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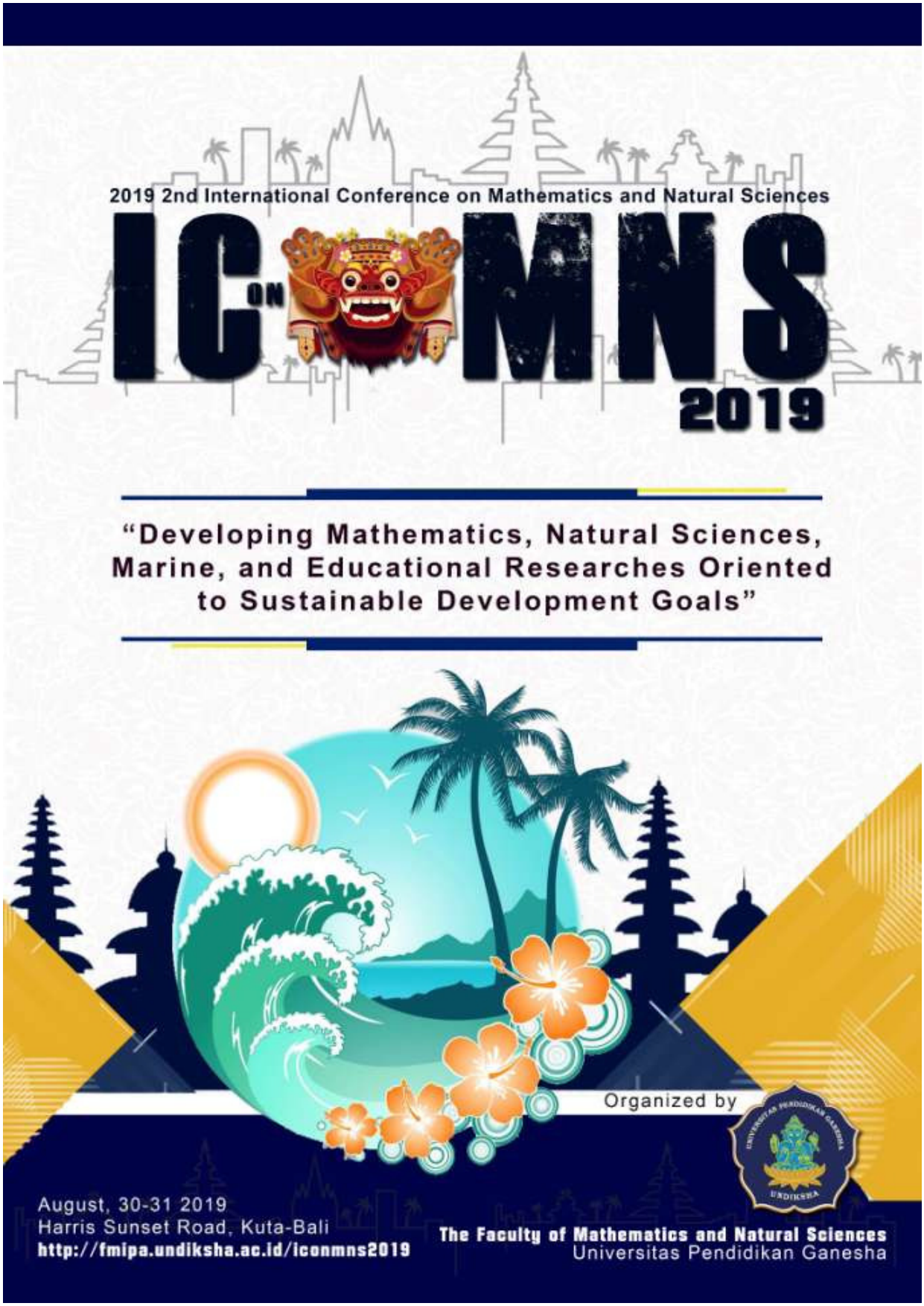

The 2nd IConMNS 2019

"Developing Mathematics, Natural Sciences, Marine, and Educational Researches Oriented to Sustainable Development Goals"

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THE 2ND INTERNATIONAL CONFERENCE ON MATHEMATICS AND NATURAL SCIENCES (IConMNS) 2019

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Bali, August 30th – 31st, 2019

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Om Swastyastu, Assalamualaikum Wr. Wb., Namo Buddhaya, Shalom,
The honourable Rector of Universitas Pendidikan Ganesha , and all Vice Rectors.
The Head of Research Institute and Community Service Universitas Pendidikan Ganesha.
The Dean of the Faculty of Mathematics and Natural Sciences and all Vice Deans,
The Speakers and Participants,
Ladies and Gentlemen,

First of all, let us praise and thank The Almighty God for His graces bestowed upon us. Allow me to heartily welcome all participants to Bali. It is my pleasure and privilege to extend our warmest welcome to all participants of the IConMNS 2019, the 2nd International Conference on Mathematics and Natural Sciences 2019 with the theme of "Developing Mathematics, Natural Sciences, Marine, and Educational Researches Oriented to Sustainable Development Goals". The purpose of this conference is to promote and encourage the exchange of thoughts and ideas of the advanced research in the fields of mathematics, natural sciences, education, marine, and computer science.

The Faculty of Mathematics and Natural Sciences, Universitas Pendidikan Ganesha is proud to organized and host this conference. We received 217 abstract submissions, of which 194 manuscripts will be presented tomorrow on 31st of August. Moreover, the conference is also attended by 34 non-presenter participants. To all presenters and participants, thank for your enthusiastic responses to the conference. Your present in this conference is highly appreciated.

In this special occasion, let me also give a special welcome to our keynote and invite speakers who are pleased to make contributions to our conference and share their new research ideas with us. They are Prof. Dr. Susanne Bogeholz from Department of Biology Education, Faculty of Biology and Psychology Albrecht-von-Haller-Institute for Plant Sciences Waldweg, Gottingen, Germany; Prof. Dr. Ernesto Mollo from Institute of Biomolecular Chemistry, Italia; Prof. Kazuhito Kawakita, Ph.D from Nagoya University, Japan; Prof. Sathoshi Ohkura from Nagoya University, Japan; Prof. Dr. Phil IGP. Sudiarta from Universitas Pendidikan Ganesha, Indonesia; Dr. Eliani Ardi from Osaka University, Japan; Prof. I Nyoman Adi Asmara Giri from Institute for Mariculture Research and Fishes Extension (IMRAFE), Gondol Buleleng Indonesia.

On 31st August, we have 7 parallel presentation sessions including mathematics education, mathematics, computer science, environmental science, marine and fisheries science, chemistry, chemistry education, natural science education, physics, and physics educations. The platform is ready, so please seize this opportunity to show your thoughts, ideas, and innovations confidently.

Wish you will enjoy this conference, contribute effectively toward it and bring home the knowledge, experiences, relations, and happy memories. Thank you for your attention and have a nice day.

Om, Shanti, Shanti, Shanti, Om; Wassalamualaikum Wr. Wb.; Sadhu, Sadhu, Sadhu; Shalom

Denpasar, August 30th, 2019
Chair,

I Gede Aris Gunadi

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The Effect of Digital Literacy on the Ability of Teachers to Develop HOTS-based Assessment

The Effect of Digital Literacy on the Ability of Teachers to Develop HOTS-based Assessment

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Abstract. Digital literacy and the ability to develop HOTS-based assessment are important competencies for teachers in industrial revolution 4.0. The purpose of this research is to determine the effect of digital literacy on the ability of teachers to develop HOTS-based assessment. This study is survey research. The population is senior high school and vocational high school mathematics teachers in Bali, West Nusa Tenggara, and East Nusa Tenggara provinces. Multistage random sampling technique is applied. The data is collected by using a questionnaire. It is analysed by using simple regression analysis methods. Data processing is carried out by using the SPSS 23.0 program with a significance level of alpha = 0.05. The results of data analysis show a value of F = 60.594 with a significance value 0.000 which means that digital literacy has a significant effect on the ability of teachers to develop HOTS-based assessment. The magnitude of the digital literacy influence on the ability of teachers to develop HOTS-based assessment is 13.2%. Thus, the ability of teachers to develop HOTS-based assessment can be influenced by other factors of 86.8%. The recommendation proposed is that further research is needed to reveal other variables that contribute on the ability of teachers to develop HOTS-based assessment.

Keyword: digital literacy, ability, HOTS-based assessment, competencies

1. Introduction

The industrial revolution 4.0 has brought various changes in many aspects of human life. The advancement of information technology has significantly impacted human life. This phenomenon can be obviously seen through some life simplicity: complicated calculations have become easy and complex jobs can be completed quickly. Information technology overcomes the limits of space and time, making it easier for human life. In this era, job opportunities have appeared to be unpredictable. Many new business opportunities are very promising in accordance with the development of technology. This phenomenon requires high creativity and innovation in order to adjust and be able to go with the flow of change. Advances in technology bring changes in human activities that are usually done in the real world by manually changing to cyberspace[1].

On the other hand, a number of negative impacts have emerged. Human labour has been partially replaced by machines, making many people lose their jobs. Uncertain situations due to highly dynamic changes require the ability to think critically to solve problems in the real world. Many established businesses have been uprooted and replaced by automation and digitisation systems. Humans need adequate digital literacy skills so they can keep up with changes and dynamics that prominently relate

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to technology[2]. Collaboration becomes an important element to build networks in problem solving. The collaboration built aims to improve connectivity among the fields of science[3]. Problems in the medical world can be solved with the help of computerised systems and advanced IT technology. In addition, work in agriculture can be facilitated with the help of technology-based machines. Another ability that is no less important is the ability to communicate. Communication in a broad sense means being able to use various social media in the form of newspapers, magazines, radio, television, films, and various smartphone applications (Whatsapp, Line, Facebook, Twitter, and many more) facilitated by the internet to convey information to humans in any human life hemisphere[4].

Based on the argumentation above, there are 4 competencies needed in the industrial revolution 4.0, namely critical thinking and problem solving, creativity and innovation, collaboration, and communication. Critical thinking and problem solving reflect the ability to identify, analyse, and evaluate situations, ideas, and information to convey responses and solutions. Creativity and innovation relates to the ability to imagine and design innovative new ways to solve problems, answer questions and express meanings through application, and adapt to the objectives of acquiring diverse knowledge. Collaboration is the ability to work in teams to achieve common goals and improve connectivity in various fields of science including the ability to prevent and manage conflicts. Communication is the ability to communicate widely using various media to convey information to humans wherever they are.

Digital literacy is the ability to use and create technology-based content, including finding and sharing information, answering questions, and interacting with others and computer programming. Digital literacy will create a social order with critical and creative mindset so that people are not easily provoked by false issues, hoax, and digital-based fraud[2]. Being a digital literate means being able to process various information in the form of messages and communicate effectively with others in various forms, and understand when and how technology must be used so that it is effective in achieving the intended goals. This includes awareness and critical thinking in the various positive and negative impacts that may occur due to the use of technology in everyday life. Digital technology allows people to interact and communicate with family and friends without any time and distance boundaries. Unfortunately, today's cyberspace is increasingly filled with content that contains false news, expressions of hatred, and radicalism, even fraudulent practices. The existence of negative content that destroys the digital ecosystem at this time can only be resisted by building awareness of each individual[5].

Digital literacy deals with how technology is utilised in a wide variety of challenges and opportunities in various aspects of life. Within the limited scope of the use of ICT in the work environment of high school and vocational school teachers, digital literacy can be interpreted as the use of technology in education[6]. The most essential basic skills of teachers in digital literacy are: (1) operating Microsoft Office software, such as Word, Excel and Powerpoint applications, (2) using internet services and applications, (3) choosing digital learning resource media, and (4) utilising ICT-based learning media in learning and assessment. Thus, digital literacy should be utilised to facilitate teacher tasks such as the operation of learning and assessment software and the use of the internet[7].

There are 8 essential elements for developing digital literacy stated as follows. (1) culture related to understanding the various contexts of users of the digital world; (2) cognitive about thinking power in assessing content; (3) construction, namely the ability to create copyrights; (4) communication, namely understanding network and communication performance in the digital world; (5) responsible confidence; (6) creativity in doing new things in new ways; (7) critical thinking in responding to content; and (8) social responsibility[6].

Regarding the elaboration above, it can be concluded that digital literacy is knowledge and skills in using digital media, communication tools, or networks to find, evaluate, use, create information, and use them in a healthy, wise, intelligent, accurate, precise, and law-abiding manner in order to foster

communication and interaction in everyday life. Digital literacy is one of the competencies that must be possessed by high school and vocational mathematics teachers in the development of learning and assessment in the classroom. Digital literacy can improve teacher skills in the preparation of assessment instruments in accordance with the 21st century life skills demands.

HOTS-based assessment is an assessment that serves to measure the ability to think at a higher cognitive level, namely the ability to think that is not merely to remember (recall), restate, or refer without doing processing (recite). HOTS-based assessment in the context of assessment measures the ability of: 1) transferring one concept to another, 2) processing and applying information, 3) looking for links from different information, 4) using information to solve problems, and 5) analysing ideas and information critically. However, HOTS-based questions do not mean that these questions are more difficult than recalling[8].

The characteristics of the HOTS-based assessment can be detailed and explained as follows[9].

1) Measure higher order thinking skills
   High order thinking skills include the abilities that are closely linked to problem solving, critical thinking, creative thinking, reasoning, and decision making. To solve HOTS-based problems, high creativity and innovation are needed. Creativity that is used to solve HOTS-based problems consists of: (a) ability to solve unfamiliar problems, (b) ability to evaluate the strategies used to solve problems from a variety of different perspectives, (c) new settlement models that are different from previous ways[10].

   Higher order thinking skills can be trained in the learning process in the classroom. Therefore, the learning process should provide some space for students to acquire activity-based knowledge. Activities in learning must be able to encourage students to build creativity and critical thinking.

2) Contextual and Trending Topic-Based Problems
   HOTS-based assessment is an assessment based on real situations in everyday life in which students are expected to apply learning concepts in class to solve problems. Contextual problems faced by the world community today are related to the environment, health, earth and space, social life, cultural penetration, and the use of science and technology in various aspects of life. The contextualisation of the problem in the assessment evokes a critical and caring attitude towards the environment[3].

   To create a good stimulus so that information, topics, discourse, situations, news or other forms of information are chosen (trending topic), it is highly recommended to raise issues that are close to where students are located or to be based on emerging global problems. Questions with less attractive stimuli are not able to show the ability of students to relate the information presented in the stimuli or use information to solve problems using critical thinking logic.

3) Not Routine and Carrying Novelty
   One of the goals of HOTS-based assessment is to build students' creativity in solving various contextual problems. Creative attitude is closely related to innovative concepts that bring newness. HOTS-based assessment cannot be tested repeatedly on the same test takers. If an item that is originally a HOTS-based problem is tested repeatedly on the same test taker, the student's thinking process becomes memorising or recalling-based. Students only need to remember ways that have been done before. In this case, higher order thinking process does not occur. These questions can no longer encourage test participants to be creative in finding new solutions. In fact, the question is no longer able to explore the original ideas possessed by test takers to solve the problem[11].

The steps for constructing the HOTS-based assessment can be described as in the following flowchart[12].

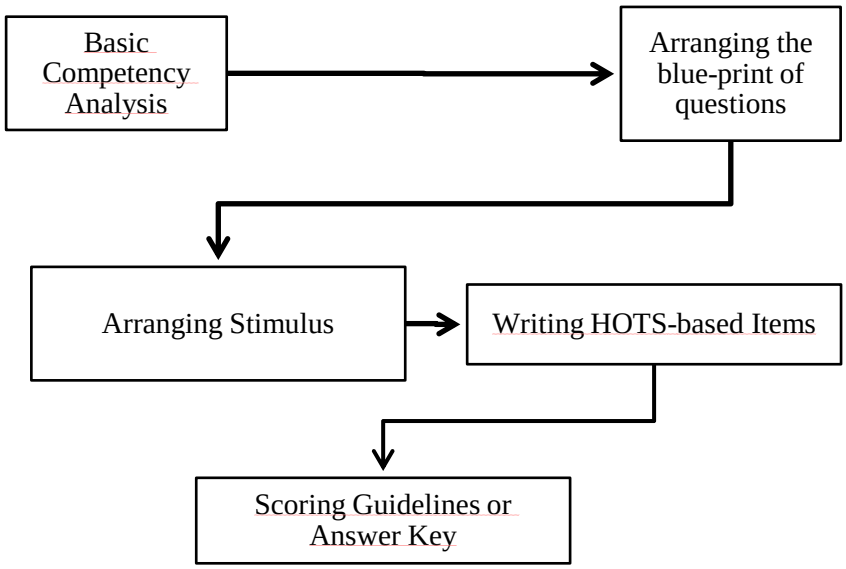

Figure 1. HOTS-based Assessment Development Flowchart

Explanation

a. Analyse Basic Competency (BC) that can be used in the HOTS-based assessment
   Initially, the teachers identify and choose the BC that can be made as the basis of HOTS-based assessment. Not all BCs can be transformed into HOTS-based models. Choose a BC that includes the cognitive level in the realm of C4, C5, or C6[13]. Teachers can conduct an analysis of BCs that can be used as the basis of HOTS assessment independently or collaboratively.
b. Arranging the blue-print of questions
   The HOTS assessment writing grid aims to help teachers write HOTS-based assessment. These grids are needed to guide the teacher in: (a) determining the minimum ability shown in BCs that can be used as the basis of HOTS-based assessment, (b) choosing the subject matter related to the BC to be tested, (c) formulating the problem indicators, and (d) determining the cognitive level. The following is an example of the HOTS-based assessment blueprint[14].

Tabel 1. Blueprint of HOTS-based Assessment

Subjects : Mathematics
Class/Semester : .....

No.	Basic Competency	Subject Matter	Indicator of Items	Cognitive Level	Forms of Items	No. Items

c. Formulate an interesting stimulus and context
The stimulus used must be interesting and has never been read by students. It can also be any current issues that are being raised. Whereas, contextual stimulus means stimulus that is in accordance with reality in daily life. Some factors that need to be considered to arrange stimulus about HOTS are stated as follows. (1) Test designers should choose some information which can be in the form of pictures, graphs, tables, discourse, and other media that have a connection with the case presented in the question; (2) stimulus should demand the ability to interpret, search for relationships, analyse, conclude, or create; (3) Test designers should choose contextual and interesting cases or problems; and (4) The stimulus should directly be related to questions (subject matter).

d. Write question items according to the blueprint
The items are written according to the HOTS-based assessment construction rules. The rules for writing HOTS-based assessment are basically almost the same as the rules for writing items in general. The difference lies in the material aspects (must be adjusted to the characteristics of the HOTS-based problem stated above), while the aspects of construction and language are relatively similar. Each item is written on a question card.

Table 2. Card Items
(Multiple Choice)

Subject	: .....
Class/Semester	: .....
Basic Competency	: .....
Subject Matter	: .....
Indicator Item	: .....
Cognitive level	: .....
Item	: .....

Key: .....

Theoretically, digital literacy affects the ability of teachers to compile HOTS-based assessment. In accordance with the characteristics of the HOTS-based problem, HOTS-based assessment generally contains stimulus based on contextual and interesting issues. To get contextual information or specific cases related to the topic to be tested, teachers can download it via the internet. Various texts, pictures, graphs, and tables can be easily obtained through the internet. If the teacher is capable of utilising the internet media, the teacher will have no difficulty writing the stimulus so that the questions written are of higher quality. The ability to download information from various sources both via the internet or other social media is part of digital literacy. So far, teachers find it difficult to construct HOTS-based assessment because of their inability to get the information needed through various ICT-based sources. Thus, digital literacy is absolutely necessary when teachers deals with the construction process of HOTS-based assessment[9].

The ability of high school and vocational mathematics teachers to write HOTS-based assessment also requires good mastery of HOTS-based assessment concepts. Teachers can get theories about HOTS-based assessment through various sources including digital-based media[15]. Through digital media, teachers can explore extensively to obtain HOTS-based assessment concepts so that the teacher's knowledge is getting richer. If the teacher does not have sufficient digital literacy skills, it is very likely that the teacher will have difficulty developing HOTS-based assessment. Therefore, good digital literacy skills can improve teachers' ability to write HOTS-based assessment.

2. Research Methods

This research is a quantitative type of exposure study that is research that does not provide specific treatment to the sample. The study population was all high school and vocational high school mathematics teachers in the provinces of Bali, West Nusa Tenggara and East Nusa Tenggara. The sample selection method uses multistage random sampling. In the first stage, selected districts and cities in each province are treated as a sample. In the second stage, the selection of samples in the form of schools (high schools and vocational high schools) is randomly selected from districts and cities that have been selected as a sample. All mathematics teachers at selected schools are treated as research sample. Based on these steps, 400 high school and vocational high school mathematics teachers in the 3 provinces are selected. All high school and vocational high school mathematics teachers are spread in 64 schools in Bali province, 18 schools in West Nusa Tenggara province, and 18 schools in East Nusa Tenggara province. Research data is collected by using a questionnaire given to the sample. The data obtained is subsequently analysed by using simple regression technique through the use of the SPSS 23.0 for Windows program with a significance of alpha = 0.05.

3. Results and Discussion

The results of data analysis using the SPSS 23.0 for Windows Program are presented as follows.

Table 3. Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.363[a]	.132	.130	3.37844

a. Predictors: (Constant), X2
b. Dependent Variable: X1

In Table 3. The Summary[b] Model above states that the magnitude of the coefficient of determination R Square = 0.132 which means that digital literacy has an influence on the teacher's ability to compile HOTS-based assessment by 13.2%. While 86.2% of the ability of high school and vocational high school mathematics teachers to compile HOTS assessment is influenced by other factors.

Table 4. Coefficients[a]

Model		Unstandardised Coefficients		Standardised Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	34.917	1.521		22.953	.000
	X	.194	.025	.363	7.784	.000

a. Dependent Variable: Y

In Table 4., coefficients depict that the value of Constant B = 34.917 and coefficient X (digital literacy) = 0.194 with significance alpha = 0.000 (significant) which means that the regression equation obtained can be used to describe the effect of digital literacy on the ability of teachers to arrange HOTS-based assessment. Thus, the regression equation is Y = 34.917 + 0.194X + e (not standardised) or Y = 0.363X (after standardisation).

Tabel 5. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	691.607	1	691.607	60.594	.000[b]
	Residual	4542.703	398	11.414		
	Total	5234.310	399			

a. Dependent Variable: X1
b. Predictors: (Constant), X2

Table 5. ANOVA[a] shows the value of F = 60.594 with a value of sig. = 0.000 which means that the effect of digital literacy on the teacher's ability to compile HOTS-based assessment is significant.

The results of data analysis show the value of F = 60.594 with a value of sig. = 0.000 which means that digital literacy has a significant effect on the ability of teachers to prepare HOTS-based assessment even though the effect is quite small. The magnitude of the effect of digital literacy on the ability of teachers to compile HOTS-based assessment is only 13.2%. Digital literacy indicators that affect the ability of teachers to develop HOTS-based assessment include: (1) the level of teacher skills using digital media and the internet, this is closely related to the teacher's ability to compile or find contextual and interesting stimuli that can generally be obtained through social media and internet; (2) the amount and variety of digital-based reading materials and teaching aids accessed by teachers, the skills to use digital-based reading materials and teaching aids are one indicator of the extent to which digital literacy mastery is owned by teachers; (3) school policies regarding the use and utilization of information and communication technology, for example policies in schools related to learning and assessment such as the use of digital-based learning media, e-report, delivery of information or web-based announcements, etc., indicate the extent to which school residents master digital literacy including teachers. These policies can be used as indicators of the digital literacy capabilities of teachers and school citizens in general.

Thus, the ability of teachers to compile HOTS-based assessment can be influenced by other factors by 86.8%. Digital literacy is one of the factors that influences the ability of high school and vocational high school mathematics teachers to compile HOTS-based assessment. Adequate digital literacy skills can make it easier for teachers to get knowledge about the concept HOTS-based assessment. At present, there are still many high school and vocational teachers who have not mastered ICT well. This is one of the reasons teachers have not been productive in preparing HOTS-based assessment.

Based on empirical facts in the field, other factors that are thought to influence the ability of teachers to develop HOTS-based assessment include motivation and understanding of concepts about HOTS questions. When the teacher does not have the motivation to practice develop HOTS-based assessment, it is unlikely that the teacher can develop HOTS-based assessment, and conversely teachers who have high enthusiasm and motivation have a great chance of better HOTS-based assessment skills. Understanding the concept of HOTS-based assessment is a must for teachers before starting to learn to prepare HOTS-based assessment. Without adequate knowledge and understanding of concepts, teachers will find it difficult to distinguish between compiled questions whether HOTS is included or not. It will even be difficult to start writing because the characteristics of the HOTS problem are not clearly understood.

Theoretically, the factors thought to have contributed to the ability of teachers to develop HOTS-based assessment include style of thinking and creativity. Divergent thinking style is a lateral thinking style, not linear, not routine, a way of thinking to solve problems in ways that are not structured and not common. Considering the characteristics of HOTS-based assessment are non-routine questions, the teacher's divergent thinking style is one of the important factors teachers have in order to arrange HOTS questions well. Divergent (lateral) and even radians' thinking styles affect a person's innovation and creativity including the teacher's creativity to be able to develop HOTS-based assessment.

Therefore the teacher's style of thinking and creativity must be developed first, so that the teachers are able to develop HOTS-based assessment better.

4. Conclusion

One of the characteristics of the HOTS-based problem is that it is contextual and attractive. To get contextual stimuli, teachers need to get information from the internet or other social media. Information that can be accessed if the teacher has adequate digital literacy skills. Naturally, the results of the study point out that the digital literacy factor has become one of the variables that significantly affects the ability of teachers to develop HOTS-based assessment. Without mastering digital literacy properly, teachers will have difficulty developing HOTS-based assessment. It is expected that teachers have good digital literacy skills. Eventually, it is hoped that teachers are more productive in developing HOTS-based assessment.

Digital literacy skill is not the only factor influencing the ability of teachers to develop HOTS-based assessment. The ability of high school and vocational high school mathematics teachers to develop HOTS-based assessments is also influenced by other factors not examined in this research. Therefore, this research needs to be developed by other researchers to uncover the other variables that contribute to the teacher's ability to prepare HOTS-based assessments.

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