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Development of digital literacy assessment instruments using the rasch model measurement analysis method in high school students in Indonesia

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Abstract

Digitization in day-to-day life has significant implications for education. This increasing use of digital technology requires the presence of digital literacy, which is one of the vital competencies that must be mastered by students, especially in today's era where everything is digital. To get an accurate picture of the digital literacy level in students, a quality measuring instrument is necessary. Thus, the researchers conducted this study which focused on developing a measurement scale or digital literacy instrument for students using the Rasch model. The research participants were 317 high school students in Madiun Regency and Madiun City. Based on the analysis results using the Winsteps program, it is found that there are 46 items (out of 50 items) that meet the item-model fit index, with a reliability coefficient alpha of 0.97. Overall, it can be concluded that the digital literacy scale of these students has good psychometric properties, hence it can be used for assessment and research.

Introduction

Technological developments have changed the dynamics of families, schools and communities. Numerous activities that are usually done conventionally are now able to be done digitally.

Ribble (2015) states that these changes have been seen in family habits. He claimed that

> *"In the past it was the norm for families to join together around a dinner table and talk about the events of the day. Now families who want to learn what members of the household are doing check status updates, post, or send texts. The days of the dining room discussion has gone away and now dining rooms have been changed to "gathering spaces.""*
>
> (Ribble, 2015).

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Based on the explanation above, there have been changes which are caused by technological developments, especially within the family. The activities of family members become more efficient with the help of smartphones, in which extended family communication can be done either through text messages, voice and video calls, no longer having to communicate directly. In addition to the aforementioned points, these changes have occurred in the school and community environment as well. In the past, student discussions could only be carried out in class, but now students can discuss through digital spaces, whether through Zoom meetings, Google Classroom, or e-Learning platforms provided by the school. Before, people could only sell their products in physical stores, but now online stores are available. These digital stores can accommodate many products with a wider market reach. Naturally, this change may increase internet usage among the public.

This increase is also inevitable for Indonesian society. This can be seen in Indonesia's significant increase in internet users every year. The increase in internet users in Indonesia can be seen in the results of a survey conducted by Asosiasi Penyelenggara Jasa Internet Indonesia (APJII), which shows that the internet penetration rate in Indonesia in 2018 was 64.80 percent; then in 2019–2020, it was 73.70 percent; and as of 2021–2022, it will increase to 77.02 percent (Asosiasi Penyelenggara Jasa Internet Indonesia [APJII], 2022). This means that during the period 2021–2022, 210.026.769 Indonesians have been connected to the internet, dominated by children and teenagers in the age range 13–18 years (99.16 percent), followed by those aged 19–34 (98, 64 percent) (APJII, 2022).

Thus, based on the explanation above, most internet use is dominated by the younger generation, who are the successors of the baton in maintaining the existence of the Indonesian state in the international arena. The increase in internet users among Indonesia's young generation is one challenge that Indonesian citizens must face and be able to overcome amidst increasingly rapid changes. Therefore, efforts to increase digital literacy among Indonesian citizens, especially the younger generation, urgently need to be carried out immediately and given to the younger generation as provisions for facing challenges amidst the rapid development of technology and information.

The development of digital literacy in the younger generation can be done through the National Literacy Movement (GLN), which has been executed by the Ministry of Education and Culture since 2016. With the development of this digital literacy, hopefully it will support children and youth to maximize the meaningful use of the internet. Therefore, based on the explanation above, the researchers developed an assessment instrument related to digital literacy to determine the distribution of digital literacy levels among Indonesian citizens, especially the younger generation.

Literature Review

According to the Indonesian digital literacy survey, the national digital literacy index will increase by 0.05 points in 2022. Rahmadanita and Hidayat stated that this increase in digital literacy could affect technology acceptance, making accessing public services easier (Rahmadanita & Hidayat, 2023).

This is reinforced by research conducted by Iswanto (2021) which states that increasing digital literacy needs to be carried out starting from village government, providing education and training that encourages the development of community knowledge so that they can be technologically literate. Digitization in day-to-day life has significant implications for education (Iswanto, 2021). With the recent development of digital devices and educational software, even schools and educators are still grappling with ways to integrate technology into the curriculum and prepare students for the future. As stated by Pangrazio, the concept of digital literacy helps educators, researchers and education bureaucrats make sense and meet the demands of schools and students in a digital society (Pangrazio et al., 2020). As of today, a number of school demands have switched digitally, both learning resources and learning media in the learning process. The essence of education is a process of searching for identity that lasts throughout life to develop potential in order to give meaning to life. Yet, after the industrial revolution, the aim of education was to improve reading, writing and numeracy skills to produce a skilled and work-ready workforce. Fundamentally, the goal of national education focuses on innovative, creative, independent and critical human resources without abandoning their local wisdom.

In the field of education, many are already bringing the digital world into the classroom with the aim of enhancing the learning and teaching process, engaging learners and aiding the acquisition of new skills, in line with White (2017), who stated that in this digital era, many are questioning traditional learning in the digital era, and they are trying to turn the digital world into a classroom (White, 2017). The existence of online courses and the use of digital content as learning

resources are prime examples of such statement. On the other hand, there is still debate about the application of proper pedagogy and the role of teachers in digital learning. Thus, in the digital era, it is expected that both teachers and students are able to possess skills regarding digital literacy.

The 21st century skills which students must have include, (1) Students must be able to think creatively and critically to solve problems and make decisions; (2) Students are able to collaborate with others and the community and have skilled communication; (3) Students must master Information and Communications Technology (ICT) and information literacy in order to develop their works; and (4) Students must be able to become good citizens, namely, those who have responsibility for themselves, family, religion, nation and state (White, 2017). From White's statement above, it can be concluded that to face the challenges of the 21st century, we must have the ability to think critically, creatively, innovatively, technology-based problem solving. According to a survey in rural areas of Canada, it was found that the frequency of digital technology use activities has potential both inside and outside the classroom (Wilson et al., 2015).

This increasing use of digital technology requires the presence of digital literacy. This is in accordance with Shopova (2014) who states that the development of the literacy level of students and their digital competence is crucial for improving the effectiveness and efficiency of the learning process as well as the adaptation of students to the dynamically changing labor market. Shopova's findings in her research revealed that most of the students who enrolled already had the skills to access the internet, including accessing social media, e-mail, Skype and other applications, but students' knowledge and competence in using technology for learning was still relatively low (Shopova, 2014).

Early thoughts about digital literacy were suggested by Gilster (1997, as cited in White, 2017). Digital literacy includes several abilities including knowledge of digital tools, critical thinking and social involvement (White, 2017). Anyangwe (2012) states that the term digital literacy is formed to cover all aspects, which are the development of knowledge, skills, competencies, confidence and abilities needed to use, interact, communicate, study, work and be creative with digital technology (Anyangwe, 2012; White, 2017). The researchers revealed that the main problem with the inappropriate use of technology is low digital literacy (Benaziria, 2018; Prasetiyo et al., 2021). Digital literacy is a key aspect of responsible internet use (Prasetiyo et al., 2021) With digital literacy, we can learn to use digital technology in a productive, creative, critical, safe and ethical way. Hence, in order for these digital literacy skills to be able to be mastered by students, teachers can implement digital-based learning.

In her research, Anne revealed that schools have an important role in introducing digital technology in hope to develop the digital literacy of students (Bjørgen & Erstad, 2015). This is in line with Setyaningsih (2019) who states that the use of e-learning can increase the digital literacy of students (Setyaningsih et al., 2019). In addition, the results of Desi's research stated that in schools it is necessary to develop a digital literacy movement in learning that is integrated into the curriculum which aims to develop the creativity and innovation of the younger generation (Desi, 2020). The curriculum in schools must certainly prioritize the responsible use and sharing of information, identify trusted sources of information and protect students during online activities. Teaching materials are required to suit certain age groups at school and involve parents to guide and support their children in online activities (Azzahra & Amanta, 2019). There are 4 aspects of digital literacy skills used to measure digital learning, namely, the aspect of the ability to use digital media, aspects of digital learning platform management, aspects of advanced digital media use, and ethical and security aspects in the use of digital media (Ozdamar-Keskin et al., 2015).

Methodology

This research aims to develop digital literacy instruments for high school students in Madiun Regency and City. In this study, the method used by the researchers is a qualitative and quantitative approach, often called mixed method research. As Creswell (2016) said, mixed research is a combination of two approaches, which are quantitative and qualitative. The qualitative approach and the quantitative approach are used sequentially and combined with the objective to produce more comprehensive, valid and objective data (Creswell, 2016). A mixed approach is appropriate for use in this research because, at the qualitative approach stage, it is used to collect various sources and literature while developing this digital literacy instrument, namely, through literature review and through the observation process to contextually adjust conditions.

Meanwhile, the quantitative approach in this research was used to analyze data from the pilot study results to determine the quality of the instrument being developed.

Thus, choosing a mixed methods approach in this research is the right approach to research the development of digital literacy instruments.

Research Stages

There are several stages in the research on the development of this measuring instrument, which include: *first*, identification of the measuring objective (determination of the theoretical construct). The construct revealed is student digital literacy. Digital literacy of students is the student's ability to operate, utilize, identify, and analyze information digitally. *Second*, formulation of aspects and indicators in the dimensions of digital literacy as shown in the blueprint. The digital literacy scale for these students is compiled and developed based on aspects or dimensions of digital literacy by Ozdamar-Keskin et al (2015), including the ability to use media, managing digital learning platforms, using advanced digital media, and ethics and security in the use of digital media (Ozdamar-Keskin et al., 2015). The blueprint for digital literacy scale of students is presented in Table 1 below.

The scaling method used in this scale is the summated ratings (Likert) method with five response options, which are VS (Very Suitable), S (Suitable), MS (Moderately Suitable), U (Unsuitable), and VU (Very Unsuitable). The author created 50 items according to the blueprint that has been made before. The form of the item is a statement with five response options. For item reviews, the author carried out such both in terms of language and content (professional judgment). This review aims to see the suitability of the items that have been written with the aspects that are disclosed and the suitability of the language used. This process is conducted in order for the scale created to have appropriate content validity. The item validation process was executed by a validator who was from Education of Informatics Engineering and possessed experience with digital literacy. In the item review, the validator stated that all the items described were by substance, containing the same meaning as research by Schmidt et al. (2009).

Thus, the evaluation results provided by expert validators in assessing item validity show that all question items are considered to be by the measurement objectives using language easily understood by the assessor or validator. Next, a pilot study was carried out on the instrument by testing 317 high school students in Madiun Regency and City as subjects in this research.

Data Analysis

Data analysis was conducted using the Rasch model analysis and the Winstep application to evaluate the validity and feasibility of the digital literacy instrument developed in this research. This Rasch model analysis was chosen by researchers with several considerations, where the Rasch model analysis method is an analysis method with more detailed and in-depth results related to the data being evaluated. In this case, with the Rasch model analysis method, researchers can find the results not only by focusing on the value of each item for each variable but also by knowing the value of the components of the respondents' demographic characteristics. In the Rasch analysis method, the model will display results in summary statistics, respondent suitability index, unidimensionality, item-respondent map, and rating scale analysis. From these results, researchers can find the value of each item, which is the basis for evaluating the instrument's validity as evidence of the instrument's validity as evidence of the instrument's suitability. The higher the Rasch model analysis results at both the item and respondent levels, the more valid and reliable the instrument is.

Table 1 Blueprint of digital literacy scale of students

Construct	Dimension	Item	Frequency	Weight (%)
Digital Literacy	Ability to use media	- I can operate a mobile phone to access digital learning platforms when learning online.	13	25
	Managing digital learning platforms	- I can upload various types of files such as doc, pdf, ppt, audio and video on Google Classroom and other digital learning platforms.	9	25
	Using advanced digital media	- Advanced use of digital media - I can publish various digital content, such as videos, files (doc, pdf and ppt), articles and articles on blogs/websites on various online media platforms.	13	25
	Ethics and security in the use of digital media	- I can communicate well with teachers by using messages through the WhatsApp application.	15	25

In addition, by using Rasch model analysis, researchers can determine which items are the most difficult for respondents to agree with. In line with the results of this Rasch model analysis, the researchers could detect respondents who answered the questionnaire carelessly. Thus, the analysis of the Rasch measurement model in assessing the level of validity of this digital literacy instrument can be used as a reference for researchers that the digital literacy instrument developed by researchers is a good, valid, and a suitable instrument for use as a digital literacy measurement tool and is capable of measuring digital literacy competence: students, especially high school students in Indonesia.

Results

The analysis using the Rasch model resulted in gaining various information, both in terms of items and respondents who were participants in the scale trial (person). In this study, data analysis was conducted twice and obtained a number of items that met the item-model appropriateness index. The stages of analysis are summarized in Table 2 below.

According to Boone et al. (2014), the parameters used to determine the fitting or suitability of the item are based on several things, including: *first*, the value of outfit mean square (MNSQ) accepted: 0.5 < MNSQ < 1.5. *Second*, the value of the outfit Z-standard (ZSTD) accepted: -2.0 < ZSTD < +2.0. *Third*, the value of point measure correlation (Pt Mean Corr) accepted: 0.4 < Pt Measure Corr < 0.85 (Boone et al., 2014). In this process, items that are unsuitable with the model will be eliminated or removed from the analysis process, and the analysis will stop until there are no more items that are indicated to have low model fitting (misfit). At this testing stage, based on the OUTFIT MNSQ displayed in Appendix A, such showed that 4 items were "invalid" on the digital literacy instrument for students, namely, Es11, Es12, Es13 and Es15, where the MNSQ values of each item showed Es11 (1.83), Es12 (1.68), Es13 (1.52) and Es15 (1.52), values greater than 1.5. The remaining 46 items met the OUTFIT MNSQ criteria, designating that there are 46 items (items) that fit or are suitable to measure (Appendix A).

Afterwards, Appendix A also shows the validity testing of the instrument items using the Item (Column): Fit Order on Winsteps by looking at the OUTFIT Z-STANDARD (ZSTD) value with valid criteria if -2 < ZSTD < +2. In this instrument, it was found that there were 22 items that did not meet the validity criteria, namely, items: Es15 (8.67), Es11 (7.47), Es12 (5.86), Es13 (6.10), (Am3 (4.06), Adm8 (3.30), Am4 (3.30), Es8 (2.52), Es14 (2.34), Es7 (-2.12), Mp7 (-2.75), Adm4 (-2.53), Mp3 (-2.92), Es3 (-2.74), Am8 (-3.08), Adm13 (-3.03), Es5 (-3.51), Adm7 (-3.72), Es4 (-3.74), Adm5 (-4.02), and Adm6 (-4.50), signifying that the remaining 28 items have met the OUTFIT Z-STANDARD (See Appendix A).

The next instrument's validity test is to look at the Point Measure Correlation (Pt Measure Correlation) value with valid criteria; if 0.4 < Pt Measure Cor < 0.85, then it is found that the polarity item has a positive Point Measure Correlation value and meets the required criteria. This signifies that all items of the digital literacy instrument have no conflict between the items and the construct which are being measured. Thus, out of the 3 validity criteria (OUTFIT MNSQ, OUTFIT Z-STANDARD, and Point Measure Correlation) there are 4 items, namely, Es15, Es11, Es12, and Es13 which do not meet the other 2 requirements; hence, these items must be dropped or not used. Therefore, there are a total of 46 items that meet the item-model fitting index. The results of the final analysis of the digital literacy measurement scale for students containing 46 items with a total number of respondents of 317 students are displayed in Table 3.

Table 3 Summary of final analysis results

	Output	Result
Person	Mean Logit (SD)	1.50 (1.37)
	Separation Index	4.17
	Person reliability	0.95
Item	Mean Logit (SD)	0.00 (0.51)
	Separation Index	6.36
	Item reliability	0.98
Instrument	Cronbach's	0.97
	Raw variance explained by measures	40.3%
	Unexplained variance in 1st contrast	9.7%
	Unexplained variance in 2nd contrast	6.4%

Table 2 Summary of analysis stages

Stage	Number of Analyzed Respondents	Number of Analyzed Items	Result	Action
1	317	50	4 items do not fit the model	Eliminate items which do not fit the model
II	317	46	No more items which do not fit the model	-

On the whole, the results of the analysis of the items and the respondents showed that there were no items that were left unanswered for the respondents to answer. This is visible from the numbers from the results of item measures and person measures. The item reliability value of 0.98 indicates that the item quality in this instrument is high. In other words, the forty-six items identified as fit with the model are indeed quality items. Furthermore, the reliability value of the respondents showed 0.95, indicating that the consistency of the respondents' answers is high. In other words, respondents answered all items seriously (not carelessly). In order to clarify the description of the results obtained, the following shows information on item distribution based on the level of agreement of the respondents.

Figure 1 shows Wrighmap, which functions to shows information on item distribution based on the level of agreement of the respondents. Based on Figure 1, 2 items were found to be difficult for respondents to agree on, namely, item Adm2 and item Adm3. As show in Figure 1, the item which was most easily approved by the respondents was the Mp8 item. Based on Figure 1, it can be concluded that item Adm 2 and item Adm 3 have the highest difficulty level and item Mp8 has the lowest difficulty level. In Table 3, the Summary of Analysis Results shows that the digital

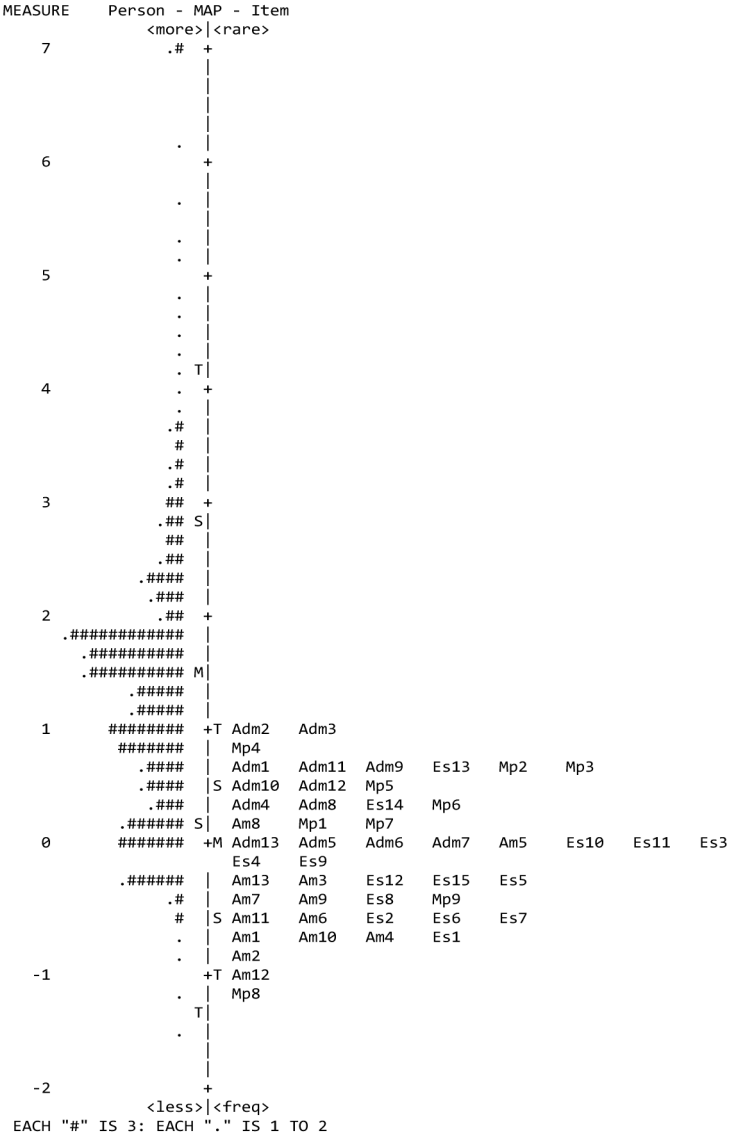

Figure 1 Wrightmap

literacy measurement instrument for students has a person reliability of 0.95, Cronbach's alpha reliability of 0.97 and item reliability of 0.98, which is close to 1, meaning that the reliability of this instrument is included in the good category.

The grouping of respondents and items can be seen from the separation index. The respondent's separation index obtained was 4.17 and the item separation index was 6.36, meaning that there were 4 groups of persons and 6 groups of items. To see the grouping in detail, we can use the strata separation equation H = {(4 x separation index) + 1)/3}. As a result, the respondents have H = 5.67 (rounded to 6). This shows that respondents can be divided into six groups. Meanwhile, items have H = 8.33 (rounded to 8), which means that the items used in this study can be divided into eight levels based on their degree of difficulty for respondents to agree. Cronbach's alpha value obtained from the results of instrument analysis is 0.97. This shows that the reliability obtained by this measuring instrument is high.

Another important result that must be known in the development of a measuring instrument is the unidimensionality of the measuring instrument. This result is useful to determine whether the developed instrument is able to measure the object that will or should be measured, namely, digital literacy of students. From Table 3, it is found that the measurement results of raw variance data are 40.3 percent. According to Sumintono and Widhiarso, the minimum requirement for unidimensionality is 20 percent, and if the value is more than 40 percent, then it is even better, and the variance that cannot be explained by the instrument ideally does not exceed 15 percent (Sumintono & Widhiarso, 2014). Based on this explanation, the results of the raw variance data of 40.3 percent indicate that the unidimensionality requirement of at least 20 percent has been met and is even classified as good as it exceeds 40 percent. The results of the analysis of variance that cannot be explained by the instrument at 9.7 percent also meets the criteria, which is, it does not exceed 15 percent. Afterwards, a rating scale analysis will be performed with the aim to verify whether the rating or choice scale used is confusing the respondents or not. The results of the analysis are presented in Figure 2.

From the results of the validity test by looking at the results of the test rating (partial – credit) scale as presented in the table of test results for the Rating (Partial – Credit) Scale below, it is found that each rating (1, 2, 3, 4, 5) has a separate peak, designating the probability of each rating is clearly visible to the difference by the respondents. This shows that respondents can clearly distinguish between the answer choices according to what is proposed by the researcher. Thus, based on the results of this analysis, it can be seen that the measurements which are carried out have been going well.

Discussion

From the results of the analysis using the Rasch model, it is known that the digital literacy measurement scale for these students provides consistent results and is proven to reveal one unidimensional construct, which is digital literacy for students. Of the 50 items analyzed, there are 46 items that fit the model, with a reliability coefficient alpha of 0.97. This alpha value is a measure of reliability which in practice measures the interaction between the respondent and the item as a whole. The results of the alpha reliability coefficient of 0.97 signify that the digital literacy scale for these students has a high reliability coefficient, which in turn means that this scale produces a measurement score that is consistent and reliable. The reliability coefficients of the items and the respondents are also quite good, respectively being 0.98 and 0.95. This shows that the forty-six items are quality items and the group of respondents answered them seriously. These two results further strengthen and confirm that the digital literacy scale for students is indeed a quality measurement tool, since not only are the measurement results reliable, but also the forty-six items are also quality items.

In contrast to the analysis of classical test theory, analysis using the Rasch model results in information about the index of accuracy of the respondents with the model. With this information, it is found that there are inconsistent and abnormal response patterns in a group of respondents.

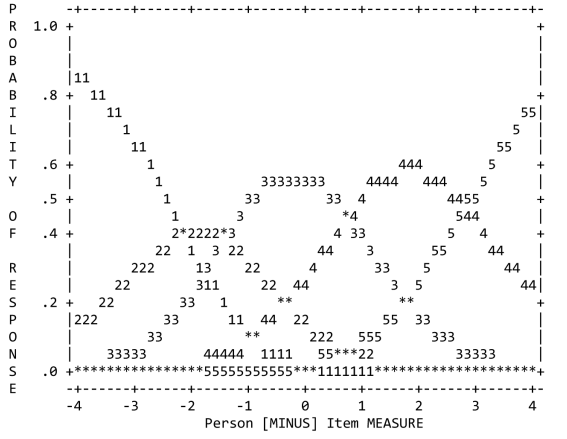

Figure 2 Rating scale test

This shows an indication of answering carelessly in a group of respondents. Meanwhile, when using the classical test theory, all respondent data are processed without being able to know accurately the consistency and sincerity of the respondents in answering the items. This clearly shows that the Rasch model indeed produces more accurate calculations as it does not only analyze items' suitability but also respondents' suitability.

Based on the results of the analysis, there are 4 items that are identified as not fit with the model. In other words, the four items have low model accuracy; hence, they need to be dropped. In terms of the level of difficulty, it is found that the items that are the most difficult for respondents to agree on are item Adm 2 "*I can be the host who arranges and gives permission for participants to join in online discussions via Zoom or Google Meet*" and Adm 3 "*I can be the host/moderator and can mute all participants so that the discussion runs smoothly when conducting online discussions via Zoom or Google Meet*." It appears that these items are the most difficult items for respondents to agree on due to the fact that they involve elements of using advanced digital media or require more expertise in operating digital media devices. This is because not all students can operate digital media, particularly the ability to become an admin or host in an online discussion. A person can use digital media to chat, or to take part in a seminar or discussion that is held virtually or online via Zoom or Gmeet, but not everyone can become an admin and manage digital media (Zoom or Gmeet) in order for these activities/events to be running smoothly. Therefore, it is not easy for respondents to agree with these items easily.

On the other hand, the item that is easiest for the respondents to agree on is the Mp8 item "*I can send assignments via WhatsApp*". It seems that this item is easily approved by respondents because it is not a new thing for respondents. This is because respondents are used to utilizing and using the WhatsApp application every day, both for communicating and for sharing documents with other people. Therefore, respondents can agree with this item easily. Alternatively, the separation index obtained by the respondents in this study is 4.17, and the item separation index is 6.36. According to Sumintono and Widhiarso, the greater the value of separation, the better the quality of the instrument in terms of overall respondents and items because it can identify groups of respondents and items (Sumintono & Widhiarso, 2014). When seen in more detail using the strata separation equation (H), then respondents have H = 5.67 (rounded to 6) and items have H = 8.33 (rounded to 8). These results indicate that respondents can be divided into six major groups, namely, groups that have very high, high, medium, low, moderately low, and very low digital literacy values/levels. Concurrently, items can be divided into five levels based on the level of difficulty for respondents to agree, which are very easy, fairly easy, easy, moderate, moderately difficult, difficult, too difficult, and very difficult. From this, it can be interpreted that the items used are able to carefully assess respondents' answers based on the digital literacy construct of students. Hence, by referring to the value of the separation index, both the items and the respondents are relatively large, so it can be shown that this scale has good quality as it is able to identify groups of respondents and item quite thoroughly.

In addition, by using the Rasch modeling analysis, we can determine and verify whether the rating of the options used is clear or confusing to the respondents. In this case, the results of the rating test (partial – credit) scale found that each rating (1, 2, 3, 4, 5) has a separate peak between scale 1 to scale 5, signifying that the probability of each rating is visibly different to the respondents. This shows that respondents were able to distinguish clearly between the answer choices according to what was proposed by the researcher. Therefore, the choice of options used on the digital literacy measurement scale for these students is appropriate. According to the results of this analysis, it can be determined that the measurement which was conducted had been going well. Another interesting finding is that the number of items for each aspect is imbalanced. This becomes an important note for this study, that the weight of item representation in each aspect is different. According to Azwar (2015), sometimes weight is not very important in preparing an instrument for measurement, especially for simple constructs. Nonetheless, there is no further explanation regarding this simple construct, thus it cannot be ascertained whether the digital literacy of students is considered a simple construct or not. If it is the latter, then certainly the weighting of this aspect is crucial. Azwar (2015) also explained that if each aspect does not have a specific measurement objective and role, then the difference in the number of items or weights between aspects is not to be considered in-depth. Based on these two statements, the proportionality of the number of items in each aspect is important, especially if there is a particular purpose that differentiates between aspects. However, there is also no limitation to pay attention to the proportionality of the weight or number of items in each aspect. This refers to Azwar (2015), that the behavioral aspect of a psychological attribute measured does not necessarily have the same contribution significance.

An aspect that has a greater role and has a greater contribution to the attribute must receive greater weight as well.

Conclusion and Recommendation

Based on the results of the analysis using the Rasch model, this digital literacy measurement scale for students Based on the results of analysis using the Rasch model, a scale for measuring digital literacy in high school students in the area around Madiun, Indonesia is proven to provide consistent results and has demonstrated to reveal one unidimensional construct, namely, digital literacy. There are 46 items according to the model, with an instrument reliability coefficient of 0.97, a respondent reliability coefficient of 0.95, and an item reliability coefficient of 0.98, signifying that this scale produces a consistent and reliable measurement score with good item quality. The five alternative answers (very unsuitable, unsuitable, moderately suitable, suitable, and very suitable) that were provided are appropriate because the respondents did not experience confusion in distinguishing the differences between the answer response choices. Comprehensively, from the results of the analysis, it can be concluded that this digital literacy measurement scale for students is proven to have good psychometric properties hence it can be used as an instrument in assessments and research.

The analysis results show that each aspect of the digital literacy scale for high school students around Madiun, Indonesia, is only carried out and represented by several different items in each aspect. Therefore, for further research, it is recommended to consider the proportionality of the weight or number of items from each aspect. Additionally, this study also has not conducted measurement bias detection analysis. Thus, future researchers can carry out a measurement bias detection analysis to evaluate whether or not the items compiled are more favorable or preferable to respondents with certain characteristics.

In this research, results of developing an instrument for measuring digital literacy in high school students in and around Madiun, Indonesia achieve important results at once as a form of researcher contribution and efforts to face various challenges and obstacles to the rapid development of technology in Indonesia. Therefore, the development of digital literacy measurement instruments on high school students around Madiun, Indonesia hopefully can be used and utilized by educators and policymakers in preparing and knowing the level of digital literacy in high school students.

Conflict of Interest

The authors declare that they have not known competing financial interests or personal relationships, which have, or could be perceived to have influenced the work reported in this article.

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Appendix

Appendix A Item test results (Column): Fit order

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
50	1486	385	-.14	.08	1.37	4.56	1.83	8.67	A .43	.57	55.9	55.9	Es15
46	1471	385	-.05	.08	1.57	6.61	1.68	7.44	B .43	.58	54.9	55.7	Es11
47	1494	385	-.19	.08	1.37	4.52	1.52	5.86	C .51	.57	57.2	56.0	Es12
48	1345	385	.66	.07	1.44	5.22	1.52	6.10	D .46	.61	52.5	53.2	Es13
3	1495	385	-.20	.08	1.34	4.16	1.35	4.06	E .52	.57	52.5	56.0	Am3
30	1393	385	.40	.07	1.12	1.62	1.31	3.75	F .55	.60	57.2	54.3	Adm8
4	1566	385	-.64	.08	1.15	2.01	1.29	3.30	G .54	.54	61.4	56.3	Am4
45	1471	385	-.05	.08	1.18	2.30	1.24	2.97	H .55	.58	57.7	55.7	Es10
21	1643	385	-1.17	.09	1.21	2.73	1.13	1.43	I .50	.50	58.0	57.7	Mp8
43	1516	385	-.32	.08	1.14	1.86	1.21	2.52	J .52	.56	64.0	56.2	Es8
49	1390	385	.41	.07	1.06	.78	1.18	2.34	K .53	.60	59.6	54.3	Es14
5	1454	385	.05	.08	1.14	1.80	1.15	1.90	L .52	.58	60.6	55.5	Am5
18	1362	385	.57	.07	1.12	1.59	1.13	1.67	M .60	.61	59.6	53.7	Mp5
44	1469	385	-.04	.08	1.11	1.48	1.10	1.26	N .55	.58	59.6	55.7	Es9
23	1348	385	.64	.07	1.06	.82	1.10	1.37	O .59	.61	57.7	53.2	Adm1
24	1280	385	1.00	.07	1.06	.81	1.09	1.19	P .62	.62	49.9	51.5	Adm2
36	1567	385	-.65	.08	1.08	1.07	1.04	.55	Q .56	.54	60.9	56.3	Es1
17	1326	385	.76	.07	1.04	.50	1.07	.97	R .54	.61	60.4	52.8	Mp4
41	1545	385	-.51	.08	1.05	.74	1.06	.77	S .55	.55	64.6	56.3	Es6
2	1599	385	-.86	.08	1.03	.50	1.05	.56	T .47	.53	69.3	56.7	Am2
25	1288	385	.96	.07	1.03	.48	1.05	.64	U .62	.62	53.0	51.6	Adm3
31	1338	385	.70	.07	1.05	.65	1.05	.66	V .59	.61	59.6	53.0	Adm9
7	1512	385	-.30	.08	1.01	.16	1.04	.59	W .54	.56	59.1	56.1	Am7
11	1556	385	-.58	.08	.95	-.69	1.02	.24	X .58	.54	60.9	56.3	Am11
32	1361	385	.57	.07	1.01	.14	1.01	.20	Y .61	.61	59.1	53.7	Adm10
37	1546	385	-.51	.08	1.00	-.03	.97	-.30	y .58	.55	61.4	56.3	Es2
12	1610	385	-.93	.08	.99	-.11	.93	-.84	x .56	.52	63.0	57.0	Am12
10	1571	385	-.67	.08	.97	-.33	.95	-.59	w .53	.54	64.3	56.4	Am10
33	1356	385	.60	.07	.93	-.93	.97	-.38	v .62	.61	58.8	53.5	Adm11
34	1360	385	.58	.07	.94	-.81	.97	-.39	u .62	.61	59.6	53.7	Adm12
1	1563	385	-.62	.08	.93	-.97	.96	-.51	t .54	.54	65.9	56.3	Am1
6	1537	385	-.46	.08	.91	-1.27	.95	-.57	s .58	.55	65.9	56.2	Am6
15	1332	385	.73	.07	.93	-1.00	.95	-.60	r .62	.61	60.6	52.9	Mp2
14	1419	385	.25	.08	.93	-.88	.94	-.73	q .62	.59	59.6	54.8	Mp1
19	1409	385	.31	.08	.92	-1.10	.91	-1.20	p .64	.59	62.2	54.7	Mp6
9	1517	385	-.33	.08	.91	-1.25	.91	-1.19	o .60	.56	63.5	56.2	Am9
13	1503	385	-.24	.08	.87	-1.90	.86	-1.88	n .59	.56	61.7	56.0	Am13
22	1517	385	-.33	.08	.87	-1.81	.86	-1.87	m .61	.56	66.1	56.2	Mp9
42	1533	385	-.43	.08	.85	-2.15	.84	-2.12	l .60	.55	65.6	56.3	Es7
20	1435	385	.16	.08	.83	-2.46	.80	-2.75	k .67	.59	64.3	55.2	Mp7
26	1405	385	.33	.08	.81	-2.69	.82	-2.53	j .66	.59	63.0	54.6	Adm4
16	1355	385	.60	.07	.78	-3.20	.80	-2.92	i .63	.61	62.2	53.4	Mp3
38	1457	385	.03	.08	.78	-3.19	.80	-2.74	h .62	.58	70.3	55.5	Es3
8	1426	385	.21	.08	.76	-3.44	.78	-3.08	g .65	.59	65.4	55.0	Am8
35	1473	385	-.06	.08	.77	-3.31	.78	-3.03	f .65	.57	65.6	55.7	Adm13
40	1485	385	-.14	.08	.76	-3.62	.75	-3.51	e .63	.57	69.8	55.9	Es5
29	1465	385	-.02	.08	.75	-3.75	.74	-3.72	d .66	.58	67.7	55.7	Adm7
39	1461	385	.01	.08	.74	-3.79	.74	-3.74	c .64	.58	69.8	55.6	Es4
27	1466	385	-.02	.08	.72	-4.14	.72	-4.02	b .66	.58	69.0	55.7	Adm5
28	1471	385	-.05	.08	.68	-4.82	.69	-4.50	a .66	.58	70.1	55.7	Adm6
MEAN	1458.9	385.0	.00	.08	1.00	-.13	1.03	.23			61.6	55.2	
P.SD	87.3	.0	.51	.00	.19	2.54	.24	2.90			4.8	1.4	