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Developing Instrument of Digital Age Literacy Inventory: Validity and Reliability Analysis Using Rasch Model

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Abstract

The development of a valid and reliable assessment instrument of digital-age literacy is truly required to determine the level of students' digital-age literacy competence. One major issue is the lack of standardized instruments that comprehensively measure all dimensions of digital-age literacy. This study aims to develop and analyze digital-age literacy inventory instruments (DALI) since there is no standardized instrument regarding digital-age literacy has been created. The development of the DALI is carried through three phases: research scale components identification, writing and developing the questionnaire items, and the analysis of its validity and reliability. A total of 40 statement items were developed based on the digital age literacy component. The sample of this study was 75 eleventh-graders of science State Senior High Schools in Pontianak. The data were analyzed using the Rasch Model with the help of the WINSTEP 3.73 application. The analysis results show that the total value of the Aikens V index is 0.96. DALI has obtained the value of person reliability of 0.71 (good enough), item reliability of 0.98 (excellent), and the value of Cronbach's alpha of 0.75 (good). On the whole, the statement items are declared valid based on the value of outfit MNSQ person and the item of 0,99 and the value of Outfit Z Standardized (ZSTD) in which the person analysis -0.2 and the item of -0,3. Of 40 items being analyzed, 6 items do not fit the Rasch Model, the final number of valid and usable instrument items is 34 items. The development of DALI shows that the quality of the instrument is good and can be used to measure the digital age literacy of senior high school students within the 8 components of the latter.

Keywords: Digital Age Literacy, DALI, Validity and Reliability, RASCH Model

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INTRODUCTION

The 21st century is an era in which almost all aspects of life face a transition from manual work to digital process; thus, it is also known as the "digital era" (Sujana & Rachmatin, 2019; Harjono, 2018; Dianimdri & Yuliani, 2018). One of the challenges being the main focus in the 21st century is the quality of human resources that compete globally (Nuraini, 2017). These challenges demand everyone to prepare themselves, possessing various supporting skills. For students, digital-age literacy equips them with the capacity to access information efficiently, think critically about digital content, and collaborate using technological tools. These skills enhance their learning outcomes and prepare them to become innovative problem-solvers.

Various international frameworks define the essential components of digital-age literacy, and while they share common ground, each highlights unique emphases. UNESCO's Digital Literacy Framework (2018) defines digital literacy as the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technologies. P21 Framework for 21st Century Learning (2009), positions digital-age literacy as one of the core 21st-century skills, alongside learning and innovation skills, life and career skills. European Commission's DigComp Framework offers detailed proficiency levels, making it a practical tool for assessment and curriculum development that places strong emphasis on adaptability, lifelong learning, and safe/ethical digital engagement (Ferrari, et al, 2013). The UNESCO framework (2018) tends to be overly conceptual, making it difficult to translate directly into measurable indicators. Meanwhile, the P21 (2009) framework is considered too broad and general, as digital-age literacy is only one component among various other literacies. On the other hand, DigComp (2013) does provide a detailed and operational structure, but its weakness lies in being overly technical and developed within the European context, making it not fully relevant to the educational conditions and digital culture in other countries. Therefore, a new framework that is more comprehensive, contextual, measurable, and adaptive is required to assess students' digital-age literacy competence in a valid and reliable manner, one of which can be developed by adopting the standards proposed by NCREL and the Metiri Group.

NCREL & Metiri Group in their enGauge 21st Century Skills document, set several essential skills to be mastered in the 21st century, such as inventive thinking, effective communication, high productivity, and digital age literacy (Afandi; Junanto & Afriani, 2016). Digital age literacy is a general term used to describe the various literacy, skills, and competencies needed in the digital era (Belshaw, 2011). Digital era literacy involves life skills, which are not only related to using technology, information, and communication devices but also the ability to socialize, learn and behave, as well as think critically and creatively in an inspiring way in order to adapt to the needs of the digital era. NCREL & Metiri Group have identified the components of digital age literacy, including: basic literacy - language skills (especially English) and numeracy at the level required in the work environment and society to develop knowledge and ability in the digital age; scientific literacy - knowledge and understanding of scientific concepts and processes needed in decision making; economic literacy - the ability to identify economic problems and developments as well as to adapt the global economic challenges; technological literacy - the knowledge of what technology is, how it works, and how to use it effectively and efficiently; visual literacy - the ability to use, interpret, and create pictures and videos using conventional and modern media; information literacy - the ability to search, synthesize, and use the information as well as to evaluate information from various sources using technology and electronic resources effectively and efficiently; multicultural literacy - the ability to understand and appreciate the different values, beliefs, and cultures of others; global awareness – the ability to recognize and understand problems at a global level (Afandi et al., 2019).

Digital age literacy is a crucial skill to be mastered in the 21st century. The results of Hague and Payton's research show that good digital age literacy plays a role in developing individuals' knowledge of certain subject matter by encouraging them to develop their curiosity and creativity (Akbar & Anggaraeni, 2017). Besides, Summey (2013) states that the technicalities of accessing present technology may change in the future, yet digital age literacy shapes individuals to be ready for the present and the future regardless of the form of technology in the future. In addition to this, NCREL & Metiri Group explain that to succeed in the 21st century, students must master science, technology, and culture and understand the information in various forms, all of which are within the components of digital-age literacy.

Based on the explanation above, creating a new generation with adequate digital age literacy is an essential matter to be strived for this current time, especially in the educational field. Education has a central role and prepares students to face new realities (Phuapan, Viriyavejakul, & Pimdee 2016). It is with academic achievement and 21st-century skills needed in the work environment (Alkharusi, 2017; Sadhu & Laksono, 2018). Therefore, the education system must provide a set of 21st-century skills students need to face every aspect of global life (Osman, Soh & Arsad, 2010).

The development of a valid and reliable assessment instrument of digital-age literacy is truly required to determine the level of students' digital-age literacy competence. A valid test is a test that can measure phenomena being measured accurately and thoroughly (Dewi & Sukadiyanto, 2015). Conversely, the reliability test of the instrument is intended to determine the degree of constancy on a particular measuring instrument. In this case, a reliable instrument is an instrument that will produce the same data regardless of its usability several times in assessing the same object (Sugiyono, 2009).

The Rasch model is a modern valuation theory discovered by Georg Rasch in 1960 and popularized by Bel Wright (Aminudin et al., 2019; Sumintono & Widhiarso, 2015). The advantage of the Rasch Model is that it can provide overall information, such as the quality of the instruments being used, students' responses, and the correlation between respondents and item questions (Ardiyanti, 2016; Chan Ismail, & Sumintono, 2014). Moreover, the Rasch Model can also identify error responses, predict missing data scores, differentiate the respondent's abilities with the similar raw score, and identify indications of allegations and deception (Bond, Yan, & Heene, 2020 ; Sumintono & Widhiarso, 2015).

While several instruments have attempted to measure digital literacy or related competencies, most have significant limitations. For instance, some instruments focus primarily on technical skills such as operating software or using digital devices (Cho & Littenberg-Tobias, 2016) and other instrument focus on assessing higher-order competencies like media and information literacy (Cuervo Sanchez, et al, 2019), ethical use (Jang, Choi & Kim, 2022), or digital citizenship (Ng, 2012). Others are context-specific, designed for particular countries or educational settings, which limits their generalizability (e.g., DigComp-based assessments in Europe). Additionally, many existing tools lack rigorous psychometric validation, making it difficult to ensure the validity and reliability of the results across diverse populations. Given these limitations, there is currently

no fully standardized, comprehensive instrument that captures the multiple dimensions of digital-age literacy and is psychometrically sound for broad application. Therefore, developing a new instrument and analyzing its validity and reliability using the Rasch model is necessary to provide a robust tool for assessing students' digital-age literacy competence.

METHODS

This research is an instrument development study designed to produce a set of instruments for measuring the digital-age literacy of senior high school students. The respondents in this study were 70 eleventh-grade science students from several schools in Pontianak, West Kalimantan, Indonesia, consisting of 35 males (50%) and 35 females (50%). The sampling method used was purposive sampling, in which schools and students were selected based on specific criteria relevant to the study, such as being enrolled in the science program and having regular access to digital learning resources. This approach ensured that the participants were representative of the target population for which the instrument was intended. The instrument developed in this study was in the form of a questionnaire consisting of closed-ended questions. It uses a five-point Likert scale, where respondents indicate their level of agreement or frequency for each statement. The scale ranges from 1 = Strongly Disagree to 5 = Strongly Agree, allowing the measurement of attitudes and perceptions with varying intensity.

The development of assessment questionnaire on students' digital age literacy was carried out through 3 phases, namely, the identification of research scale's components; the writing and the development of questionnaire items; the field testing, and the analysis of validity and reliability (Arsad et al., 2011). Before the field test, the contents of the instrument were validated by 6 experts consisting of 2 Biology Education lecturers at Tanjungpura University, Pontianak, and 4 biology teachers at a State Senior High School in Pontianak City. Afterward, the data were analyzed using Aiken's V calculations through the Microsoft Excel 2010 application. The value of V is obtained by using Aiken's V formula as follows:

$$V = \frac{\Sigma s}{[n\,(c-1)]}$$

Annotation:
s = r – lo
lo = The lowest validity rating score (in this case = 1)
c = The highest validity rating score (in this case = 4)
r = Number given by a validator

(Retnawati, 2016)

In this study, there were six experts (validators), the assessment of the questionnaire statements applied 4 scales, and the p-value was <0.05. Based on this, the minimum value of the questionnaire's validity according to Aiken's V table is 0.78 (V 0.78). Then, the field tkertest was conduinvalidcted by distributing instruments to respondents to determine the empirical validity and reliability of the instrument. The data obtained were then analyzed using the

Rasch model with WINSTEP 3.73 application. The results provided from the Rasch model analysis include person reliability, item reliability, Cronbach's alpha value, validity, item suitability with the Rasch model (fit item), item difficulty level, and Wright map (Bond, Yan & Heene, 2020).

RESULTS & DISCUSSION

DALI was developed through 3 phases of research. The first phase was the identification of the research scale components. It was carried out through a literature study related to digital age literacy. In this study, the main source used is enGauge 21st Century Skills by NCREL & Metiri Group. Afterward, these components were discussed with expert lecturers. There are 8 components or indicators used in the assessment instrument of digital age literacy, including basic literacy, scientific literacy, economic literacy, technological literacy, visual literacy, information literacy, multicultural literacy, and global awareness.The second phase was the writing and the development of questionnaire items based on the components of digital-age literacy that have been identified.

Table 1. Examples of statements from each component of digital-age literacy

Components	Number of statements	Examples of statements
Basic Literacy	5	I can write in English properly, both manually and digitally
Scientific Literacy	8	I can identify and explain natural phenomena occurring in everyday life
Economic Literacy	4	I rarely follow the news about economic conditions and problems in Indonesia.
Technological Literacy	4	I can use computers and smartphones effectively to do various tasks
Visual Literacy	4	I can create various visual media such as pictures, videos, as well as models to present data using computers and other technologies so that they are more attractive and easier to understand
Information Literacy	7	I can access relevant information from various sources
Multicultural Literacy	5	I think we should be aware and avoid the problems of bias, racism, prejudice, and stereotype.
Global Awareness	3	I can identify significant trends and issues in both global and local communities.

Content Validity

The content validity of DALI was assessed by experts based on 3 aspects, namely construction, content, and language. The result is shown in table 2.

Table 2. Questionnaire Validation Results Using Aiken's V

Aspect	Aiken's V Index	Interpretation
Construction	1	Valid
Contents	1	Valid
Language:		
Communicative	0,93	Valid
Effective	1	Valid
PUEBI	0,8	Valid
Compliant Standard language	1	Valid
∑V	**0,96**	**Valid**

By comparing the V value (table 2) and the minimum value of validity that must be achieved ($V \geq 0.78$), all aspects based on expert judgment are declared valid.

Rasch Model Analysis

The instrument, tested on 70 students, was then analyzed to determine the empirical validity and reliability using the Rasch Model. The analysis results are shown in Table 3.

Table 3. Statistics Summary of Instrument Using the Rasch Model

	Measured Pearson			
	Infit		Outfit	
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**
Mean	1.00	-0.2	0.99	-0.2
Reliability	0.71			
Cronbach Alpha	0.75			
	Measured Item			
	Infit		Outfit	
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**
Mean	0.99	-0.3	0.99	-0.3
Reliability	0.98			

The table measuring students' answers pattern shows that the person reliability value is 0.71 and categorized in the sufficient category. The item reliability with a value of 0.98 is included in the excellent category. Cronbach's alpha value of 0.75 is included in the good category. Outfit Mean Squared (MNSQ) is used for person analysis and the item gained is 0.99. This value is included in the criteria of $0.5 < MNSQ < 1.5$, the ideal value is 1.00 (the closer to the value of 1.00, the better the quality). Meanwhile, Outfit Z Standardized (ZSTD) for person analysis is -0.2 and items is -0.3. This value is included in the criteria of $-2.0 < ZSTD < 2.0$, the ideal value is 0 (the closer to 0, the better the quality). From these data, it can be concluded that the pattern of students' answers and the statement items of the instrument are in line with the Rasch model. Therefore, the instrument can be used as a tool to measure students' digital age literacy.

The validity of DALI can be determined from the suitability of each statement item with the Rasch model. Items are stated compatible with the model if they meet either one or two of these conditions: (1) The MNSQ outfit is between 0.5 to 1.5; (2) The ZSTD outfit is between -2.0 to 2.0; (3) The value of PT Measure-All corr is between 0.4 to 0.85 (Sumintono & Widhiarso, 2015; Azizah & Wahyuningsih, 2020; Ramdani et al., 2021).

Table 4. Interpretation of Instrument Item Validity

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT		OUTFIT		PT-MEASURE		EXACT OBS%	MATCH EXP%	Item
					MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.			
34	156	75	74.13	1.64	1.91	4.4	1.89	4.4	A-.14	.30	50.7	54.8	G2
3	249	75	53.06	1.50	1.68	3.8	1.72	4.0	B-.26	.33	22.7	45.4	A3
22	171	75	70.29	1.57	1.66	3.5	1.65	3.4	C-.39	.31	41.3	51.7	E1
31	237	75	55.70	1.47	1.60	3.5	1.62	3.6	D.00	.33	42.7	44.4	F6
28	257	75	51.24	1.52	1.56	3.2	1.59	3.3	E.02	.32	29.3	46.3	F3
19	281	75	45.31	1.63	1.54	2.8	1.56	2.9	F.39	.31	50.7	55.5	D2
14	215	75	60.40	1.46	1.52	3.2	1.51	3.1	G.22	.33	30.7	43.6	C1
2	174	75	69.56	1.55	1.42	2.4	1.46	2.6	H-.27	.32	41.3	51.1	A2
1	287	75	43.69	1.66	1.38	2.1	1.35	1.9	I.30	.30	48.0	56.8	A1
36	333	75	28.54	2.00	1.34	2.1	1.31	1.9	J.42	.25	56.0	55.0	G4
30	154	75	74.67	1.65	1.22	1.3	1.25	1.5	K-.56	.30	62.7	54.9	F5
5	275	75	46.87	1.60	1.17	1.0	1.23	1.3	L.26	.31	44.0	52.9	A5
33	129	75	82.13	1.82	1.19	1.1	1.21	1.3	M-.12	.27	58.7	53.2	G1
15	317	75	34.46	1.85	1.08	.5	1.09	.6	N.42	.27	52.0	55.9	C2
4	217	75	59.98	1.46	1.08	.6	1.09	.6	O.52	.34	41.3	43.7	A4
27	112	75	88.36	2.03	1.01	.1	1.06	.4	P-.39	.25	34.7	57.7	F2
37	304	75	38.70	1.76	.94	-.3	.92	-.4	Q.65	.28	56.0	58.4	G5
17	219	75	59.55	1.46	.94	-.4	.94	-.4	R.43	.34	40.0	43.9	C4
35	350	75	20.67	2.35	.92	-.4	.87	-.7	S.36	.22	68.0	68.4	G3
7	255	75	51.70	1.52	.88	-.7	.88	-.7	T.42	.33	46.7	46.3	B2
12	242	75	54.61	1.48	.79	-1.5	.80	-1.4	t.71	.33	54.7	44.5	B7
10	251	75	52.61	1.50	.78	-1.5	.80	-1.3	s.62	.33	53.3	46.0	B5
24	258	75	51.01	1.53	.79	-1.4	.80	-1.3	r.51	.32	56.0	46.4	E3
20	326	75	31.25	1.93	.77	-1.5	.77	-1.6	q.45	.26	62.7	54.6	D3
38	296	75	41.12	1.71	.77	-1.4	.77	-1.4	p.53	.29	58.7	58.3	H1
ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT		OUTFIT		PT-MEASURE		EXACT OBS%	MATCH EXP%	Item
					MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.			
23	301	75	39.63	1.75	.74	-1.6	.77	-1.4	o.31	.29	64.0	58.3	E2
11	258	75	51.01	1.53	.73	-1.9	.75	-1.7	n.67	.32	57.3	46.4	B6
8	252	75	52.38	1.51	.73	-1.9	.73	-1.9	m.49	.33	56.0	46.0	B3
18	318	75	34.11	1.86	.73	-1.7	.73	-1.8	l.55	.27	62.7	55.6	D1
40	284	75	44.51	1.65	.71	-1.8	.73	-1.7	k.46	.30	58.7	56.3	H3
21	321	75	33.06	1.88	.70	-2.0	.72	-1.9	j.50	.27	64.0	55.2	D4
25	267	75	48.87	1.56	.68	-2.2	.70	-2.0	i.50	.32	64.0	49.3	E4
13	260	75	50.54	1.53	.67	-2.4	.68	-2.2	h.61	.32	60.0	47.2	B8
39	313	75	35.81	1.82	.65	-2.3	.67	-2.2	g.25	.28	68.0	56.8	H2
26	308	75	37.44	1.79	.58	-2.9	.59	-2.9	f.60	.28	65.3	57.8	F1
16	266	75	49.11	1.56	.57	-3.1	.57	-3.1	e.47	.32	61.3	49.2	C3
29	304	75	38.70	1.76	.55	-3.1	.56	-3.0	d.44	.28	70.7	58.4	F4
9	259	75	50.77	1.53	.50	-4.0	.50	-3.9	c.58	.32	68.0	46.4	B4
32	287	75	43.69	1.66	.48	-3.8	.49	-3.7	b.57	.30	72.0	56.8	F7
6	259	75	50.77	1.53	.44	-4.5	.43	-4.6	a.61	.32	65.3	46.4	B1
MEAN	258.1	75.0	50.00	1.66	.99	-.3	.99	-.3			54.0	51.9	
S.D.	56.1	.0	14.38	.19	.39	2.4	.39	2.4			11.9	5.8	

Based on the analysis results, 6 items out of 40 items are not following the Rasch model. The items of G2, A3, E1, F6, F3, and C1, they are declared invalid because the MNSQ and ZSTD outfit values exceeding the maximum and the minimum standard. In consequence, the final number of valid and usable

instrument items is 34 items. The six items categorized as invalid correspond to the level of difficulty of the items, where items G2, E1, and C1 are in the very difficult category, while items A3, F6 and F3 are in the difficult category.

The Wright map is a special feature of Rasch model analysis within the WINSTEP application program that describes the distribution of students' abilities (left side) and item difficulty levels (right side) on the same scale (Ramdani et al., 2021).

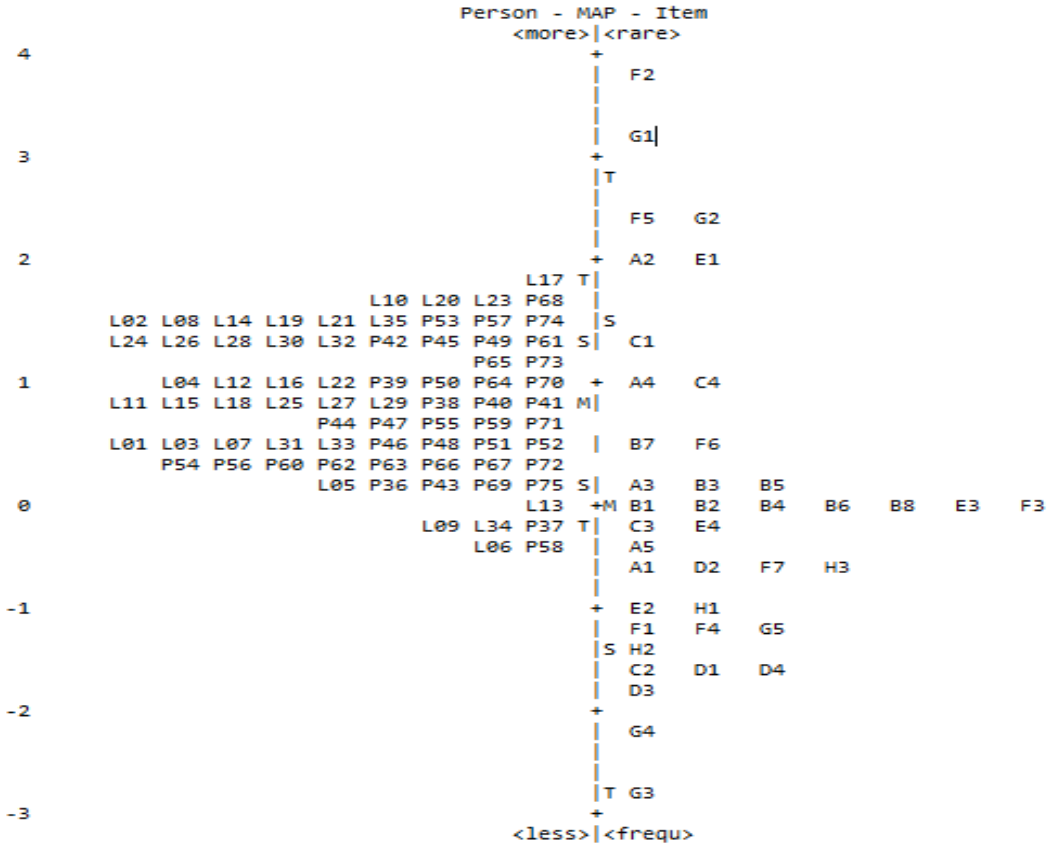

Figure 1. Wright Map

Based on the figure, it can be seen that, in general, the instrument's statement items' difficulty level is higher than the students' ability. The statement item that has the highest difficulty level is F2 (outlier). Theoretically, no student has the opportunity to answer the statement correctly because of their lower abilities. Otherwise, item G3 has the lowest difficulty level and is even lower than students' ability level. Thus, all students have the opportunity to be able to answer correctly. The left side of the figure shows that students with the highest level of ability are positioned in L17, while students with very low abilities are positioned in L06 and P58 (outliers, out of the T limit).

Another parameter that also determines the quality of the instrument is the difficulty level. It can be seen from the logit value of each item. The order of statement items from the highest to the lowest difficulty level is F2, G1, F5, G2, E1, A2, C1, A4, C4, F6, B7, A3, B5, B3, B2, F3, B6, E3, B1, B4, B8, C3, E4, A5, D2, H3, A1, F7, H1, E2, F4, G5, F1, H2, C2, D1, D4, D3, G4, and G3.

The statement items can be grouped based on the combination of the standard deviation value with the average logit value. The analysis results show that the SD value of the instrument is 1.44. Based on the SD value, the level of instrument difficulty is grouped as follows:

(1) logit > +1 SD = very difficult
(2) logit 0.00 up to + 1SD = difficult
(3) logit 0.00 up to – 1SD = easy
(4) logit < -1 SD = very easy.
(Sumintono & Widhiarso, 2015)

The following is the difficulty level of each instrument item based on the criteria above.

Table 5. Difficulty Level of Instrument Items

Components of digital-age literacy	Statement Items	Logit	Difficulty level
Basic Literacy	A1	-0,63	Easy
	A2	1,96	Very difficult
	A3	0,31	Difficult
	A4	1,00	Difficult
	A5	-0,31	Easy
Scientific Literacy	B1	0,08	Difficult
	B2	0,17	Difficult
	B3	0,24	Difficult
	B4	0,08	Difficult
	B5	0,26	Difficult
	B6	0,10	Difficult
	B7	0,46	Difficult
	B8	0,05	Difficult
Economic Literacy	C1	1,04	Very difficult
	C2	-1,55	Very easy
	C3	-0,09	Easy
	C4	0,96	Difficult
Technological Literacy	D1	-1,59	Very easy
	D2	-0,47	Easy
	D3	-1,88	Very easy
	D4	-1,69	Very easy
Visual Literacy	E1	2,03	Very difficult
	E2	-1,04	Very easy
	E3	0,10	Difficult
	E4	-0,11	Easy
Information Literacy	F1	-1,26	Very easy
	F2	3,84	Very difficult
	F3	0,12	Difficult
	F4	-1,13	Very easy
	F5	2,47	Very difficult
	F6	0,57	Difficult
	F7	-0,63	Easy
Multicultural Literacy	G1	3,21	Very difficult
	G2	2,41	Very difficult
	G3	-2,93	Very easy
	G4	-2,15	Very easy
	G5	-1,13	Very easy

Global Awareness	H1	-0,89	Easy
	H2	-1,42	Very easy
	H3	-0,55	Easy

Based on table 5, the difficulty level of the DALI statement items is regularly distributed from the categories of very difficult, difficult, easy, and very easy, signifying that this instrument has a good quality.

Discussion

The advance of information technology and the internet in the 21st century has resulted in an abundance of digital information resources (Kurnianingsih, Rosini, & Ismayati, 2017). Various learning resources and information can now be accessed rapidly, easily, and without limitations, often at very low cost (Afandi, Junanto, & Afriani, 2016; Rifqiawati, Hendriyani, & Hayati, 2020). In addition, communication can be conducted seamlessly without the constraints of time and space, and public services are increasingly enhanced through digitalization across sectors (Sujana & Rachmatin, 2019). Nonetheless, the proliferation of digital technology has brought about numerous adverse effects, such as the misuse of social media (Amalia, 2015), invasion of privacy, cyberbullying, cybercrime, fraud, dissemination of hoaxes, sexual harassment, and other digital-related criminal behavior (Sujana & Rachmatin, 2019; Jordana & Suwarto, 2017).

In addressing these challenges, students must be equipped with multiliteracy skills, particularly digital-age literacy, to navigate the complex demands of the 21st century. Digital-age literacy is one of the essential skills required for students to become lifelong learners capable of adapting to rapid changes (Afandi, Junanto & Afriani, 2016; Zubaidah, 2016). Belshaw (2011) posits that digital-age literacy encompasses not only the technical competencies in using digital tools and communication technologies but also includes the capacity to socialize, learn, behave, and think both critically and creatively in a manner that aligns with the expectations of the digital era.

Evaluating students' digital-age literacy competence is a critical preliminary step in formulating education policies aimed at enhancing 21st-century skills. For such an evaluation to be meaningful and reliable, the availability of a valid and dependable assessment instrument is crucial. An instrument that offers accuracy, consistency, and stability becomes a key element in ensuring precise measurements (Amalia & Susilaningsih, 2014).

This study involved three primary stages in developing the Digital Age Literacy Instrument (DALI): first, the identification of the scale components through a literature review; second, the formulation of questionnaire items aligned with the identified components; and third, analysis of the instrument's validity and reliability. Based on expert judgment and Aiken's V analysis, all aspects of the instrument achieved the minimum validity threshold ($V \geq 0.78$), indicating that the instrument is valid in terms of construction, content, and language. The questionnaire integrates all essential components including a title, student identity section, instructions, items, and response alternatives. Content-wise, the items

correspond to the eight components of digital-age literacy proposed by NCREL & Metiri Group (2003), namely: (1) basic literacy, (2) scientific literacy, (3) economic literacy, (4) technological literacy, (5) visual literacy, (6) information literacy, (7) multicultural literacy, and (8) global awareness. Linguistically, the items are communicative, effective, comply with PUEBI (Pedoman Umum Ejaan Bahasa Indonesia), and utilize standardized language.

The empirical validation involved Rasch model analysis using WINSTEP 3.73 software. The person reliability score of 0.71 falls within the sufficient category, suggesting good internal consistency among student responses. The item reliability score was notably high at 0.98, classified as excellent, reflecting strong consistency in item performance. Furthermore, the Cronbach's alpha value of 0.75 indicates overall reliability in the interaction between respondents and items. Of the 40 initial items, 6 were excluded for not fitting the Rasch model, resulting in a final total of 34 valid and usable items. The difficulty distribution of these items spans from very difficult to very easy, suggesting balanced and comprehensive item construction.

The urgency of improving digital-age literacy among students is reinforced by the increasing volume of information accessible through digital networks. Students must be capable of critically evaluating and selecting relevant, reliable, and up-to-date information (Panggabean et al., 2019). Several studies have integrated digital-age literacy into educational interventions. For example, Asrizal et al. (2018a) developed an adaptive and contextual learning model that successfully enhanced students' knowledge, attitudes, and literacy skills. Similarly, Asrizal et al. (2018b) demonstrated the effectiveness of instructional materials developed on the topic of pressure in improving students' digital-age literacy. Furthermore, schools and teachers play a pivotal role as facilitators in nurturing students' literacy capacities (Nuroh & Liansari, 2017).

The novelty of this study lies in the specific development and validation of a digital-age literacy instrument tailored for senior high school students, which had not been previously addressed in earlier research. This research addresses a notable gap by constructing a measurement tool that is specifically aligned with the cognitive, behavioral, and contextual characteristics of high school students—who often face distinct digital literacy challenges compared to university students. While previous instruments have been developed, their target populations and methodological approaches differ.

For instance, Mujtahid et al. (2021) developed a similar instrument targeting university-level students from Universitas Terbuka, achieving a Cronbach's alpha of 0.816—indicating high reliability. However, their instrument comprises only 29 items and is contextualized within higher education. By contrast, the present study not only adapts the digital-age literacy framework for the senior high school context but also strengthens methodological rigor through the combined use of Aiken's V for content validation and the Rasch model for empirical validation.

Moreover, this research contributes an instrument that measures all eight components of digital-age literacy as outlined by NCREL & Metiri Group (2003), whereas many prior studies tend to focus on partial aspects or lack rigorous psychometric analysis. The balanced item difficulty levels and strong item reliability enhance the generalizability and applicability of the instrument in

varied school settings. This positions DALI as a comprehensive and empirically robust tool that can support schools and policymakers in evaluating and enhancing students' preparedness for the digital era.

In sum, the current research provides a significant contribution to the field of educational measurement by introducing a validated and reliable instrument specifically designed for secondary education. This tool not only addresses the urgent need to assess digital competence at the school level but also establishes a foundation for future interventions and curriculum development aimed at fostering holistic 21st-century skills.

CONCLUSION

This research has developed an appropriate instrument to measure the digital age literacy of senior high school students. The instrument in the form of a questionnaire has met the eligibility criterion of validity and reliability using the Rasch model analysis. However, 6 items are not compatible with the model; thus, the final number of instrument's statement items is 34. The development of DALI shows that the quality of the instrument is good and can be used to measure the digital age literacy of senior high school students within the 8 components of the latter. The existence of a good quality instrument is expected to be able to measure student's skills well. Thus, it can be used as a reference for various parties in making efforts to prepare a good quality generation that can compete globally. It is recommended that tteacher integrate the instrument into classroom assessments to identify students' strengths and weaknesses in digital literacy. However, DALI testing using a larger sample size and construct validation testing are still needed, especially in the context of more diverse student populations, adapting it for different educational contexts or cultural settings, and conducting longitudinal studies to track the development of digital-age literacy over time.

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