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OPTIMIZATION OF DIGITAL LITERACY THROUGH STEM-BASED LEARNING

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Abstract

The purpose of this study is to analyze and describe students' digital literacy skills in STEM-based vector algebra courses using online learning. The participants in this study came from 30 students of the mathematics education study program at the Universitas Muhammadiyah Tangerang. The research method used is descriptive qualitative, with an instrument in the form of a digital literacy questionnaire using a likert scale. The results showed that the ability to do internet searching indicators got a score of 77.50 with high criteria, the ability to use hypertext direction guides got a score of 77.50 with high criteria, the ability to evaluate information content got a score of 78.50 with high criteria, and the ability to compile knowledge got a score of 74.50 with medium criteria. The results of the indicator's average analysis showed that student digital literacy has an overall average of indicators with a score of 76.87 with high criteria. This study recommends the use of digital devices and STEM approaches in the learning.

Keywords: digital literacy, STEM, vector algebra

Abstrak

Tujuan dari penelitian ini adalah untuk menganalisis dan mendeskripsikan kompetensi digital mahasiswa pada mata kuliah aljabar vektor berbasis STEM dengan menggunakan pembelajaran online. Partisipan dalam penelitian ini adalah mahasiswa Program Pendidikan Matematika Universitas Muhammadiyah Tangerang yang berjumlah 30 partisipan. Metode penelitian yang digunakan adalah deskriptif dan kualitatif dengan menggunakan instrumen berupa angket literasi digital dengan menggunakan skala likert. Hasil penelitian menunjukkan bahwa indikator kemampuan melakukan internet searching mendapat skor 77,50 dengan kriteria tinggi, kemampuan menggunakan panduan arah hypertext mendapat skor 77,50 dengan kriteria tinggi, kemampuan mengevaluasi isi informasi mendapat skor 78,50 dengan kriteria tinggi , dan kemampuan menyusun pengetahuan memperoleh skor 74,50 dengan kriteria sedang. Hasil analisis rata-rata indikator menunjukkan bahwa literasi digital siswa mempunyai rata-rata keseluruhan indikator dengan skor sebesar 76,87 dengan kriteria tinggi. Penelitian ini merekomendasikan penggunaan perangkat digital dan pendekatan STEM dalam proses pembelajaran

Kata kunci: literasi digital, STEM, aljabar vektor

INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) literacy or science and technology literacy is the ability to use scientific knowledge and its applications, identify problems, draw conclusions based on evidence, and understand nature and changes in nature as human activities in daily life and the decisions to respond to them (Huang et al., 2022; Wu et al., 2024). STEM literacy refers to: (1) an individual's knowledge, attitudes, and abilities to identify real-world questions and problems, describe the natural and designed world, and explain factual conclusions about STEM topics; (2) an individual's understanding of the characteristics of STEM fields as a form of knowledge, inquiry, and human design; and (3) a person's sensitivity to how STEM shapes the material, intellectual, and cultural structures of

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our environment, and (4) An individual's desire to engage with STEM topics and engage with science, technology, engineering, and mathematics ideas as a constructive, compassionate, and thoughtful citizen (Falloon et al., 2020). STEM is a new approach to developing the world of education that integrates multiple disciplines (Feng et al., 2020; Holden, 2020; Strimel et al., 2017).

STEM as a learning approach in its implementation is very appropriately integrated with reading culture. The STEM approach is which refers to the learning approach where natural sciences, technology, engineering, mathematics are combined in the learning process that orients problem solving in reality and in science (Pimthong & Williams, 2020). STEM are closely related disciplines. STEM-based digital literacy is crucial because it is closely related to the development of 21st century learning. STEM-based digital literacy is one of the potential alternative learning options that can be used to build 21st century skills (Nikou et al., 2022; Saetang et al., 2023). STEM based digital literacy can be packaged by empowering students' critical thinking skills. Learning with technological devices is part of efforts to improve students' digital literacy. Digital literacy is the set of skills a person has to use, process and communicate information received through different digital devices. Digital literacy includes computer hardware, software, the Internet and all digital devices such as mobile phones. The elements of digital literacy include computer skills, general knowledge, attitudes such as self-learning and social skills, the ability to understand digital and non-digital formats, the ability to create and communicate digital knowledge, evaluate information, create knowledge, etc. Acquire information and media skills (Dridi, 2023; Marty et al., 2013). Some of the studies relevant to the research carried out include the findings suggest that digital games are a promising pedagogical method in STEM education that effectively improves learning gains. Additionally, the study concludes with three recommendations for future research and practices on digital games in STEM education (Wang et al., 2022). Improving students' digital literacy and information technology skills is important, especially when implementing online virtual learning in classrooms. In this way, students can achieve better results in the learning process, even amid the COVID-19 pandemic (Fadillah et al., 2021). Every individual must have digital literacy skills, because almost all learning activities use digital media. The high level of digital literacy can indirectly affect the learning outcomes of students. So that slick digital literacy skills are needed, so that the use of information and communication technology in

the implementation of online learning can run according to the specified goals (Chittum et al., 2017; Jones & Procter, 2023; Vennix et al., 2018; Yan et al., 2023). Based on the description and assumptions above and from previous research, the purpose of this study is to obtain an overview of students' digital literacy in STEM based vector algebra learning.

METHODS

This type of research is a qualitative study that uses descriptive research methods. Qualitative research is a research method used to determine the meaning of things (Coleman et al., 2024; Weyant, 2022). The approach used in this study focuses on descriptive research of data analysis. The position of the researcher as the primary instrument is that of the data collector, the planner of the analysis, the implementer, the data interpreter and finally the researcher is the whistle-blower of the research findings (Roefs et al., 2024; Setiyani et al., 2022). The participants in this study were 2nd students majoring in mathematics education at the Universitas Muhammadiyah Tangerang with a total of 30 participants. The supporting instrument in this study is in the form of a questionnaire compiled based on digital literacy indicators (Hague & Payton, 2011) namely: Ability to do search on the internet (internet searching), Ability to use hypertext directional guide (hypertextual navigation), Ability to evaluate information content (content evaluation), and Ability to compile knowledge (knowledge assembly). The classification of questionnaire scores can be seen in table 1. The Likert scale is used to measure the attitudes, opinions and perceptions of a person or group of people about social phenomena (Jiří et al., 2021).

Table 1. Classification of Questionnaire Score Results

Questionnaire Score	Criteria
75 – 100	High
50 – 74,99	Medium
25- 49,99	Less
0 – 24,99	Low

RESULTS AND DISCUSSION

In this study, we will carry out teaching and learning activities on Vector Algebra. The learning activities will be carried out according to the designed lecture and event units. The applications used in the classes include Zoom Meeting, Google Meet, Microsoft Teams,

Google Classroom, etc (Crews & Parker, 2017). Afterwards, students receive learning materials and videos that match the content discussed. In the learning activities, students are given the opportunity to debate, express their opinions, discuss the content discussed, and ask questions about the content or issues they do not yet understand. Students are also given the opportunity to search for materials and information related to the content they are going to learn from various sources, both in books and online. In the next stage, students are given a digital literacy questionnaire. The focus of this study is to discuss and explain students' digital literacy in a STEM-based vector algebra course. The provided survey aims to investigate the digital literacy of students. The provided survey is a questionnaire with a Likert scale that contains negative and positive statements, with a total of 20 statements.

Based on the questionnaire given to the participants, it was found that the highest score for the aspect of students' digital skills during online learning activities of the Vector Algebra course, namely the skill indicator "Use of hypertext navigation aids" (Hypertext navigation) achieved a high standard of 83.00, while the lowest score for the skill indicator "Evaluation of information content" item "Can evaluate websites with an understanding of different domains" (Content evaluation) achieved a medium standard of 72.00.

The role of the internet is very large and dominant because participants make the internet a source of knowledge and information in vector algebra learning activities. This can be seen from the use of the internet by participants to find solutions and problem solving from the exercises or questions given, summarize or summarize the material, find information and information about vector algebra materials that will later be studied, look for terms in vector algebra, and deepen understanding of the explanation of the material presented by the teacher by looking for more information.

Based on the results of the questionnaire given to participants for the indicator of the Ability to do internet search (internet searching) it seems that they are used to even being proficient in using the internet to search the internet to find the information they need. Information searches with internet searching are carried out by participants in different ways. for the ability indicator using hypertext directional guide (hypertextual navigation), participants have known and understood hypertext which is marked with blue and sometimes underlined text. It is not seen that participants can distinguish plain text from text containing links or hypertext. For the Ability to evaluate information content (content evaluation)

indicators, the average participant can already filter which information they need or not. As for the Ability to compile knowledge (knowledge assembly) indicators, the average participant did not have difficulty in understanding the information contained on the internet and only a small part did not experience difficulties. This difficulty is because the information presented on the internet is often in the form of very long paragraphs that cause participants to feel uninterested in reading it. Participants with the highest, medium and lowest good digital literacy skills relatively gave answers that were not too different. This can be seen from participants with good literation on average still have difficulty in understanding the information presented on the internet. However, there were participants who did not have difficulty in understanding because they felt that the information presented on the internet was more concise so that it was easy to understand.

Aspects of STEM learning include: Science (science) provides knowledge to participants about the laws and concepts that apply in nature; Technology (technology) is a skill or a system that is used in regulating society, organization, knowledge or designing and using an artificial tool that can facilitate work; Engineering is the knowledge to operate or design a procedure to solve a problem; Mathematics (math) is a science that connects between magnitudes, numbers and spaces that only require logical arguments without or accompanied by empirical evidence. STEM learning emphasizes several aspects of the learning process, including: (1) Ask questions and determine the problem. (2) Develop and use models. (3) Planning and conducting surveys. (4) Analyze and interpret the data. (5) Use mathematics. Information and computer technology, and computational thinking, (6) Creation of explanations (science) and design of solutions (engineering). (7) Engage in evidence-based discussions. (8) Obtaining, evaluating, and transmitting information. The aspects of STEM learning are: Science equips students with knowledge of the laws and concepts prevailing in nature. Technology is a skill or system used to manage society, organization, knowledge, or to design and use artificial tools that can help students solve problems. Engineering is the knowledge of manipulating or designing processes to solve problems. Mathematics is a science that associates quantities, numbers, and spaces and requires only logical discussion without or with empirical evidence. Integrating STEM aspects (science, technology, engineering, mathematics) helps students solve problems in a more comprehensive way. Integrating all these aspects into the learning process makes knowledge more meaningful.

In this study, teaching and learning activities were carried out online. Students are given learning materials and videos that are in accordance with the material discussed. Students are given the opportunity to discuss, give opinions, submit arguments related to the material discussed or ask about material or problems that are not yet understood. And students are also given the opportunity to search for material from various sources both from books and online sources.

The stages of implementing STEM-based vector algebra learning carried out in this study are divided into 5 stages, namely: 1) Engagement (science): researchers inform and convey to participants to be interested in new concepts in linear transformation materials through the use of short activities to trigger curiosity. The activities carried out are connecting the initial knowledge with the learning experience that will be carried out by the participants. At this stage, participants are formed groups to carry out discussion activities about the material to be studied. 2) Exploration: at this stage the researcher gives participants the opportunity to conduct experiments to find new ideas or ideas and reveal the results of the experiments they have conducted. Indicators of building basic skills in the experimental class are found in the stages of engagement and exploration collecting information and conducting investigations to obtain information on the material forms and rules in linear transformation. Participants will gain new knowledge in digging for information properly. 3) Explanation (technology): at this stage the researcher provides an opportunity directly to convey the concepts of a deeper understanding helping to explain to the participants about the concepts that have been studied. At this stage participants were asked to think critically in understanding the information. The indicator provides a simple explanation at the Explanation (technology) stage when participants analyze the arguments regarding the information obtained by focusing the available statements. 4) Elaboration (engineering): this stage participants are challenged to expand their conceptual understanding and skills by applying the understanding they have gained. 5) Evaluation (mathematics): This stage is used to access the understanding and abilities they have gained by providing questions. This stage participants work on assignments that have been prepared by the teacher.

After students take part in STEM-based vector algebra learning activities, the next stage is to provide a questionnaire to find out digital literacy skills. Questionnaires are given to students at the last meeting and are conducted after the end of learning. The type of

questionnaire in this study is a closed questionnaire (structured questionnaire), which is a questionnaire that is presented in such a form that respondents are asked to choose one answer according to their own characteristics by giving a cross or chek-list.

The Ability to evaluate information content (Content Evaluation) indicator has the highest score of 78.00 and the Ability to compile Knowledge (Knowledge Assembly) indicator has the lowest score of 74.50. The ability of students to use technology is important and essential in visualizing digital literacy skills because digital literacy skills are definitely related to the use of technology, especially in online learning today. Expertise in using computers and accessing the internet will help in finding sources and information needed to process. This is in accordance with the research Polizzi that many verify online content by using skills in information navigation to search and compare different results on Google (Polizzi, 2020).

The convenience presented by the internet is certainly inseparable from the digital devices used in accessing the internet. Digital devices used for internet access can be smartphones, tablets, and laptops. This is because digital devices are practical and easy to carry anywhere, so participants can access the internet for learning needs anytime and anywhere. The information presented by digital media accessed via the internet can be easily obtained by participants in meeting the needs of biology learning by browsing. The convenience presented by digital media or information accessed through the internet causes a lot of information presented in it is not always valid and true. For this reason, in offsetting this, internet users, especially participants, need to have competence so that the information obtained and used is true information and tested for validity. The competence that a person has in accessing, understanding and processing information obtained from various digital sources is called digital literacy competence. The digital literacy competence of participants in biology subjects in this study focused on internet search competencies (Internet searching), hypertext direction guides (Hypertextual Navigation), Information Content Evaluation (Content Evaluation), and Information Collection (Knowledge Assembly). These four competencies are aspects in determining the level of competence of digital literacy participants in vector algebra courses.

The results of the study, it showed that participants were able to search the internet (internet searching) well. This competency becomes a competency with a score of 77.50, this can be seen from the ability of participants to use the internet as a learning resource when

there is an assignment from lecturers to find lecture materials such as journals or find literature material from assignments given by lecturers to make papers and so on. Participants are more independent and wiser to access the internet to find various information and knowledge according to the needs that are relevant to the subject of the course, such as accessing freelance articles, e-books (electronic books), e-journals (electronic journals).

Competence using hypertext direction guide (Hypertextual navigation) is the next competency that needs to be mastered by users, especially participants. Digital media literacy skills are different from printed book media literacy. Literacy in digital media is not only the ability to read, but the ability to hypertext also needs to be known. Based on the results of the study, it shows that competence using hypertext directional guides (Hypertextual Navigation) is on high criteria with a score of 77.50. ability to evaluate information content (Content Evaluation) participants get a score of 78.50 with high criteria. This competency is the competency with the highest average score compared to other competencies. This was reinforced by most participants focusing on the content of the information they were looking for without looking at the source of the information. In addition, in seeing the quality of a website, participants often visit the website that appears top when searching. This is because participants assume that the information that appears top when searching is the most visited information and is considered correct. The results of other analyses also found that participants directly used information that was considered correct without comparing with information from other sources. This shows that participants are not used to evaluating information content. The ability to compile knowledge (Knowledge Assembly) participants are in the sufficient category with an average score of 74.50. This competency is the competency with the highest average score compared to other competencies. Based on the results of the analysis carried out, it also shows that the participants' digital literacy competence in the aspect of compiling knowledge (Knowledge Assembly) is still on the medium criteria. This is evidenced by most participants using only one source in compiling knowledge used in the purposes of learning biology. In addition, participants rarely use journals, scientific articles and research results as reference sources and more often use personal blogspots or Brainly in finding information. This is because participants feel that the use of sentences on blogspot is easier to understand than journals, scientific articles or

research results. In addition, participants found it easier to find the information they needed using Brainly, because Brainly immediately gave accurate answers without having to search around first.

Based on the results of the research data that has been presented in the discussion, the participants' digital literacy competencies are on sufficient criteria and it is necessary to increase competence. Increasing digital literacy competence is very important considering the rapid development of technology. This is in line with the opinion that there is a positive and significant relationship between digital literacy and learning achievement one of the impacts of technological developments on the world of education is the large amount of information related to subjects that can be easily accessed through the internet (Erdem et al., 2023; Kayaduman et al., 2023; Soyoof et al., 2024). The explosion of information causes not a few invalid information in response to this, it is appropriate to increase the competence of digital literacy, especially for participants. Increasing digital literacy competence can be done by fostering insight and awareness to participants about the importance of having literacy competencies so that participants can fortify themselves from various things or negative impacts of technological advances.

CONCLUSION

The results showed that the indicator Internet search ability achieved a score of 77.50 at the high standard, the ability to use hypertext navigation aids (hypertext navigation) achieved a score of 77.50 at the high standard, the ability to evaluate information content (content evaluation) achieved a score of 78.50 at the high standard, and the ability to integrate knowledge (knowledge integration) achieved a score of 74.50 at the medium standard. The results of the average analysis of each indicator showed that students' digital competence met the high standard with an overall average of 76.87.

The use of digital technologies in mathematics education is not that technology is used as a substitute for conceptual understanding or the use of mathematical intuition, but on the contrary, technology enhances students' conceptual understanding of mathematical ideas and plays a role in the development of students' mathematical intuition. This is in line with the opinion states that there are three didactic functions of technology in mathematics learning, which is digital technology that functions as an alternative tool to replace paper and pencil media to carry out mathematical activities, Technology for practicing skills, namely

digital technology that functions as a learning environment to hone certain mathematical skills, Technology for developing conceptual understanding, that is, digital technology that serves as a learning environment to develop a conceptual understanding of mathematics (Agyei et al., 2024; Brunetto & Iacono, 2024; Gumiero & Pazuch, 2024).

Based on the information and information that has been obtained in this study, the suggestions to be conveyed are: 1) it is hoped that the next researcher will conduct research on the details and depth of digital competence in mathematics learning in the context of the use of digital technology. As Cheema revealed, a deeper understanding of digital literacy in mathematics is the first step to a deeper understanding of the mechanical literacy of mathematics performance, in other words, digital literacy is closely related to academic performance (Cheema, 2013). The method of assessing children's digital skills by measuring various online activities is well-received and practical. Digital literacy is very important for students because this skill allows them to adopt the positive values of the current digital age. 2) Based on the findings obtained in this study, influence of STEM learning models on student learning outcomes on other materials, so as to measure more broadly the extent to which STEM learning models can be developed in mathematics learning. STEM approaches can improve students' critical thinking skills in learning. The use of this media is expected to be an alternative in increasing students' understanding of concepts and motivation in learning mathematics, especially fractional material worth.

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