means of surveys, where students express their own opinions on their levels of competence. These types of tests are subjective and, therefore, the results questionable, since normally students tend to overestimate themselves. In the second case, the tests are based on the execution of tasks, troubleshooting, and performance of activities. Although they are designed based on technical competencies and less on formal skills, they are more appropriate and reliable for evaluating a student's performance in the face of a problem in which the use of said competence is required, as shown by Baeza González et al. [45], Casillas-Martin [46], Gonzáles Segura et al. [47], and Paredes Labra et al. [44].

Much of the research on the assessment of digital competence leans towards the self-perception approach. The works of Rodríguez et al. [48] and Casillas Martín et al. [49] analyze the self-perception that university students have about their digital competences. The ADO (Online Digital Literacy) test [50] assesses the level of media proficiency in the general population, focusing specifically on the search, dissemination, and creation of digital content over the internet. In the same line as these self-perception scales, there are studies by Almedina et al. [51], Colás Bravo et al. [42], and De Pablos Pons et al. [26]

aimed at students of primary and secondary basic education based on Likert-type scales. In the same sense, we find the tool INCONTIC (Inventory of ICT Competences) [52], whose objective is to identify the previous knowledge in digital competence of students in the last grades of secondary education and at the beginning of university, used in different contexts both in Spain and in Latin America. At the national level of Colombia, there is the work of Contreras-German et al. [53], who designed and validated an instrument for the last years of secondary basic education called the Digital Competence Assessment Scale (EVCD).

In line with the works that focus on objective tests for the evaluation of digital competence, there is the questionnaire called "Digital Campus" of Restrepo-Palacio and Cifuentes [54], whose objective is to evaluate the knowledge of university students at the University of the Sabana in Bogotá (Colombia). For primary and secondary basic education, some researchers, such as Martínez-Piñeros [55] and García-Valcárcel Muñoz-Repiso et al. [43], conclude that most of the instruments to assess digital competence in this population are based on the self-perception of individuals, who evaluate only some of the dimensions of digital competence. Therefore, it is difficult to have conclusive results. Similarly, to measure the level of digital competence of primary and secondary school students, it is necessary to consider not only what digital skills to develop, how, and when, but also the people who influence that development, such as the socio-family environment and teachers.

Despite this, there are some instruments to assess digital competence in basic education in students, such as the instrument created by Baeza-Gonzáles et al. [45] as part of the project, "Mind the gap: a snapshot of e-skills gender differences in Spain", aimed at students in the last grades of primary education. For secondary education, the "ECODIES" test is available, based on the "Digcom" digital competence assessment model, developed by the GITE group of the University of Salamanca [56], which evaluates digital competence through questions on knowledge, skills, and aptitudes.

Finally, the scarcity of works that study and evaluate digital competence in primary and secondary basic education in the Colombian context is highlighted. Given the absence of instruments to assess digital competence in the Colombian context, the following study aims to analyze the psychometric properties of the "ECODIES" instrument, with the objectives of: (a) validating and adapting the instrument through its application to a pilot sample in the Colombian context; (b) determining the multidimensionality of the instrument through exploratory factor analysis; (c) confirming the multidimensionality of the instrument through confirmatory factor analysis; and (d) analyzing the reliability of the instrument.

2. Materials and Methods

Considering Montero and León [57], the present research is framed in instrumental studies for the adaptation and validation of the psychometric properties of the "ECODIES" instrument to a sample different from the original. This type of design is relevant for the validation of instruments created, or for the validation of another previously developed for use in another context [58]. The study has a quantitative approach of descriptive character framed in the non-experimental design of cross-sectional typology; data collection was carried out at a certain point of time [59].

2.1. Participants

The population under study was made up of students of secondary basic education of a public district school (IED) located in the town of Usme in the city of Bogotá (Colombia), with a population of 1081 students. Its sample size was amply representative, with a total of 777, which represents a sampling error of 1.9%, well below the 5% commonly accepted in research. Sample selection was performed by stratified random probability sampling [59,60] consisting of students in grades 6–11. Of the participants, 48% were female, 51.5% male, and 0.5% identified with another gender. The students were between the ages of 11 and 19. The mean age was 13.9 years (Table 2).

Table 2. Distribution of the sample by grade, gender, and age.

		Gender			Distribution of the Sample by Age	
Grade	Frequency	Female	Male	Other	Age	Frequency
6°	24.7%	82	110	0	11	179 (23%)
7°	13.5%	45	60	0	12	74 (9.5%)
8°	16.5%	67	59	2	13	88 (11.3%)
9°	18%	64	74	2	14	98 (12.6%)
10°	17.9%	73	66	0	15	138 (17.8%)
11°	9.4%	40	33	0	16	108 (13.9%)
Total	100%	371	402	4	17	61 (7.9%)
					18	25 (3.2%)
					19	6 (0.6%)
					Total	777 (100%)

2.2. Instrument

The instrument used in this study ("ECODIES") is modelled on the Common Framework for the Development and Understanding of Digital Competence in Europe (DigCom), established by the European Commission in 2013 [40], which established five areas, three levels, and three areas. In 2016, an update called the European Framework for Digital Competence of Citizens (DigCom 2.0) was published [61], which retained practically the same structure of DigCom 1.0. Finally, Carretero et al. [62] presented the latest update, which is now known as DigCom 2.1, and has 21 competencies grouped into 5 areas, as shown in Table 3, with 8 levels of difficulty (Figure 1).

Table 3. Competence areas and competences of the DigCom 2.1. framework. Source Carretero et al. [62].

Competence Areas	Competences
Problem-solving	1. Solving technical problems
	2. Identifying needs and technological responses
	3. Innovating and creatively using technology
	4. Identifying digital competence gaps
Information	5. Browsing, searching, and filtering information
	6. Evaluating Information
	7. Storing and retrieving information
Safety	8. Protecting devices
	9. Protecting personal data
Communication and collaboration	10. Protecting health
	11. Protecting the environment
	12. Interacting through technologies
	13. Sharing information and content
	14. Engaging in online citizenship
	15. Collaborating through digital channels
	16. Netiquette
	17. Managing digital identity
Content creation	18. Developing content
	19. Integrating and re-elaborating
	20. Copyright and licenses
	21. Programming

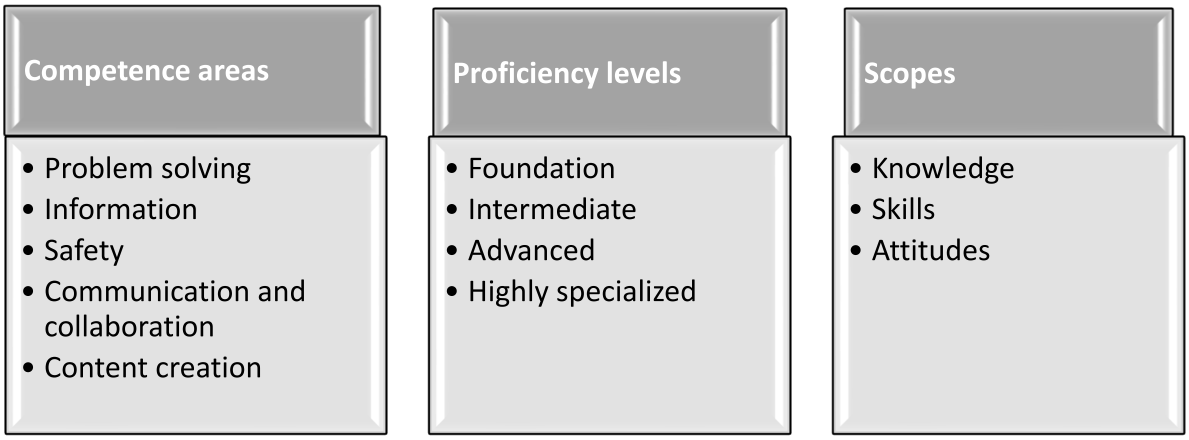

Figure 1. DigCom Framework 2.1. Own elaboration.

The "ECODIES" test created by the researchers of the GITE group [56] is based on the DigCom model [40]. Initially, indicators were developed for each of the areas that make up digital competence: Area 1 (A1: problem solving), Area 2 (A2: information literacy), Area 3 (A3: security), Area 4 (A4: communication and collaboration), and Area 5 (A5: content creation) [43]. Subsequently, the external validation of the indicator model was carried out by expert judges from different educational levels. For a level of agreement among the judges, the Lawshe model [63] and the Tristan-López revision [64] were considered. The instrument was improved after a pilot test was carried out during the 2017–2018 academic year. The final version of the test consists of 108 items disseminated among knowledge, abilities, and attitudes (Table 4). Finally, the instrument obtained values in the Cronbach's alpha internal consistency test of 0.89, which is considered high [65].

Table 4. Number of items that make up the "ECODIES" test.

Competence Areas	Knowledge/Skill	Attitudes	Total
A1: Problem solving	16	6	22
A2: Information	12	6	18
A3: Safety	16	6	22
A4: Communication and collaboration	18	6	24
A5: Content creation	16	6	22
Total:	78	30	108

Note: own elaboration.

A variable was created that added the correct items for ability and knowledge to obtain the average of each area: the correct answers were coded as "1" and the other three incorrect answers as "0", for a total score of 78 points. As for the items of attitude, they were coded on a scale of 1 to 5: (1) strongly disagree, (2) disagree, (3) indifferent, (4) agree, (5) strongly agree, for a total of 30 points to be obtained by students in this component.

2.3. Procedure

For the collection of these data, we had the endorsement of the ethics committee of the University of Granada, with registration number 2982/CEIH/2022, the permission of the rectory of the educational institution, and the informed consent of the families of the participating minors. The test was presented in the form of an online questionnaire conducted on Google Forms for this purpose. We collaborated with the afternoon and morning teachers, who provided spaces for meeting with the students.

The questionnaire was administered for this validation during mathematics classes, making use of the institution's systems room. The researchers orally explained the purpose of the research, guaranteed anonymity and use of the data exclusively for research purposes, and invited participants to participate voluntarily. Instructions for completion of the test were given orally, although they could also be found in writing on the form, possible doubts were clarified, and the administration proceeded. It was carried out in two sessions to avoid fatigue of the participants.

2.4. Data Analysis

The internal consistency of the instrument was calculated using Cronbach's alpha coefficient, using the IBM SPSS 22 program [66]. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed using statistical programs Jamovi 2.2 [67] and Jasp 0.16 [68].

3. Results

For the structural validity of the test, the sample was divided randomly into equal parts. The exploratory factor analysis (EFA) was performed with the first sample and the confirmatory factor analysis (CFA) was performed with the second sample.

3.1. Exploratory Factorial Analysis (EFA) of the ECODIES Test in the Study Population

In the EFA of principal components, for each area and for the attitude test, the coefficient KMO (Kaiser–Mayer–Olsen) and Bartlett's sphericity test (Table 5) were obtained.

Table 5. KMO (Kaiser–Mayer–Olsen) and Bartlett's test.

Competence Areas	TEST KMO	BARTLETT´S TEST		
		Chi-Square Value	Gl	Sig.
Area1(PS)	0.598	293	120	0.000
Area2(I)	0.715	296	66	0.000
Area3(SA)	0.609	369	120	0.000
Area4(CO)	0.755	647	153	0.000
Area5(CC)	0.616	313	120	0.000
Total test "Ecodies"	0.691	5479	3003	0.000
Attitude scale	0.950	5805	435	0.000

Note: Area 1: problem-solving; Area 2: information; Area 3: safety; Area 4: communication and collaboration; Area 5: content creation.

The coefficient (KMO) obtained in each of the areas ranged between 0.598 and 0.755, that is, between low and acceptable, because they were higher than 0.050 [69], and in the attitude test a coefficient of 0.950 (excellent) was obtained. Bartlett's sphericity test indicated that the test was highly significant ($p < 0.05$), which corresponds to a degree of correlation between the variables. Therefore, the application of factor analysis was considered appropriate, as was the sample.

For principal component analysis, with the Varimax rotation method normalized with Kaiser, items were grouped into common variables to reduce their number. In this case, the new variables were named after the subareas of the original DigCom document [40]. Two factors were taken for this analysis (Factor 1: "Attitude" and Factor 2: "Knowledge and Ability") [46] (Table 6).

The area with the highest burden on the "Knowledge/Ability" test (Factor 2) was "Communication and Collaboration" and the lowest "Content Creation", as in the "Attitudes" test (Factor 1), where the "Content Creation" area appears with the lowest factorial load. On the other hand, the "Knowledge/Ability" test explained more than 50% of the overall test variance (58.8%) with one component rotation. The percentage variance of the total test ("Knowledge/Ability together with "Attitude") was 65.2%, which was a good indicator of the validity of the test (Table 7).

Table 6. Factor loadings.

Factor 1: Attitudes			Factor 2: Knowledge/Skill	
Area	**Factor Loading**	**Unicity**	**Factor Loading**	**Unicity**
Area 1(PS)	0.805	0.352	0.753	0.434
Area 2(I)	0.837	0.3	0.762	0.419
Area 3(SA)	0.842	0.29	0.757	0.427
Area 4(CO)	0.882	0.223	0.837	0.299
Area 5(CC)	0.868	0.246	0.708	0.499

Note: Area 1: problem-solving; Area 2: information; Area 3: safety; Area 4: communication and collaboration; Area 5: content creation.

Table 7. Total explained variance.

Factor	Total	% Of Variance	% Accumulated
Attitude	3.54	35.4	35.4
Knowledge/Skills	2.98	29.8	65.2

In the matrix of principal components (Table 8), most of the subareas obtained values greater than 0.40 and saturated Factor 2 ("Knowledge/Ability"), thus confirming the original location by the expert committee that validated the test [46]. Similarly, items of attitudes saturated Factor 1 ("Attitude"), with values higher than 0.50. With these values, it is considered that both the subareas and the attitude items are determinants for the test. No values less than 0.40 are found; however, two low values stand out in Factor 2: Area 4: "Communication", subarea: "Interaction with new technologies" (0.524) and the subarea: "Sharing information and content" (0.548).

Table 8. Matrix of the principal components.

Area	Variables	Factor	
		Factor 1	**Factor 2**
Area 1 (Problem solving)	C1: Solving technical problems	0.019	0.736
	C2: Identifying needs and technological responses	−0.022	0.553
	C3. Innovating and creatively using technology	0.098	0.560
	C4. Identifying digital competence gaps	0.072	0.668
	Attitude 1	0.824	0.189
	Attitude 2	0.734	0.128
	Attitude 3	0.792	−0.097
	Attitude 4	0.745	−0.026
	Attitude 5	0.779	0.091
	Attitude 6	0.637	0.021
Area 2 (Information)	C1. Browsing, searching, and filtering information	0.082	0.669
	C2. Evaluating information	0.0683	0.763
	C3. Storing and retrieving information	0.082	0.764
	Attitude 1	0.636	0.239
	Attitude 2	0.784	0.121
	Attitude 3	0.626	0.164
	Attitude 4	0.843	0.133
	Attitude 5	0.765	0.007
	Attitude 6	0.711	−0.100

Table 8. *Cont.*

Area	Variables	Factor	
		Factor 1	**Factor 2**
Area 3 (Safety)	C1. Protecting devices	0.114	0.680
	C2. Protecting personal data	0.056	0.726
	C3. Protecting health	0.100	0.682
	C4. Protecting the environment	0.081	0.580
	Attitude 1	0.607	−0.151
	Attitude 2	0.733	0.190
	Attitude 3	0.674	0.214
	Attitude 4	0.711	0.154
	Attitude 5	0.675	0.056
	Attitude 6	0.732	0.164
Area 4 (Communication and collaboration)	C1. Interacting through technologies	0.017	0.524
	C2. Sharing information and content	0.080	0.548
	C3. Engaging in online citizenship	0.141	0.783
	C4. Collaborating through digital channels	0.040	0.742
	C5. Netiquette	0.175	0.720
	C6. Managing digital identity	0.126	0.614
	Attitude 1	0.742	0.128
	Attitude 2	0.813	0.126
	Attitude 3	0.806	0.088
	Attitude 4	0.752	0.141
	Attitude 5	0.807	0.069
	Attitude 6	0.745	0.096
Area 5 (Content creation)	C1. Developing content	0.168	0.691
	C2. Integrating and re-elaborating	−0.013	0.741
	C3. Copyright and licenses	0.094	0.619
	C4. Programming	0.100	0.675
	Attitude 1	0.806	0.110
	Attitude 2	0.774	0.124
	Attitude 3	0.735	0.170
	Attitude 4	0.756	0.114
	Attitude 5	0.729	−0.027
	Attitude 6	0.710	0.117

Note: Area 1: problem-solving; Area 2: information; Area 3: safety; Area 4: communication and collaboration; Area 5: content creation; C1: competence 1.

3.2. Confirmatory Factor Analysis (CFA) of the ECODIES Test in the Study Population

With the other part of the sample, the CFA [70] was carried out to verify what the EFA yielded: two factors, for the items of "Knowledge/Capacity" and "Attitude" of the different areas of digital competence. As can be seen (Table 9), all the values obtained in the goodness adjustments for each area were very positive [71,72].

Table 9. Goodness-of-fit indices of the model (CFA).

Area	Model	X^2 (gl)	Gl	RMR	TLI	CFI	IFI	RMSEA IC 90%
Problem-solving	2 factors	45.665	34	0.048	0.999	0.999	0.999	0.030 (0.000–0.050)
Information	2 factors	35.99	26	0.046	0.994	0.996	0.996	0.032 (0.000–0.050)
Safety	2 factors	39.962	34	0.044	0.997	0.998	0.998	0.021 (0.000–0.050)
Communication and collaboration	2 factors	75.927	53	0.046	0.998	0.998	0.998	0.033 (0.000–0.050)
Content creation	2 factors	45.514	34	0.044	0.997	0.998	0.998	0.030 (0.000–0.050)

Note: X2: chi-square; Gl: degrees of freedom; RMR: root mean residuals; TLI: Tucker–Lewis fit index; CFI: comparative fit index; IFI: incremental adjustment index; RMSEA: root mean squared error of approximation; IC: confidence intervals.

Factor loadings for problem solving ranged from 0.39 to 0.99, which is considered acceptable and significant (Figure 2).

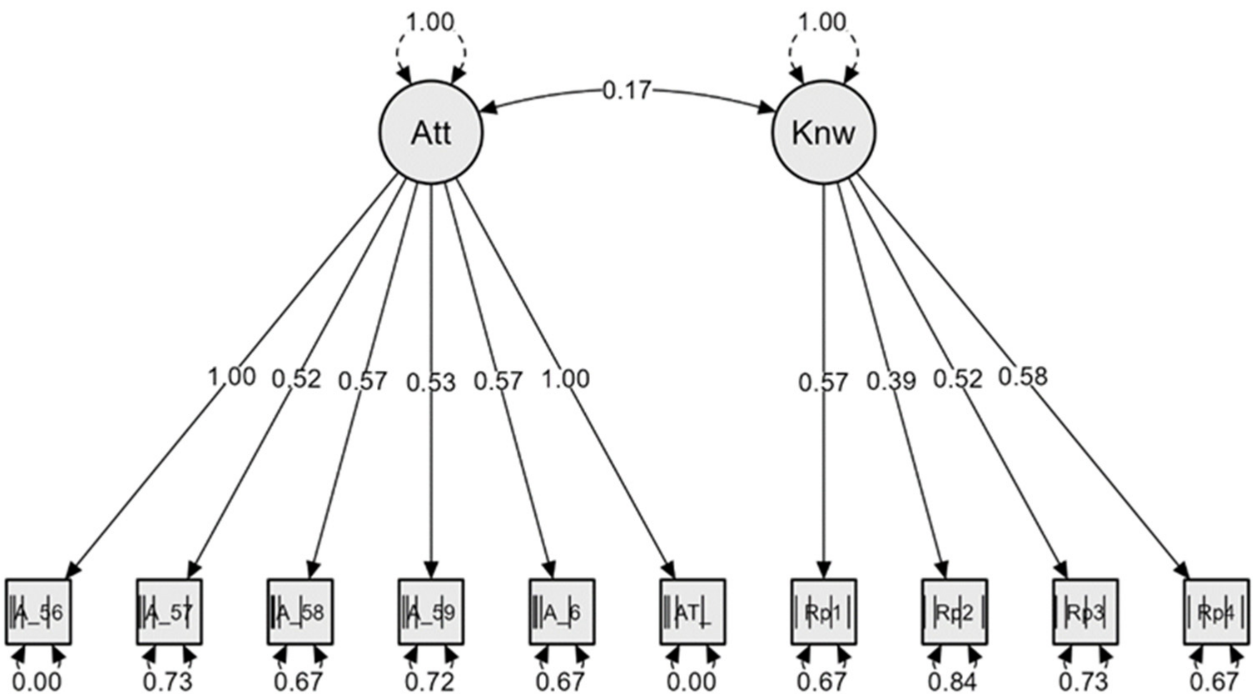

Figure 2. Factor loadings for the problem-solving area.

Factors loadings for the area of information literacy ranged from 0.43 to 0.83, which is considered acceptable and significant (Figure 3).

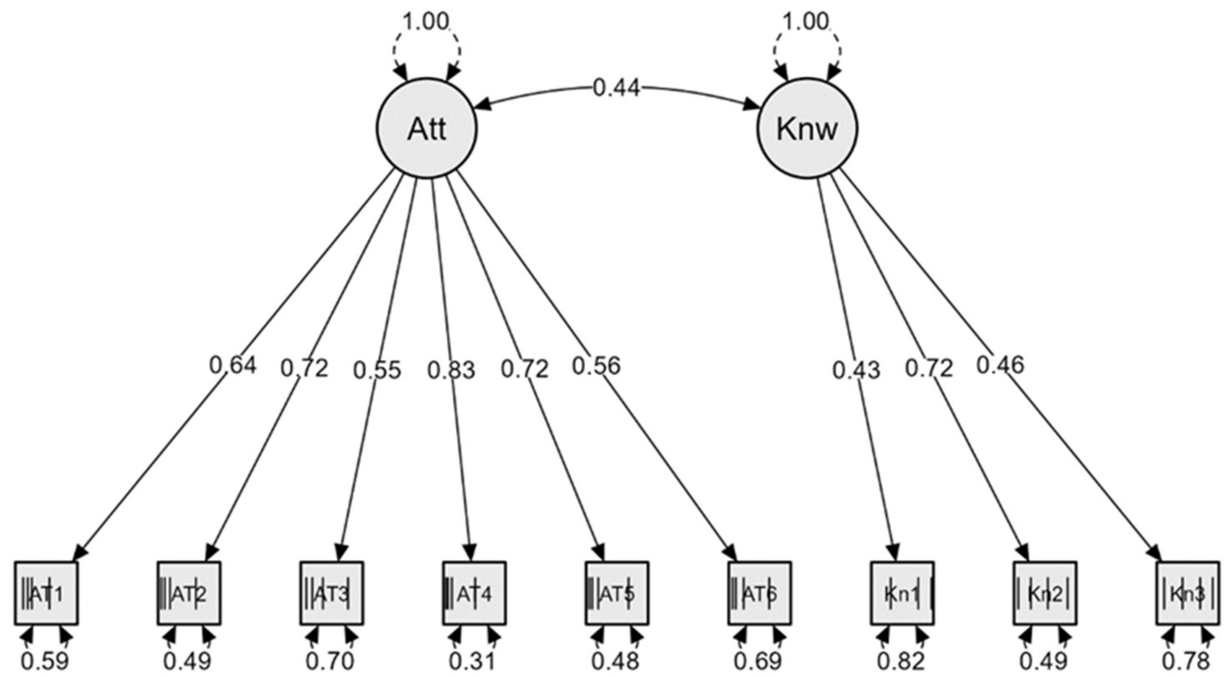

Figure 3. Factor loadings for the area of information literacy.

Factor loadings for the security area ranged from 0.47 to 0.74, which is considered acceptable and significant (Figure 4).

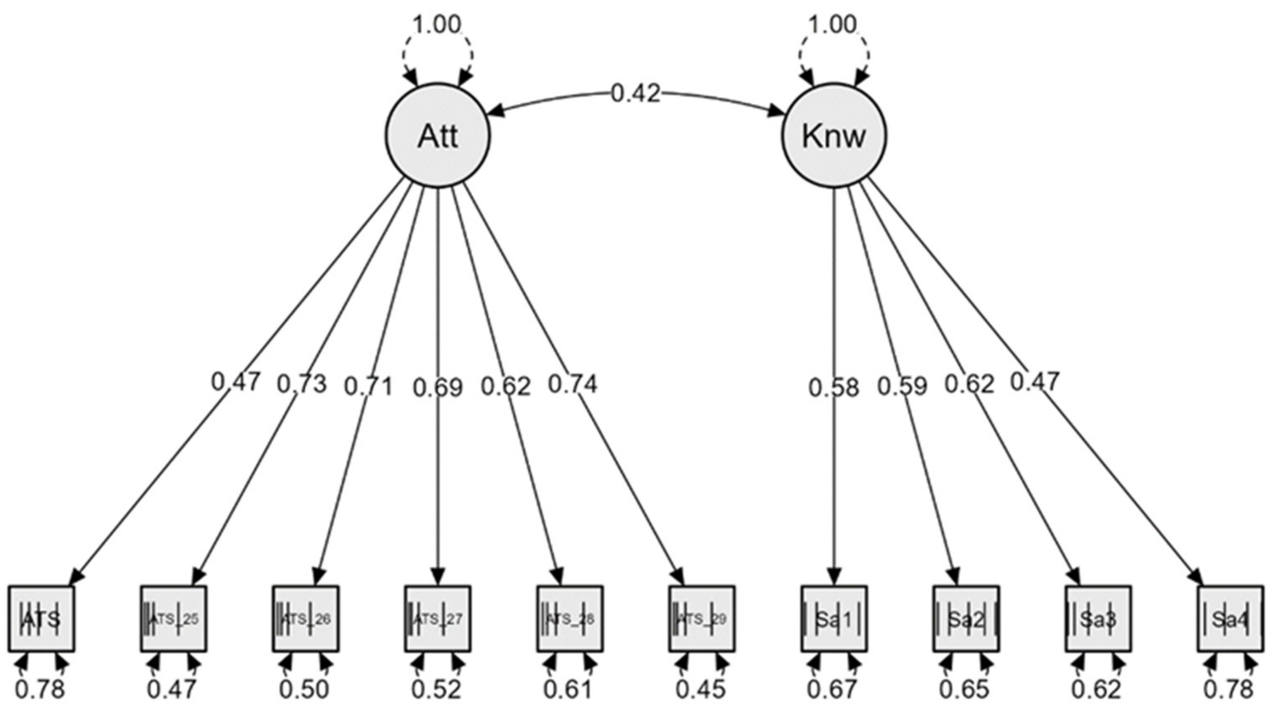

Figure 4. Factor loadings for the security area.

Factor loadings for the area of communication and collaboration ranged from 0.50 to 0.83, which is considered acceptable and significant (Figure 5).

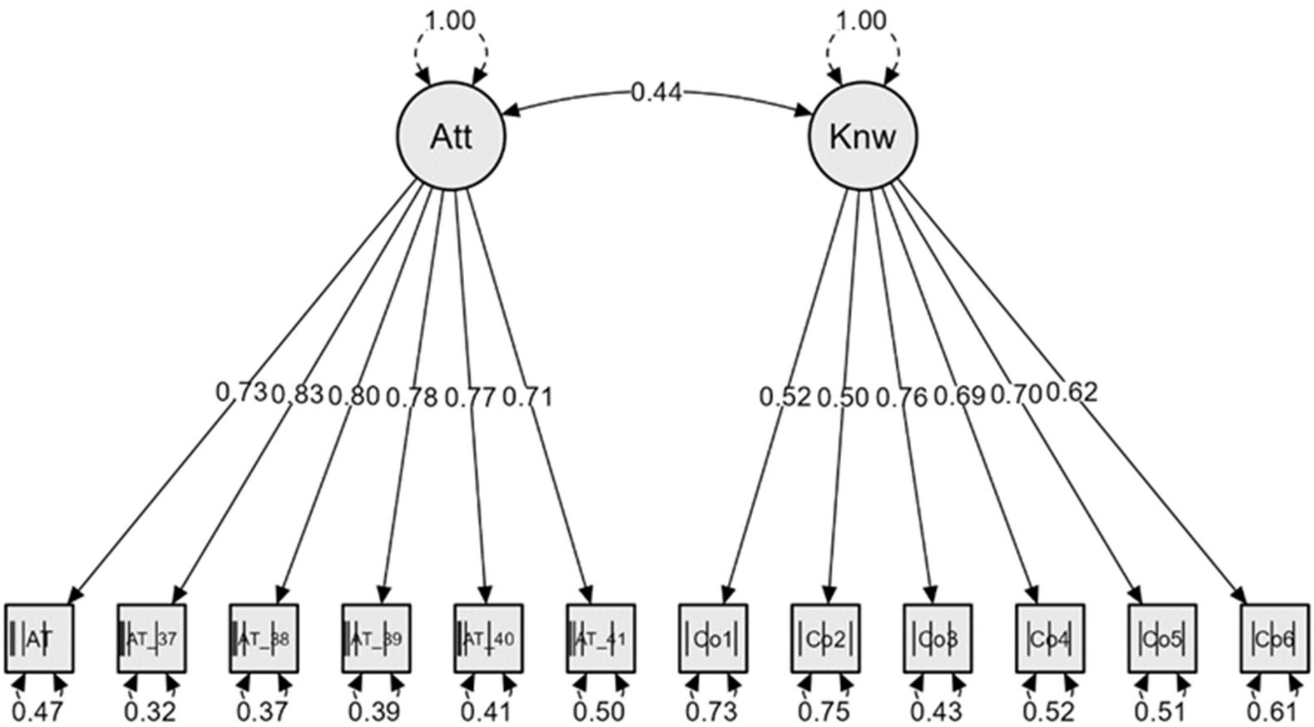

Figure 5. Factor loadings for the area of communication and collaboration.

Factor loadings for the content creation area ranged from 0.47 to 0.81, which is considered acceptable and significant (Figure 6).

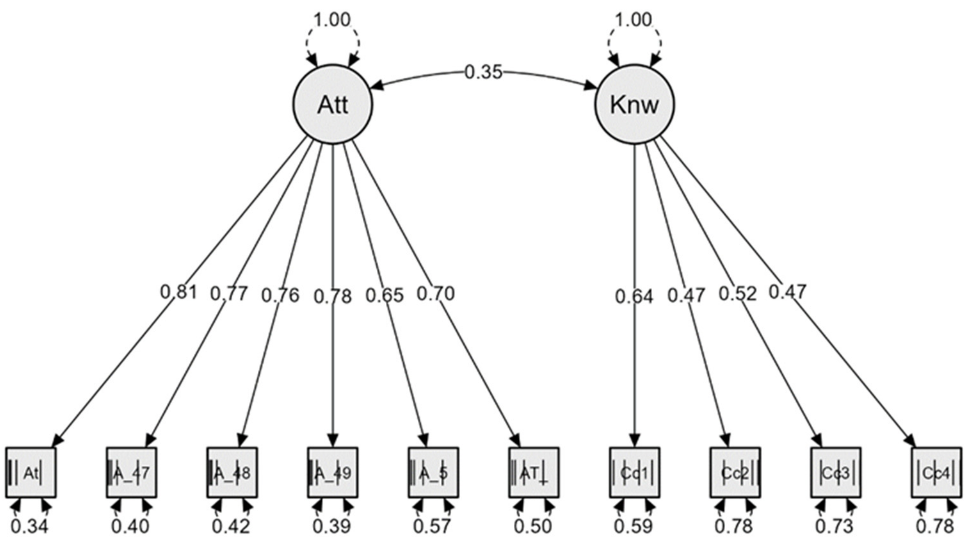

Figure 6. Factor loadings for the content creation area.

The factorial load obtained in the analysis confirmed the location of the items in the factors shown in the EFA.

3.3. Reliability ECODIES Test in the Study Population

The reliability analysis of internal consistency was calculated using the coefficient of McDonald's omega and Cronbach's alpha on both of the two components ("Attitudes" and "Knowledge/Ability") and on the total test. The results of the "Attitudes" component and the complete test indicated a good level of reliability (>0.80) for both statistics. However, in the "Knowledge/Ability" component, the values presented were not so good, especially in the omega McDonald statistic (Table 10).

Table 10. Reliability analysis.

	Total	Component 1	Component 2
Component reliability analysis Mc Donald omega	0.819	0.950	0.48
Component reliability analysis Cronbach alpha	0.841	0.950	0.649

4. Discussion and Conclusions

As has been justified, digital competence is a part of knowledge and learning that is indispensable to our secondary school students. The acquisition and development of digital competence will ensure access to opportunities provided by our knowledge society. This training must go beyond the management of hardware and software that for many years has been the only teaching students have received in computer classrooms. Making changes to curricula to address this training first requires reliable and valid instruments to collect information [49,73], since the importance of digital training is mentioned in the educational legislation itself [74]. However, prior to drawing a digital competency and attitudinal profile of the students, we must start with a map of digital competence for its optimization, which was the objective of this work.

For this reason, we tried to validate the instrument for the evaluation of digital competence in secondary school students for the Colombian population, "ECODIES", created and validated in Spain for this population by the GITE group [56]. The EFA yielded two differentiated factors in which the items were grouped, the factor of "Knowledge/Capacity" and the factor of "Attitudes", as established in the original study validated for Spain [46], and that can also be differentiated in the validations by area of competence [43,75,76], as these two factors explained 65.2% of the variance. The results of the EFA were subsequently confirmed with the CFA; although in the original validation this analysis is not available, the data obtained in the RMSEA of each area were less than 0.05. Likewise, the CFI and TLI were higher than 0.9, which demonstrates the suitability of the instrument. The values obtained in both analyses guaranteed the test's validity and reliability in such a way that it becomes an option to be applied as a diagnostic test of knowledge about digital competence in the context for which it has been validated.

Regarding reliability, results considered acceptable (0.841) were obtained for the total test, approaching that obtained in the original test validated for Spain (0.89) [33]. However, when reviewing the reliability index of some studies focused on some of the competence areas, it is highlighted that the Cronbach's alpha index for the "Knowledge/Ability" factor is not acceptable (<0.70) [67–75], which is because the Cronbach's alpha statistic is not recommended to calculate reliability on a scale of less than five categories [77,78], which can be verified in the present study with the reliability index of the "Knowledge/Capacity" component where reliability indices lower than 0.70 were obtained, although they were close. In the "Attitude" component, the reliability index is quite acceptable for both statistics, like that obtained in studies focused on competence areas.

The values obtained guaranteed the test's validity and reliability in such a way that it becomes an option to be applied as a diagnostic test of knowledge about digital competence in the context for which it has been validated. In addition, it is considered a complete instrument since it groups the 5 areas and 21 competences of the DigCom model.

The validation of the instrument for the context in which it is applied will allow identification of the shortcomings of secondary education students in the Colombian context and thus carry out interventions at the curricular, pedagogical, didactic, and methodological levels for the acquisition and development of digital competence in educational institutions, as noted by Henríquez Coronel et al. [79], stating that assessing digital competence in students is essential today, given that these results will serve as a basis for designing and implementing digital literacy proposals in educational institutions.

It is known that most of the instruments to assess digital competence have focused on student self-perception [43,55]. However, this test also allowed us to evaluate the knowledge and attitude that students possess in the different areas of competence and thus identify the shortcomings that students have in the areas of digital competence. Applying these types of questionnaires also helps teachers improve their digital competence for integration into their teaching practice.

However, despite being a complete instrument, its extension is highlighted as the main shortcoming, since for its application an average time of ninety minutes is required; this implies that students could show some tiredness and apathy, especially in the lower grades, which could influence their responses. It was recommended to apply the instrument by areas and thus avoid this loss of interest in its content when applied completely. Another limitation to point out has to do with the sample; the data were collected in a single educational institution. Although the sample was correct for the analysis, it is recommended to apply the test to more educational institutions in the locality.

To conclude, it is important to recognize that digital competence is indispensable for the interaction of young people in different digital environments and that digitalization is here to stay. In Colombia, there is no model to evaluate digital competence in basic education. For this reason, advancing and deepening the subject in classroom practices is essential to promote the acquisition and development of digital competence and not leave the digital learning of students in the hands of the socio-family environment, which in turn presents many shortcomings (socioeconomic and academic) that will accompany students in their academic process. This would continue to widen the digital divide between those with diverse resources and knowledge and those without. This work is encouraged to become a starting point and application of the test in the Colombian context so that, later, new results can be counted on in many educational institutions and regions of the country, which will allow for a deepening of the field of digital competence in students of secondary basic education.

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