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Research Artikel

DEVELOPMENT OF SCIENCE TEST TO MEASURE HOTS AND DIGITAL LITERACY OF JUNIOR HIGH SCHOOL STUDENTS ON THE TOPIC OF CITY NOISE

PENGEMBANGAN SCIENCE TEST UNTUK MENGUKUR HOTS DAN DIGITAL LITERACY SISWA SMP PADA TEMA KEBISINGAN KOTA

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Abstract

The 2013 Curriculum emphasizes the process to improve HOTS and digital literacy. However, no appropriate science test instrument can measure the combination of these two aspects in contextual topics and relate to real-world problems. This kind of science test will engage students in-depth thinking as well as improve their digital literacy. This research aims to develop science tests based on HOTS and digital literacy in the City Noise theme for 8th-grade students. HOTS is operationally defined as critical thinking, creativity, collaboration, and communication (4C), while digital literacy is a thinking and operation skill. Borg & Gall models were adopted in this research and development. A total of 21 private school students in Semarang were subject to this research and investigated the validity and reliability of developed science tests. Based on expert judgment, the science test instrument, which consists of 25 multiple choice items and five essay items, was in a very good category. Based on the Rasch model analysis, the science tests are valid (28 items are valid) and reliable (Alpha cronbach=0.79). It can be concluded that the developed science test is feasible to use to measure HOTS and digital literacy of junior high school students on the topic of the City Noise.

Keywords: Digital literacy; HOTS; vibration and wave; science test; integrated science

Abstrak

Kurikulum 2013 menekankan pada proses peningkatan HOTS dan digital literacy. Namun, belum banyak tersedia instrumen tes sains yang mampu mengukur kombinasi dari kedua aspek tersebut dalam topik yang kontekstual dan berhubungan dengan masalah nyata. Jenis science test seperti ini dapat melibatkan siswa dalam proses berpikir mendalam serta dapat meningkatkan digital literacy. Tujuan dari penelitian ini yaitu mengembangkan science test berbasis HOTS dan digital literacy pada tema Kebisingan Kota untuk siswa kelas 8. HOTS secara operasional didefinisikan sebagai critical thinking, creativity, collaboration and communication (4C) sementara digital literacy sebagai thinking skills dan operation skills. Penelitian ini merupakan penelitian pengembangan (R&D) yang mengadaptasi dari Borg & Gall. Sebanyak 21 siswa dari SMP swasta di Semarang digunakan sebagai subjek dalam penelitian ini dan digunakan untuk mengetahui validitas dan reliabilitas science test hasil pengembangan. Berdasarkan hasil validasi ahli, instrumen science test yang terdiri dari 25 item pilihan ganda dan 5 item uraian termasuk dalam kategori baik. berdasarkan hasil analisis Rasch model, science test dikatakan valid (28 item valid) dan reliabel (Alpha Cronbach=0,79). Dengan demikian dapat disimpulkan bahwa science test hasil pengembangan layak digunakan untuk mengukur HOTS dan digital literacy siswa SMP pada tema Kebisingan Kota.

***Kata Kunci**: Digital literacy; HOTS; getaran dan gelombang; science test; IPA terpadu*

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INTRODUCTION

Learning science requires a lot of practice and direct experience in everyday life. Students cannot understand science material if it is only taught in the form of theories and concepts. It is necessary to provide examples of contextual cases related to everyday life so that students can be more responsible for their environment (Lathifah & Wilujeng, 2016; Nisa, Nadiroh, & Siswono, 2018; Saptono, Rustaman, Saefudin, & Widodo, 2013). Students' thinking ability in science concepts can be improved by involving knowledge, reasoning, and learning application (Mullis & Martin, 2014). This can be trained through HOTS test instruments that can connect learning material with real-life students so that learning is more meaningful (Widana, 2017) by the 21st-century learning concept. The types of questions on the test instrument significantly affect students' thinking skills (Budiman & Jailani, 2014). Reasoning abilities and thinking abilities can increase if teachers can facilitate and have creativity in supporting learning (Saptono et al., 2013).

Test instruments following the 2013 curriculum emphasize 21st-century skills, namely critical thinking, creativity, collaboration, and communication that students need to master (Khasanah & Herina, 2019; Paige, Bentley, & Dobson, 2016; Retnawati, Djidu, Kartianom, Apino, & Risqa, 2018; Widana, 2018). Students' skills need to be improved by using appropriate test instruments in order to be able to achieve HOTS (Istiyono, Mardapi, & Suparno, 2014; Nurwahidah, 2018; Widana, 2017). HOTS skills are an essential aspect of learning (Heong et al., 2011). Assessment is carried out to measure the achievement of learning done (Astuti, Prasetyo, & Rahayu, 2012). An excellent way to train HOTS skills is to make students active in learning (Limbach & Waugh, 2010). So far, students' HOTS abilities are in the low category because they are not trained to work on HOTS questions (Kusuma, Rosidin, Abdurrahman, & Suyatna, 2017). Teachers have not developed many tests related to HOTS so that there are not many test instruments that can measure HOTS well (Widana, 2017). Students must often do exercises by working on questions containing HOTS in order to improve their abilities. Teachers need to make questions that can train students to reason and understand a problem from various points of view so that they can determine the most appropriate solution.

HOTS and the latest technological developments also require teachers to make fair use of technology to support learning activities (Eryansyah, Erlina, Fiftinova, & Nurweni, 2019). Teachers and students need to adjust to technological developments to improve schools' quality of education (Khalid et al., 2016). The influence of digital media is tremendous on the development of student abilities. Humans often access information through digital media in everyday life (Ouahidi, 2020); this is inevitable. Teachers can use this so that students' use of digital media is focused, and there is no misuse of digital media (Pratiwi & Pritanova, 2017).

Digital literacy also needs to be integrated into question instruments to measure students' digital literacy skills. Understanding and using digital media wisely and adequately can improve student learning outcomes. Digital literacy is part of the 21st-century skills (Voogt & Roblin, 2012) which need to be developed by current digital technology developments. One thing that needs attention is that teachers have not many test instruments that have developed digital literacy. Guidelines for understanding and digital literacy skills are increasing with the covid-19 pandemic determined by WHO as a world pandemic (Khatri et al., 2020; Zhou, Huang, Cheng, & Xiao, 2020). Based on these conditions, the government adopted a policy of instructing schools and colleges to implement online distance learning using the internet network (Reimers, Schleicher, Saavedra, & Tuominen, 2020; Wargadinata, Maimunah, Dewi, & Rofiq, 2020). This was done to break the chain of the spread of covid-19 (UNESCO, 2020) (UNESCO, 2020). It is a challenge for teachers to adjust online learning as quickly as possible to facilitate comfortable learning with students. Based on these problems, this study was conducted to develop a science test that can measure HOTS and digital literacy of junior high school students on the theme of City Noise.

METHOD

This research is a research development (R&D) which adapts from Borg & Gall (1983), namely (1) a preliminary study; (2) planning; (3) initial product development; (4) product validation; (5) product revision; (6) limited trial; (7) revision. The preliminary study stage was carried out by conducting literature studies and field studies. A literature study is carried out by analyzing literature related to the application of HOTS and digital literacy, students' HOTS and digital literacy abilities, as well as studies relevant to the research to be carried out. The field study was carried out by digging up information about the conditions of science learning in schools, the use of media that supports HOTS and digital literacy, teachers' ability to arrange test instruments, the ability of students to master HOTS and digital literacy. The collection of this information is done by conducting direct interviews or by using online questionnaires. This stage is carried out to analyze needs so that science tests can be developed according to what teachers and students need.

The planning stage is carried out by analyzing HOTS and digital literacy components so that a science test pointers can be made that can be used to measure HOTS and digital literacy. Through this science test, students' ability to understand HOTS and digital literacy can be interpreted. Next is the product development stage.

The initial product development stage is a further step after describing the HOTS and digital literacy components. HOTS in this study is operationally defined as critical thinking, creativity, collaboration and communication (4C) which refers to (NEA, 2012) while digital literacy is as thinking skills and operation skills (Techataweewan & Prasertsin, 2018). The science test was developed in 25 multiple choice questions and five essay questions. Questions are packaged in digital form using the Google Classroom platform.

The material used in the science test is sound waves with the theme of city noise which is the science material for grade 8 even semester. Furthermore, the science test is validated by eight validators who are material experts and evaluation experts. The validation and suggestions from the validator are used as consideration in revising the product to make it better. Validators are lecturers at several universities who are already experts in this field.

The validation results are converted into a scale of four (Directorate of Senior High School Development, 2010). The following is the score of the validation results on the content, presentation, and language components.

Table 1. Questions' pointers based on HOTS components

No.	HOTS Component	Indicator	Question No.	Type of Question
1	*Critical Thinking*	- Using various types of reasoning to suit the situation - Analyze parts of the whole interaction with each other to come to the right conclusion - Analyze and evaluate facts effectively - Synthesize and make connections between information and make appropriate arguments - Interpret information and draw conclusions based on the best analysis	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27.	Multiple choice
2	*Communication*	- Articulate thoughts and ideas effectively using spoken and written words in various forms and contexts	26, 30	essay
3	*Creativity*	- Using various creative idea techniques in solving problems	28, 29	essay

Table 2. Questions' pointers based on digital literacy components

No.	Digital Literacy Components	Indicator	Question No.
1	*Thinking skill (analysis)*	- Analyze statements that support facts - Analyze the effect of a component - Analyze the right solution to solve the problem - Analyze the relationships between components	1, 2, 7, 14, 19, 24, 26
2	*Thinking skill (evaluation)*	- Evaluating the right statement - Evaluating the relationship between components with one another - Evaluating an event - Evaluating the facts that occur in everyday life - Evaluating the influence between components	8, 13, 16, 17, 21, 22
3	*Operation skill (cognition)*	- Reasoning the influence between components - Understanding the relationship between components with one another - Reasoning the cause of an event - Apply the relationship between components with one another - Apply comparisons between components	3, 4, 5, 6, 9, 10, 11, 12, 15, 18, 20, 23, 25, 27
4	*Operation skill (invention, presentation)*	- Designing designs that can solve problems - Describe and compare experimental results	28, 29, 30

Table 3.The results of the conversion of the validation score on the content, presentation, and language components

Component	Score Interval	Category
Content	$74{,}75 \leq \underline{M} \leq 92$	Very good
	$57{,}5 \leq \underline{M} < 74{,}75$	Good
	$40{,}25 \leq \underline{M} < 57{,}5$	Enough
	$23 \leq \underline{M} < 40{,}25$	Less
Presentation	$22{,}75 \leq \underline{M} \leq 28$	Very good
	$17{,}5 \leq \underline{M} < 22{,}75$	Good
	$12{,}25 \leq \underline{M} < 17{,}5$	Enough
	$7 \leq \underline{M} < 12{,}25$	Less
Language	$13 \leq \underline{M} \leq 16$	Very good
	$10 \leq \underline{M} < 13$	Good
	$7 \leq \underline{M} < 10$	Enough
	$4 \leq \underline{M} < 7$	Less

The suggestions from the validator are used as references in improving science tests. The revised science test was then used for limited trials of 21 students of class IX MTs Al Khoiriyah Semarang. Furthermore, after a limited trial was carried out, the science test was revised to make it more perfect.

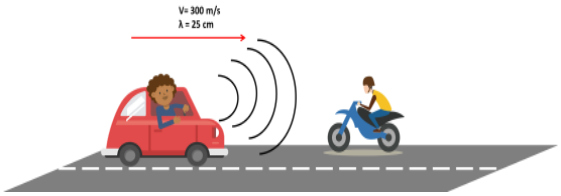
RESULTS AND DISCUSSION

The science test is an instrument that contains 25 multiple choice questions and five description questions on sound waves with the theme "city noise" which was developed based on HOTS components and digital literacy. The development of science tests is carried out to assist teachers in providing test instruments that can be used to measure HOTS and digital literacy. Based on the analysis of the students' needs, the HOTS ability is still low, the students are not familiar with HOTS, and many teachers have not done digital literacy questions and the development of HOTS questions and digital literacy. A science test was developed to measure HOTS and digital literacy to meet this need. If students 'abilities regarding HOTS and digital literacy can be measured properly, it will be easier to improve students' abilities. Also, the increasingly sharp development of digital media makes students inseparable from

digital media related to learning and personal life which does not always have a good impact (Pratiwi & Pritanova, 2017). The HOTS components of critical thinking, creativity, and communication are broken down into several indicators used as references in making science tests based on these indicators. Digital literacy is an important aspect to be integrated into various aspects of student learning and social media life because, at adolescence, students experience digitalization the most (Vélez & Zuazua, 2017). One of the most frequently accessed content in today's digital era is social media (Kurnia & Astuti, 2017).

The science test is validated by eight evaluation experts and material experts who are lecturers from various universities in Indonesia. Based on the validation results, several inputs improve the science test to make it better. These suggestions include, 1) consistency in writing answer options to make it more consistent, for example starting with all uppercase letters or all lowercase letters); 2) avoid using conjunctions of more than one in one sentence; 3) in making answer options, it is better to make choices that require in-depth analysis from students to determine whether the answer is correct/not so that the context of the answer choices is not the true/false statement in the options, but rather the accuracy of the statement; 4) need to add illustrations or pictures to make it easier to understand the questions. Based on these suggestions, improvements to the science test are shown in Table 4.

Table 4. Revised science test based on validator suggestions

Question No.	**Suggestion**	**Before revision**	**After revision**
6	Need to add illustrations or pictures to make it easier to understand the problem	Sebuah bus pariwisata melaju kencang, tiba-tiba di depan bus tersebut ada pengendara sepeda motor yang akan menyeberang jalan sehingga bus tersebut membunyikan klakson dengan cepat rambat 300 m/s. Diketahui panjang gelombang bunyi klakson tersebut 25 cm. Jika bus membunyikan klakson untuk kedua kalinya dengan frekuensi bunyi setengah dari frekuensi semula, maka panjang gelombang bunyi tersebut menjadi .... a. ¼ kali semula b. ½ kali semula c. 2 kali semula d. 4 kali semula	Sebuah mobil melaju kencang, tiba-tiba di depan mobil tersebut ada pengendara sepeda motor yang akan menyeberang jalan sehingga mobil tersebut membunyikan klakson dengan cepat rambat 300 m/s. Diketahui panjang gelombang bunyi klakson tersebut 25 cm.  Jika mobil membunyikan klakson untuk kedua kalinya dengan frekuensi bunyi setengah dari frekuensi semula, maka panjang gelombang bunyi tersebut menjadi .... a. ¼ kali semula b. ½ kali semula c. 2 kali semula d. 4 kali semula

Question No.	Suggestion	Before revision	After revision
11	- The distracting element of the answer choices does not appear to need revision - need to add illustrations or pictures to understand the problem faster	Tono melihat pemain gitar idolanya di televisi sedang memainkan gitar listrik. Gitar listrik tersebut memiliki frekuensi dasar A sebesar 420 Hz. Jika perbandingan frekuensi B : A adalah sebesar 26 : 40, maka besarnya frekuensi B adalah . . . . a. 273 Hz b. 276 Hz c. 672 Hz d. 726 Hz	Tono melihat pemain gitar idolanya di televisi sedang memainkan gitar listrik. Gitar listrik tersebut memiliki frekuensi nada dasar A sebesar 420 Hz.  Jika perbandingan frekuensi B : A adalah sebesar 26 : 40, maka besarnya frekuensi B adalah . . . . a. 273 Hz b. 545 Hz c. 620 Hz d. 646 Hz
20	Calculation questions do not need to be used. However, the calculation concept can be used as a "tool" to analyze a phenomenon.	Suara sirine ambulans yang melintas di jalan raya terdengar dengan frekuensi 40 Hz dan memiliki panjang gelombang 8 m. Frekuensi sirine ambulans tersebut ketika memiliki panjang gelombang 5 m adalah . . . . a. 25 Hz b. 40 Hz c. 45 Hz d. 64 Hz	Suara sirine ambulans yang melintas di jalan raya terdengar dengan frekuensi 32 Hz dan memiliki panjang gelombang 10 m. Ketika frekuensi sirine ambulans dinaikkan menjadi 40 Hz, panjang gelombangnya adalah 8 m. Sedangkan jika frekuensi sirine ambulan dinaikkan lagi menjadi 64 Hz, panjang gelombangnya juga ikut berubah. Berdasarkan uraian tersebut pernyataan yang paling tepat adalah . . . . a. Besarnya frekuensi tidak dipengaruhi oleh panjang gelombang b. Frekuensi meningkat jika panjang gelombang meningkat c. Panjang gelombang semakin kecil jika frekuensi semakin kecil d. Panjang gelombang semakin kecil ketika frekuensi meningkat
25	Improve the sentence so that the questions are more challenging and by HOTS	Pada jarak 300 cm dari sumber bunyi, ayah mendengar bunyi dengan intensitas 50 dB. Pada jarak 200 cm, ayah mendengar bunyi dengan intensitas 54 dB. Dan ketika mendekat lagi pada jarak 100 cm dari sumber bunyi ayah mendengar bunyi dengan intensitas 60 dB. Hal ini menunjukkan bahwa . . . . a. semakin dekat dengan sumber bunyi intensitas bunyinya semakin kecil b. semakin dekat dengan sumber bunyi intensitas bunyinya semakin besar c. semakin jauh dengan sumber bunyi intensitas bunyinya semakin besar d. intensitas bunyi tidak dipengaruhi oleh jarak	Ayah berdiri di titik A dan ada sebuah sumber bunyi. Kemudian ayah berjalan ke titik B sejauh 400 m ke arah utara, ayah mendengar bunyi tersebut dengan intensitas 50 dB. Kemudian ayah berjalan ke titik C sejauh 300 m ke arah timur, maka pernyataan yang benar adalah .... a. intensitas suara yang akan didengar ayah masih tetap sama b. intensitas suara yang akan didengar ayah lebih kecil c. intensitas suara yang didengar ayah lebih besar d. intensitas suara yang didengar ayah tidak dapat diprediksi
29	Sentences are too redundant, so it is necessary to improve the editorial of the sentences	Guru seni di SMP Negeri 1 Semarang ingin membuat ruangan khusus seni musik. Letak ruangan tersebut berdekatan dengan ruang kelas. Hal ini membuat guru takut ketika ada kegiatan musik di ruang tersebut dapat mengganggu pembelajaran di ruang sebelahnya. Karena itu guru musik bermaksud ingin membuat ruang musik dapat meredam bunyi dengan baik. Menurut kamu alternatif apa saja yang dapat dilakukan untuk membuat ruang musik tersebut meredam suara dengan baik?	Guru seni di SMP Negeri 1 Semarang ingin membuat ruangan khusus seni musik. Letak ruangan tersebut berdekatan dengan ruang kelas. Karena guru khawatir bunyi dari ruang musik akan mengganggu pembelajaran di ruang sebelahnya, maka guru berniat untuk membuat peredam bunyi yang dipasang dalam ruangan tersebut. Menurut kamu, alternatif apa saja yang dapat dilakukan oleh guru seni?

Table 4 shows some suggestions and improvements that have been made to the questions. Revisions are carried out by adding image illustrations, changing answer choices so that there are distracting elements, and changing the sentences' editorial to make them easier to understand. The revised science test resulted in a more interactive and easy-to-understand test instrument. The results of the science test assessment by the validator are shown in Figure 1. Eight validators gave scores on the content, presentation and language components used in the science test. The content component is developed based on the HOTS component indicator and digital literacy.

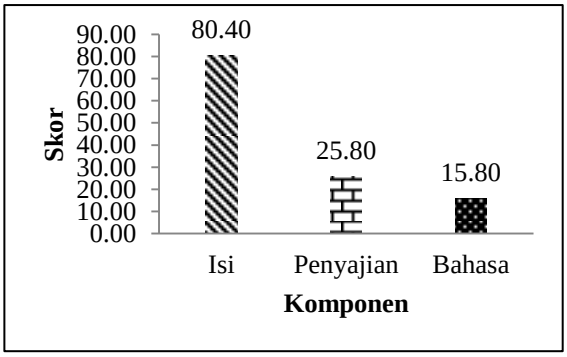


Figure 1.The results of the validator's assessment of the science test

Based on the three components' assessment, it obtained an average score in the very good category. This shows that the science test that has been developed is suitable for measuring HOTS and digital literacy of junior high school students.

After the first revision of the science test, 21 students of MTs Al Khoiriyah who had received sound wave material were given the test. The results of this trial were used as an analysis of the instrument's validity and reliability using the Rasch Model with the help of Winstep software. The Rasch model analysis output uses an odd log unit (logit), which provides a scale with the same interval to meet the minimum criteria of a measurement (Adams, Sumintono, & Mohamed, 2018; Sumintono & Widhiarso, 2014). The characteristics of the developed science test instrument are presented in Table 5.

Table 5. Characteristics of the Science Test

	Average	SB	Separation	Reliability
Person	-0,28	1,00	1,73	0.75
Item	0.00	0,92	1,36	0.65

Based on Table 5, it is known that the reliability of the person is 0.75 which states that the consistency of students in answering the questions is in the good category and the items can distinguish students well. The item reliability of 0.65 states that the probability of students answering each item is quite good. The higher the item reliability estimate, the better the item can measure latent variables (Bond & Fox, 2015). Reliability-based on classical test theory uses Alpha Cronbach's calculation, the interaction between person and item, which is estimated by this software is 0.79 which indicates that the development results of science tests meet the criteria of being reliable (Bambang & Wahyu, 2015).

The validity of each item is determined based on the criteria for the amount of Outfit Means Square (MNSQ), namely between 0.5 to 1.5; Z-Standard (ZSTD) outfit between -2.0 to +2.0; and Point Measure Correlation (Pt Mean Corr) from 0.4 to 0.85 (Sumintono & Widhiarso, 2014). If at least one of the three criteria is met, the item is said to be valid. Table 6 presents a summary of the validity of the items in the science test.

Table 6. Summary of Item Validity

	Item No.	Description
Valid	28	
Not Valid	2	Items number 7 and 10 because none of the criteria is met

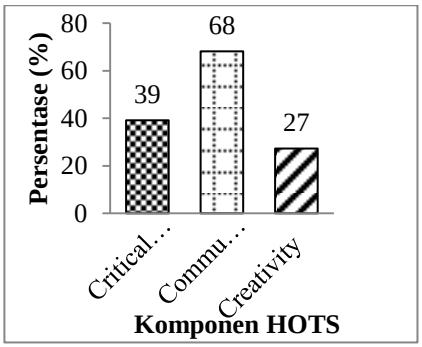


Figure 2. Junior high school students' HOTS skills

Based on Figure 2, it can be seen that the HOTS abilities of students in the components of critical thinking, communication, and creativity are still not maximal. Mostly in creativity which was only able to be achieved 27% and critical thinking by 39%. Problems with the HOTS indicator using various techniques and creative ideas could not be answered correctly by students. Even question number 28, which is a component of creativity, can only be answered correctly by one student out of 21 students. This shows that students still have difficulty exploring the ability to create and express ideas and write them down. It needs to be the teacher's attention to familiarize and provide space so that students can express their creative ideas in learning. The indicators of interpreting information and drawing conclusions based on the best analysis are also student weaknesses. The ability to answer on this indicator only reaches 27%.

HOTS ability is essential for students. HOTS associates students to relate and apply the knowledge they have learned (Jailani, Sugiman, & Apino, 2017). One of the factors causing the students' low HOTS ability is that the teacher's ability to compile HOTS test instruments is still low (Widana, 2017).

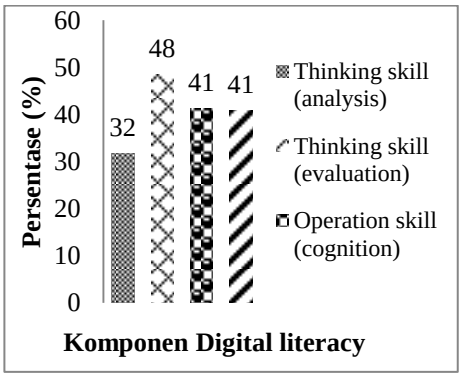


Figure 3. Junior high school students' digital literacy skills

The science test developed also contains a digital literacy component for students. The results of the science test showed that students' digital literacy skills were still not maximal. The results of students' digital literacy abilities can be seen in Figure 3.

Figure 3 shows that the highest digital literacy ability only reaches 48% in the thinking skill evaluation component, while the lowest thinking skill analysis is only 32%. Based on these results, we can conclude that students' digital literacy skills are still lacking.

One of the factors for students' digital literacy is the teacher's ability to understand digital literacy. New teachers adapt to the integration of digital literacy into learning (Kurniawati, Maolida, & Anjaniputra, 2018). It takes commitment from the teacher and students to understand and apply it to learning optimally. The use of technology in learning is per 21st-century skills (Eryansyah et al., 2019) which must be applied to current learning. Teachers need to know the necessary knowledge and understanding of digital literacy application so that its implementation in the classroom can be effective (Khalid et al., 2016) (Ouahidi, 2020). It can also be seen through digital literacy how to communicate in the digital era (Marsh, Hannon, Lewis, & Ritchie, 2017) (Chan, Churchill, & Chiu, 2017). Communication in learning, which is usually done face-to-face; in 2020, there will be significant changes. This is due to the covid-19 pandemic, which causes communication in the learning process and evaluation of learning to be done digitally. This is what drives the importance of improving students' digital literacy competencies.

The integration of digital literacy into the test instrument is carried out to measure students' digital literacy skills so that the right strategy can be determined to improve it. This needs to be done so that students can be accountable for using technology that has become part of their daily lives (Ouahidi, 2020). Students need to develop digital literacy skills (Hall, Nix, & Baker, 2013).

CONCLUSION

Based on the study results, it can be concluded that the developed science test results are declared valid by experts with the very good and reliable category according to data analysis using the Rasch model. Thus, the developed science test is suitable for teachers to measure HOTS and digital literacy of junior high school students on the

theme of "city noise". Students' abilities in HOTS and digital literacy at MTS Al Khoiriyyah are still low and need improvement. There are limitations in this study, namely the digital literacy aspect which has not been thoroughly researched because it is combined with HOTS. Therefore, it is recommended to research the measurement of digital literacy for students and teachers in the aspects of collaboration and awareness skills given the importance of collaboration skills and awareness of intellectual property rights in digital format in the era of the Industrial Revolution 4.0.

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