Analysis of STEM Ability and Digital Literacy of Students for Development of STEM-Based Digital Assessment Applications for Prospective Digitally Capable Teachers

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Abstract. The concept of independent learning curriculum education integrates literacy skills, knowledge skills, and technology mastery skills and attitudes. The STEM approach is used to strengthen the implementation of the Independent Learning Curriculum. This study aims to describe the STEM ability and digital literacy of students as users of digital assessments, and the results of the analysis become the basis for the development of STEM-based digital assessments. The research method is descriptive quantitative, data collection using a questionnaire instrument to describe STEM abilities and digital literacy. The sample of this research is the fourth-semester students of the Elementary School Teacher Education Study Program, Universitas Muria Kudus. The study found that in students' STEM abilities, Technology occupies the first level with a percentage of 79.79%, then Engineering at 76.88%, Mathematics at 76.77%, and the lowest is Science with a percentage of 75.78%, all of which are included in the good category. Meanwhile, students' digital literacy skills were in the Very Good category in the aspect of internet searching at 87.03%, content evaluation at 82.97%, knowledge assembly at 83.65%, and the Good category in the aspect of hypertextual navigation at 80.31%. To realize students as prospective teachers who are digitally capable and to implement an independent curriculum, the STEM-based Digital Assessment is suitable to be developed.

Keywords: STEM ability, Digital literacy, Digital assessment.

1 Introduction

Education always strives to produce students in making updates at any time, they not only can pursue higher education but also can become agents of change in small and large scopes. The resulting change and innovation efforts can contribute to the maximum progress of the nation by having quality human resources. So that universities are expected to be able to innovate in every learning process, namely with student-centered learning that supports the achievement of quality graduates to be ready to face the changing times [1]. In the current era of digitalization, technological developments affect the quality of education. Where in every activity carried out both teachers and students cannot be separated from digital-based devices [2]. As a generation

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that has been introduced to the internet, a student must have a different mindset from the previous generation and have a very active character in using digital technology and have skills in operating internet-based technology [3].

To prepare Indonesian students to acquire 21st-century skills, namely the skills of thinking through critical thinking, creativity, the ability to solve problems and make decisions as well as how to work together through collaboration and communication, the STEM approach is used to strengthen the implementation of the Independent Learning Curriculum [4]. STEM is an abbreviation of a learning approach, namely science, technology, engineering, and mathematics, which focuses on solving problems in real everyday life. So with the STEM-based assessment, it can help students solve problems, so students are educated to think creatively, and analytically and focus on solutions [5]. STEM provides instructions for students about concepts and principles in science, technology, engineering, and mathematics (STEM) that are used in an integrated manner to develop systems, processes, and products that can be utilized in human life [6] [7].

One of the policies of the Minister of Education and Culture is the Merdeka Campus, which provides a policy for universities for students to exercise freedom of learning for three semesters outside of the study program. So that there are campuses that independently create new concepts by providing freedom for students to study at the college level [8] [9] [10]. The concept of independent learning curriculum education integrates literacy skills, knowledge skills, skills, and attitudes as well as mastery of technology. The freedom applied in the 21st-century concept will provide opportunities for students to explore as much knowledge as possible. One of the things that can be done is through literacy activities, developing talents through skills and positive things that support the development of each student [2].

The six basic literacies consist of literacy, science, numeracy, digital, financial, and cultural and civic literacy. Due to the rapid progress of Information and Communication Technology (ICT), digital literacy, information, and technology skills are as important as other general abilities [11] [12] [13]. Digital Literacy is very necessary for the ability to understand and use information in various formats so that it is not wrong to receive various kinds of information, and Digital Literacy it can also provide several advantages in the learning and teaching process in lectures [14].

According to Kern in Firmansyah [15] literacy is important for students in carrying out learning in Higher Education with the following characteristics: a. Responding, Students responding to the assignments given by the lecturer, and the materials they get to focus on the learning process. b. Revision, Students evaluate and process assignments that have been prepared to achieve maximum results, and c. Reflecting, After evaluating, students can make readers understand the information contained in the assignments they are doing [16]. The process or activity that systematically and continuously collects information from the process and student learning outcomes and makes decisions based on certain criteria and considerations is called an assessment [17] [18]. Assessment is a general term that is also defined as a process carried out to obtain information to make student decisions in education, both about programs, curriculum, and policies [19] [20].

Paul Gilster in Nasrullah in Ade Dwi Nurrizqi [21] states that a person needs to have competence, which is contained in four classifications of digital literacy skills, namely: internet

searching, Hypertextual Navigation, Content Evaluation, and Knowledge Assembly. For each, the competencies can be explained as follows.

Internet searching is the ability possessed by a person in using the internet and carrying out various activities on the internet. Several components in this competency area. Ability to use search engines to find information on the internet; and B. The ability to perform various activities in it.

Hypertextual navigation; is the skill of reading hypertext navigation and understanding it through a web browser. This competency has four components of knowledge about: a. hypertext procedures; b. hyperlink procedures; c. web procedures; and d. able to understand the characteristics of web pages.

Content evaluation; is the ability possessed by a person in critical think and assess something found online, accompanied by the ability to identify the validity and completeness of information as referred to by hypertext links. This competency has five components: distinguishing between display and information content, with the user's perception of understanding the web page that is opened; analyzing background information on the internet, finding out more about the source and conscious creator; and analyzing the pages on the web that are opened.

Knowledge assembly; is the ability to organize knowledge, and form information obtained from various sources by collecting and evaluating facts and opinions properly and without prejudice. This competency includes three components, namely: a. Ability to analyze background from various information obtained, b. Ability to crosscheck from various information obtained, c. Ability to compile various sources of information obtained from the internet.

Based on observations in learning the educational assessment course, it was found that students still experience confusion in making assessments for students, both formative, summative, and diagnostic. Because the challenge itself as a prospective teacher must be able to assess learning. The existence of a new curriculum independent that is applied to learning in elementary schools also supports the development of STEM-based digital assessments for prospective digitally skilled teachers. Due to increasingly advanced technology, the assessment that will be developed is online, so it can be arranged in such a way that the work can be done anywhere and anytime according to the settings applied.

Independent Campus is the most effective strategy to gain knowledge freely to forge a future that is in line with students' career aspirations. Human Resources that are qualified and able to be competitive will greatly determine the progress of a nation or country. Students must be able to manage and utilize data and information properly because currently access to obtain data and information is very easy. Students must be able to find quality sources of data and information and be able to manage/select them so that they can be used to solve problems and needs in the community. So the purpose of this study is to analyze the STEM capabilities and digital literacy possessed by students as prospective teachers who are digitally capable of implementing an independent curriculum because the MBKM program is a program that has an information technology backbone that provides great hope for the Indonesian nation and state to prepare a productive workforce. quality with the latest knowledge so that they can compete both regionally and globally.

2 Methods

This research method is descriptive quantitative, which focuses more on the occurrence of the symptoms or events studied, and no special treatment is given. Researchers can identify anything, however, and the reasons why a symptom or event can occur, which can be taken from the results of the descriptive data obtained. The research steps in this method begin with formulating problems from various backgrounds, determining what types of information or reference sources are needed in research, collecting research data, processing data obtained from the research, and concluding research results [22].

The data collection instrument used in this study was a questionnaire with students as respondents, with a closed questionnaire type, in which respondents could not give answers freely because the answers that could be selected were already available in the questionnaire. The questionnaire was arranged in the form of a checklist consisting of several question items according to the indicators used according to the research objectives, namely to determine the data analysis of STEM abilities and digital literacy skills. Respondents can choose one answer from each question item, with the criteria that have been used. The criteria for the results of this questionnaire use a Likert scale (1-5) which is not good to very good.

Sampling in this study was obtained through a cluster random sampling technique, based on the courses taken this semester, namely the "Educational Assessment" course. The sample of this study was the fourth-semester students of the Elementary School Teacher Education study program Universitas Muria Kudus which was carried out in June 2022. The data analysis technique in this study was carried out quantitatively based on the calculation of the results of the questionnaire data that had been filled out by the respondents.

Table 1. Questionnaire Value Category

No	Category	Value (%)
1	Very Good	81 - 100
2	Good	61 – 80
3	Fairly Good	41 – 60
4	Poor	21 – 40
5	Not Good	1 – 20

Quantitative analysis of questionnaire data begins with determining the total score for each indicator given by the respondent, then calculating the highest score for each indicator. The next step is to determine the percentage of each indicator. The formula for calculating indicators is as follows:

$$Percentage\ Score = \frac{Total\ Score}{Highest\ Score} x100\%$$

Then data processing is carried out to generate percentage values and analyze them using categories which can be seen in table 1.

3 Results and Discussion

The results obtained by the formulation of the research problem described earlier are to describe students' STEM abilities and digital literacy as initial data for the development of STEM-based digital assessments. 21st-century education framework, referring to Trilling and Fadel [23] in their book entitled 21st Century Skills: Learning for Life in Our Times, there are several competencies and/or skills that must be possessed by 21st-century human resources. 21st-Century Skills emphasize students' ability to find out from various sources, formulate problems, think analytically, and collaborate in problem-solving, with three skills namely Learning and Innovation Skills; Information, Media, and Technology Skills; and Life and Career Skills. So that each lesson can integrate 21st-century skills in STEM (Science, Technology, Engineering, and Mathematics) [24]. the rubrics of STEM ability students can be seen in table 2.

Table 2. The rubric of the questionnaire in this research, with indicators STEM.

No.	Variable STEM	Statement
1	Science	I am able to know scientifically and process the understanding of the nature and world
2		I participate in making decisions to influence scientific knowledge and processes.
3	Technology	I am able to know how to use new technology
4		I am able to see how new technology can be developed.
5		I am able to analyze new technologies that can have an impact on individuals, communities, countries, and the world.
6	Engineering	I am able to know how technology can be developed through the engineering/design process
7		I am able to know the engineering/design process using project-based lesson themes by integrating several different subjects (interdisciplinary) through technology
8	Mathematics	I am able to analyze reasoning and communicate ideas effectively in math problems in different situations.
9		I am able to solve problems mathematically by formulating and interpreting solutions in a variety of different situations.
10		I apply knowledge to solve real-world problems.

The Results of the percentage of STEM ability students from the highest to the lowest can be seen in table 3.

Table 3. The Results of the percentage of STEM ability students

No	Aspect	Percentage (%)
1	Technology	79.79
2	Engineering	76.88
3	Mathematics	76.77
4	Science	75.78

The developed STEM-based digital assessment will be able to bring students to be more digitally proficient and can be implemented in learning activities in the independent curriculum. At this stage, an analysis of the STEM abilities possessed by students is carried out, the results are shown in Figure 1.

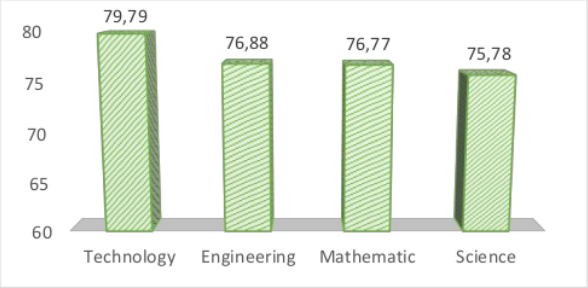

Fig 1. Student STEM ability results

From the data processing shown in Figure 1, it can be obtained that the four STEM abilities, Technology occupies the first level with a percentage of 79.79%, then Engineering with 76.88%, Mathematics with 76.77%, and the lowest is Science with percentage of 75.78%. From the results of the student's STEM ability, it can be seen that the student's ability belongs to the good category, for it is necessary to increase the student's STEM ability to get very good. Nevertheless, students are considered to be ready to face the era of the industrial revolution 4.0 and towards the revolution of society 5.0. This is appropriate and suitable if the development of a STEM-based digital assessment will be carried out, STEM here is the basis for the development of a STEM-based digital assessment. According to Ifa and Saeful [25]. The use of the STEM approach in the field of education has the aim of preparing students to be competitive and ready to work according to the field they are engaged. STEM provides educators with the opportunity to show students that STEM concepts, principles, and techniques are used in an integrated manner in the development of products, processes, and systems used in everyday life [26].

The research from Dazhi Yang, and Sally J. Baldwin [27], states that there are four strategies in using technology that supports learning in integrated STEM learning, namely: the existence of an authentic learning context, the existence of a web-based inquiry environment, the expansion of learning through interactive technology, and the ability to transform students from consumers to creators. This research provides practical implications and research directions for technology-supported learning in integrated STEM learning. So that by knowing the STEM abilities of students, it can have an impact that the use of technology in integrated STEM learning environments with a digital assessment development plan can be implemented, because with this ability students can expand effective teaching and learning beyond what is possible with a traditional teaching and learning approach.

The results of data acquisition of students' digital literacy skills of fourth-semester PGSD students at Universitas Muria Kudus, there are 4 indicators of digital literacy skills presented, namely: 1) internet searching, 2) hypertextual navigation, 3) content evaluation, and 4)

knowledge assembly. The rubric of the questionnaire on digital literacy skills can be seen in table 3.

Table 3. The rubric of quetionare in this research, with indicators of literacy digital skills.

No	Aspect	Statement
1	Internet searching	get information by operating digital media.
2		select and sort various information from various accessible sources
3		select and sort various information that is considered useful for digital media users.
4		understand pre-selected information.
5	knowledge assembly	analyze by looking at the pluses and minuses of previously understood information.
6		cross-confirm with similar information
7		consider risk mitigation before distributing the information by considering how it is used
8		consider risk mitigation before distributing information by considering the platform to be used
9		share information considering who will access the information.
10		compile new information that is accurate, clear, and ethical
11	content evaluation	play an active role in sharing good and ethical information through social media and other online communication activities.
12		initiate and distribute honest, accurate, and ethical information in collaboration with other stakeholders.
13		know about the digital landscape – internet and cyberspace, and various digital applications
14		know about the values of Pancasila and Bhinneka Tunggal Ika which are the foundations of digital skills in cultural, national, and state life.
15	hypertextual navigation	Interact, participate, and collaborate in the digital space by the rules of digital ethics and applicable regulations
16		know the digital track record in the media (download and upload)
17		protect my digital identity and personal data on digital platforms
18		detect digital fraud
19		encourage the behavior of loving domestic products and other productive activities.
20		analyze information that contains hoaxes, hate speech, pornography, bullying, and negative content

Each indicator is then put into one of five categories, namely very good with a score (of 81-100)%, good with a value (of 61-80)%, quite good with a value (of 41-60)%, not good with a score (21 -40)%, and not good with a value of (0-20)%. The results of digital literacy skills can be seen in Figure 2.

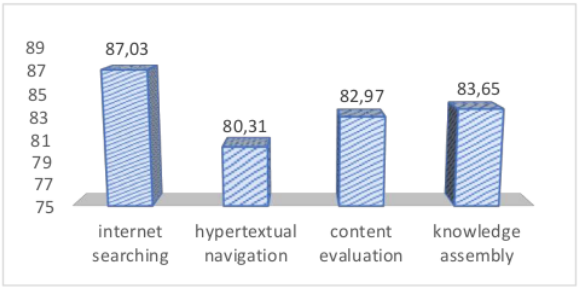

Fig 2. Results of student's digital literacy skills

From the data in Figure 2, According to the data, it can be explained that the four indicators, internet searching 87.03%, content evaluation 82.97%, and knowledge assembly 83.65% are in the very good category, while hypertextual navigation, gets a score in the good category, with a value of 80.31 %. The Results of the percentage of digital literacy skills student's from the highest to the lowest can be seen in table 2.

This can be interpreted that students' digital literacy skills are classified as good and very good, so in the development of STEM-based digital assessments, it is very appropriate if given to PGSD students at Muria Kudus University, by the opinion of Ade Dwi Nurrizqi [21] who says that the application of digital literacy is an activity that has a positive value for improving education. Due to the excellent value of digital literacy students' abilities, a student must master the media in tracing information so as not to stutter in technology. Digitally literate students will find it easy to use and utilize digital devices that support the search for information, and it will also be easier to determine a reliable website to obtain information because they understand the characteristics of a website. Digital literacy is the ability to process various information, understand messages, and communicate effectively with others in various forms. In this research, digital literacy means being able to understand when and how technology must be used to be effective in achieving goals.

Table 2. Results of the percentage of digital literacy skills students

No	Aspect	Percentage (%)
1	Internet searching	87.03
2	knowledge assembly	83.65
3	content evaluation	82.97
4	hypertextual navigation	80.31

In the independent curriculum driving school module, Setyawan & Masduki [28], states that there are 5 principles in assessment, namely: 1) Assessment is an integrated part of the learning process, facilitates learning, and provides information as feedback for teachers, students, and parents. 2) Assessment needs to be designed and carried out by the objectives. 3) Assessments are designed in a fair, valid, and reliable manner, providing rich information for teachers,

students, and parents about learning progress and achievements, as well as decisions about the next steps. 4) Assessment should include various forms of tasks, instruments, and techniques that are by the targeted learning objectives. 5) Reports of learning progress and student achievement are simple and informative, providing useful information for students and parents, and useful data for guaranteeing and improving the quality of learning.

The developed STEM-based digital assessment is defined as STEM literacy according to each aspect of the four disciplines, including 1) Science: in the form of knowledge about assessment. 2) Technology: new technology that will be developed in the form of digitalization or online in making and working on assessments. 3) Engineering: This aspect in STEM-based digital assessments is developed in the form of various forms of assessment that can be made by students for different subjects and later adapted to the independent curriculum. 4) Mathematical: this will be realized by providing scores along with scoring guidelines in making digital assessments that will be carried out by students. This is by states that assessment is a process of selecting, collecting, and interpreting information to make decisions or provide an assessment of a product or program, or knowing about the success of the chosen approach in solving problems to achieve perfect goals [29] [30] [31].

4 Conclusion

Based on the results and discussion, it can be concluded that the student's STEM abilities, Technology ranks first with a percentage of 79.79%, then Engineering with 76.88%, Mathematics with 76.77%, and the lowest is Science with a percentage of 75, 78%. Meanwhile, digital literacy skills are in the Very Good category in the aspect of internet searching 87.03%, content evaluation 82.97%, and knowledge assembly 83.65%, and in the Good category in the aspect of hypertextual navigation with a value of 80.31%. So that the fourth-semester students of the Elementary School Teacher Education study program are declared to have STEM abilities in a good category in all aspects, and digital literacy skills have a very good category in three aspects, and a good category in only one aspect. The analysis of these results serves as a reference in realizing students as prospective teachers who are digitally capable and to implement an independent curriculum, the development of a STEM-based Digital Assessment is suitable to be applied to students of the Elementary School Teacher Education study program.

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