MARISEKOLA: Jurnal Matematika Riset Edukasi dan Kolaborasi
Volume 4 No. 2, Oktober 2023
ISSN 2774-6879

Investigating Education Students' Numeracy Skills

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ABSTRAK

Sehubungan dengan terbitnya Permendikbudristek No. 17 Tahun 2021 tentang Asesmen Nasional, khususnya Asesmen Kompetensi Minimum (AKM), literasi dan numerasi menjadi perbincangan dalam dunia pendidikan di Indonesia. Namun penelitian mengenai topik ini hanya berkisar pada siswa sekolah dasar dan menengah. Penelitian yang berkaitan dengan tingkat numerasi orang dewasa masih sedikit, dalam hal ini adalah guru atau mahasiswa di program studi pendidikan (mahasiswa yang sedang menjalani pelatihan menjadi guru). Penelitian ini bertujuan untuk menganalisis bagian mana dari numerasi yang menjadi kelemahan mahasiswa program studi pendidikan. Penelitian ini dilakukan dengan menggunakan pendekatan deskriptif-kualitatif. Penelitian ini melibatkan tiga mahasiswa pendidikan dari salah satu universitas di Sulawesi Utara. Data yang dikumpulkan bertujuan untuk mengetahui kemampuan berhitung mahasiswa prodi pendidikan berdasarkan kemampuannya dalam menyelesaikan soal-soal jenis AKM. Peneliti menganalisis pekerjaan tiga siswa pendidikan pada tes yang terdiri dari tiga jenis soal yang berbeda (masalah numerasi yang mirip dengan soal-soal AKM). Berdasarkan studi ini, peneliti menemukan bahwa mahasiswa prodi pendidikan yang terlibat dalam penelitian, mengalami masalah dalam memahami konsep matematika yang disajikan dalam konteks tertentu. Ketiganya masih memahami matematika sebagai mata pelajaran yang perlu dihafal rumusnya dibandingkan memahami cara pengembangan rumusnya.

Kata Kunci: Asesmen Kompetensi Minimum, Penilaian Kompetensi Minimum, pendidikan siswa, berhitung

ABSTRACT

Due to the issue of Permendikbudristek No. 17 in the year 2021 about the National Assessment, particularly *Asesmen Kompetensi Minimum* (AKM) or Minimum Competency Assessment (MCA), literacy and numeracy have become the talking point in Indonesia's education field. However, research on this topic was only around students at primary and secondary school. There is only a small number of studies related to adults' numeracy level, in this case, teachers or education students (university students training to become a teacher). This study aimed to analyze which part of numeracy became the weakness of the education students. This study was conducted by using a descriptive-qualitative approach. The study involved three education students from one university in North Sulawesi. The data collected was to determine the education students' numeracy skills based on their ability to solve MCA-type questions. We analyzed three education students' work on a test consisting of three different kinds of problems (MCA's numeracy problems alike). Based on the study, we found that education students involved in the study were having problems comprehending mathematics concepts in a context. All three still understand mathematics as a subject that the formula needs to be memorized rather than to understand how it is developed.

Keywords: *Asesmen Kompetensi Minimum*, Minimum Competency Assessment, education students, numeracy

INTRODUCTION

Literacy and numeracy have become the latest buzzwords in Indonesia's education field. It is due to the issue of Permendikbudristek No. 17 in the year 2021 about the National Assessment, particularly Asesmen Kompetensi Minimum (AKM) or Minimum Competency Assessment (MCA)

Info Artikel: Diterima 22 Mei 2023 ▪ Disetujui 20 Juni 2023 ▪ Diterbitkan 31 Oktober 2023

replacing the National Examination which was conducted in the country since the '50s (Suwarta, 2019). Indonesian MoEC describes that MCA's purpose is to obtain information about student achievement regarding two core competencies; literacy and numeracy. It is designed to generate information that triggers improvement in teaching-learning quality (Pusmenjar, 2020).

Minimum Competency Assessment (MCA) in general aims to measure the literacy and numeracy skills that students in primary and secondary education must have (Permendikbudristek No. 17, 2021). However, in this study, the researcher will mainly focus on one skill measured on MCA, which is the numeracy skill.

The focus of this regulation is to assess students' literacy and numeracy. Moreover, the teachers are expected to be able to use these competencies to develop effective and high-quality learning strategies according to student achievement (Pusmenjar, 2020). However, in Indonesia, we have not had a specific test to measure teachers' literacy and numeracy as MCA for students. Whereas, in developed countries such as Australia (Department of Education, 2023; Bennison, 2022) and the United Kingdom (Department for Education & Nick, 2019) they have conducted a compulsory test of literacy and numeracy at the end of the education and training program for their prospective teachers. These facts show that information about education students' literacy and numeracy level is crucial. We need it to ensure that our prospective teachers receive sufficient support and training from the university as the Education Institution for Teachers (*Lembaga Pendidikan Tenaga Kependidikan*) to meet the standards of literacy and numeracy required to be a teacher.

To date, In Indonesia, there is still a small number of studies related to adults' numeracy level, particularly the education students' (Basri et al., 2022; Hadiyanto et al., 2017; Maghfiroh, 2022; Nahdi et al., 2020; Nuraini et al., 2022; Prijowuntato et al., 2022., 2022). These studies are varied from finding out the level of general soft skills (including numeracy skills) of education students (Hadiyanto et al., 2017), to analyzing the relationship between numeracy skills to other stuff such as problem-solving ability (Nahdi et al., 2020) or students' achievement (Prijowuntato et al., 2022), exploring how the education students utilize their numeracy skills in the society (Basri et al., 2022) to elaborating frameworks that can be applied to enhance education students' numeracy skills (Maghfiroh, 2022; Nuraini et al., 2022).

In fact, this issue needs to be discussed and studied more since many final-year students still have difficulty in processing, comprehending, and solving problems related to composing sentences, analyzing problems, and discussing different data presentations, such as tables, pictures, diagrams, and so on. Moreover, students still find it difficult to describe numerical data and convey the idea systematically, logically, critically, and analytically. As a result, university students (including education students) have difficulties in qualifying scientific articles or articles in newspapers (Prijowuntato et al., 2022)

By considering the issues discussed in the previous paragraphs, the researcher sees the need to find out the information related to education students' (university students who are prepared to be prospective teachers) numeracy skills to make sure they are capable of carrying out their responsibility to design high-quality lesson plans to improve and support the development of their students' numeracy skill. Therefore, the researcher decided to conduct a study by exploring the following research question: *How are the education students' numeracy skills?*

With the guidance of this research question, we analyzed the three education students' work and interview results thoroughly. We expect the result of the current study could give a general view of prospective teachers' numeracy skills and encourage future research on what kind of framework universities (Education Institutions for Teachers) could develop to level up the students' education and training.

THEORETICAL BACKGROUND

In the past, proficiency in numeracy was defined as the ability to understand numbers, to do reasoning, and to make effective use of numeric information (Peters, 2012; Peters et al., 2006; Reyna et al., 2009 as cited in Jonas, 2018). But Jonas (2018) stated that numeracy involves human psychological mechanisms. Therefore, it could significantly help people make accurate judgments and appropriate decisions in many aspects of people's daily lives.

UNESCO (2006) defined numeracy as the ability to do arithmetic operations (addition, subtraction, multiplication, and division). In a much wider definition, numeracy is the knowledge, skills, and ability needed to effectively order and sort, count, estimate, compute, measure, and follow a mathematical model to mathematical situations with varied situations, involving many different mathematical ideas and mathematical representations such as objects, pictures, numbers, symbols, formulas, diagrams, maps, graphs, tables, and text.

Undeniably, the discussion about the urgent need for adults' knowledge has been emphasized in PISA as well, in which the assessment of mathematical literacy and science literacy. This idea underlines how the focus of mathematics and science education shifted from traditional concepts of formal knowledge in mathematics or science to the students' readiness for entering adults' life (Jonas, 2018).

This new path in mathematics education offers the exploration of a more relevant and practical mathematics curriculum for preparing students who in the future will have to implement mathematical concepts and ideas to understand our quantitative world (Hoogland et al., 2019).

One of the most popular definitions of numeracy which was used in many studies about numeracy for adults is the definition from PIAAC (Programme for the International Assessment of Adult Competencies). PIAAC is an assessment and analysis of adult skills programs. It measures adults' proficiency in key information-processing skills, including numeracy used in their daily life at home, at work, and in society. According to PIAAC, numeracy is the ability to access, apply, comprehend, and communicate any numerical data and mathematical ideas, to be involved in many situations that need mathematics in adult life (PIAAC Numeracy Expert Group, 2009).

As a form of adaptation to the development of the world of education and improvement of the quality of education in Indonesia, since 2021, there has been a change in Indonesia's national assessment. The Ministry of Education and Culture replaced the national examination (NE) with Minimum Competency Assessment (MCA) (Purnomo et al., 2022).

In general, Minimum Competency Assessment aims to assess students' literacy and numeracy skills. As Windisch (2015) stated that these two skills (literacy and numeracy) should be viewed as social practices in numerous contexts in our life rather than technical skills for human activities. Therefore, MCA aims not only to obtain information about student's literacy and numeracy skills, but also to provide information that could trigger the improvement of the quality of teaching and learning in the class, so we can formulate high-quality and effective learning strategies (Prijowuntato et al., 2022). MCA has many forms of questions, such as multiple-choice, complex multiple-choice, matchmaking, short entry, and essay (Depdikbud, 2020). In Table 1, we explained the numeracy in MCA based on three aspects.

Table 1. Minimum Competency Assessment Components (Numeracy)

MCA Aspects	Numeracy
Content	**Numbers**, including representation, sequence properties, and operations on various types of numbers (whole numbers, fractions, decimals, and so on).
	Measurement and geometry, including comprehending the concept of two-dimensional figures, the volume and the surface area using everyday life context. Also assessing students' understanding of the measurement of length, weight, time, volume and discharge, as well as measuring area using standard units.
	Data and Probability, including understanding, interpretation and presentation of data and probability.
	Algebra, including equations and inequalities, relations and functions (including number patterns), as well as ratios and proportions.
Cognitive process	**Understanding**, the ability to understand facts, procedures and mathematical tools.
	Application, the ability to apply mathematical concepts in real life routine situations.

	Reasoning, the ability to reason with mathematical concepts to solve non-routine problems.
Context	**Personal**, related to personal interests.
	Socio-cultural, related to inter-individual interests, cultural and societal issues.
	Scientific, relating to issues, activities, and scientific facts both in the past and in the future.

Source: (Pusmenjar, 2022)

Based on the PISA score in 2018, Indonesia ranked 74th out of 79 participating countries. Since 2000, Indonesia has always participated in PISA. However, the average score is still disappointing. Our mathematics literacy is the lowest, followed by scientific literacy and reading literacy (Prijowuntato et al., 2022).

In addition to issues regarding students' numeracy skills, adults' numeracy skills in Indonesia are still a concern. A large-scale international survey for measuring, analyzing, and comparing adults' basic skills of literacy, numeracy, and digital problem-solving, also known as PIAAC (The Program for the International Assessment of Adult Competencies), was surveyed in Indonesia in 2014. Indonesia participated in Cycle 1, Round 2 in the year 2014, but unfortunately, results were either not reported or reported separately, due to unspecified reasons (whether sampling problems, response rate problems, or other procedural problems with the data) (IES-NCES, n.d.). Therefore, this issue remains unresolved.

Regarding the issue of adult numeracy, especially for education students, we can learn from Australia. Since all teachers have to support students to apply their numeracy skills in the subjects they teach, then education students are expected to start to develop effective numeracy teaching strategies during their training (Bennison, 2022). Therefore, all graduates from Education students' Education need to meet specified standards. Even some universities offer a course that focuses on numeracy alone (e.g., Monash University; see Forgasz & Hall, 2019) while others, as is the case of the university where this study was conducted, have one course that aims to address both literacy and numeracy. (Bennison, 2019).

RESEARCH METHOD

This study was conducted by using a descriptive-qualitative approach which can help researchers to describe clearly and in detail the errors made by students in solving numeracy questions (Muda et al., 2022). The data collection technique used in this research is the evaluation of learning outcomes, namely a description test given to students, which aims to investigate and analyze students' answers referring to numeracy based on the minimum competency assessment. Interviews were conducted to obtain a complete picture of students' thinking processes and were used as supporting data for student learning evaluation results. The interview was conducted after giving the numeracy test.

The study involved three education students from one university in North Sulawesi. The data collected is to determine the education students' numeracy skills based on their ability to solve MCA-type questions. We analyzed three education students' work on a test consisting of three different kinds of problems (MCA's numeracy problems alike). In addition, we conducted an unstructured interview to gather in-depth information about the research participants' answers in the given test. The details of the problems in the test are as follows:

1. 1 question at the Junior High School level (Phase D) with the topic of Numbers (Arithmetic).
2. 2 questions at the Senior High School level (Phase E) with the topic of 3-dimensional Figures and Algebra.

Observation and tests were used to collect data to examine the education students' numeracy. The test consisted of 3 MCA-based items and took about 50 minutes. Expert validation was carried out to determine the validation of the questions used in the test. The data analysis technique used was descriptive. The analysis conducted is based on the theory of numeracy aspects by Pusmenjar (2022) and PIAAC's definition of numeracy.

FINDINGS AND DISCUSSIONS

Tests Items

Item 1:

Figure 1. Oil Container in Item 1

Mr. Hamid is a cooking oil seller. He usually keeps the cooking oil in a large drum (container) with a diameter of 56 cm and a height of 85 cm. To ease him to transfer the oil to other containers, he installed an automatic pump on the drum. ($\pi = \frac{22}{7}$).

Choose **True (T)** or **False (F)** for the statements below!

1.	The surface area of the drum is at least $2m^2$.	**T**	**F**
2.	The maximum volume of the drum is 210 liters	**T**	**F**
3.	He needs at least 136 cylinder containers with a diameter of 14 cm and a height of 10 cm to accommodate all the cooking oil in the large drum	**T**	**F**

Item 1 is a question related to three-dimensional figures. It is for senior high school level or phase E. The participants were expected to use their knowledge and understanding about finding the volume and the surface area of a three-dimensional figure, a cylinder.

Item 2: Mrs. Sinta made a sponge cake for her family. She prepared the ingredients as follows:

- $\frac{1}{4}$ kg eggs
- $\frac{1}{8}$ kg sugar
- $\frac{1}{8}$ kg flour
- 0.1 kg butter

Mrs. Sinta wanted to make the cake softer, so she modified the recipe by adding the butter three times more than the original recipe and reducing the flour by subtracting the original measure to a half of the original measure. What is the total measure of all ingredients based on the modified recipe in grams?

Item 2 is a question related to numbers (arithmetic). It is for junior high school level or phase D. The participants were expected to use their knowledge and skills to apply arithmetic operations on fractions and decimals.

Item 3:

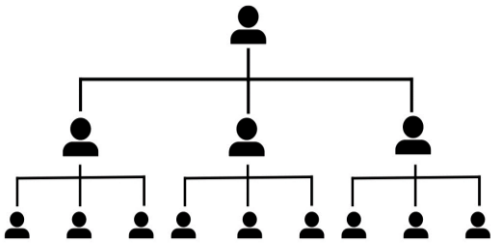

Figure 2. Matrix Rule for Item 2

Since the beginning of January 2023, Rinto has joined a Multi-level Marketing Company which sells Health Products. He had to recruit new members in accordance with the matrix's rule applied in the company, as did the other members who joined the company with Rinto. They had to achieve the target within a month. If all the new members joining in the beginning of January 2023 achieve their target, the number of new members joining in June 2023 is ….

A. 12 members
B. 18 members
C. 243 members
D. 729 members
E. 2,187 members

Item 3 is a question related to algebra. It is for senior high school level or phase E. The participants were expected to use their understanding of algebra and knowledge of geometric sequence.

Analysis of Participants' Answer

Participant A

As could be seen from the answer sheet, for item 1 participant A structured the answer effectively by writing down what is known from the question, what is asked, and the answers to each sub-question. The participant translated each sentence into mathematical statements correctly. He/she utilized various types of number conversion, from decimals to fractions and conversely, and the concept of addition and multiplication for fractions. However, participant A made a mistake when converting a fraction to decimal which led to the incorrect answer. Despite the fact that his/her answer was incorrect,, we found out in the interview that participant A comprehended the question very well, understood the context, and knew what mathematical content, procedures, and tools needed to solve the problem. The participant A was also familiar with the context used in the question.

Then, for item 2, student A answered the question correctly. Among the three participants, participant A was the only participant who answered the question correctly. He/she structured the answer as what he/she did in item 1. The participant A wrote down what is known, what is asked, and the answer. Based on the interview, the participant comprehended the mathematical content, in this case 3-Dimensional Figures. Moreover, he/she already memorized the formula for finding the cylinder's volume and surface area. It helped him/her to proceed to the answer. When asked about the context used in the question, the participant thought he/she can relate to the context since it was quite familiar with his/her life.

Unlike the two previous questions, participant A did not answer item 3 correctly. Based on the answer sheet, we figured out that the participant comprehended the question and what mathematical concept needed to be applied to answer the question. However, he/she could not recall the formula for finding the nth terms in a geometric sequence. As a result, his/her answer was incorrect. When asked for other alternative ways to answer the question without using the formula, the participants answered that he/she could count it manually, starting from January 2023 to June 2023.

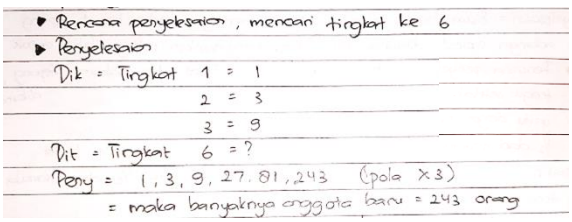

Figure 3. Participant A's answer on Item 3

Participant B

For item 1, participant B answered it correctly. He/she structured the answer well by stating what was known first. Then he/she continued by writing what is asked and the answer for each sub question. By utilizing various types of number conversion, from decimals to fractions and conversely, and the concept of addition and multiplication for fractions, participant A answered the question correctly. Moreover, in the part of the cognitive process, we can see how the participant utilized the correct procedures and mathematics tools to find the answer. Based on the interview conducted, we found out that participant B comprehended the question very well and understood the context. The participant recognized what mathematical concepts, in this case fractions and decimals needed to solve the problem in item 1. The participant also understood the mathematical facts, procedures, and tools that were needed to apply in answering the question.

In question 2, participant B made mistakes in the first sub-question. Participant B used the formula of the area of a circle to find the surface area of a cylinder which can be seen in Figure 4. Based on the interview, participant B misunderstood the "surface area" in the question as the upper side of the container which is in the shape of a circle. The misunderstanding was caused by the word "*permukaan*" in Bahasa Indonesia sometimes being translated to the upper surface of things. That is the reason why the participant used the circle formula to find the surface area. However, when asked about the formula to find the surface area of a cylinder, he/she cannot recall it. Then the researcher asked whether the participant can find the surface without memorizing the formula. He/she replied that he/she cannot do it without the formula.

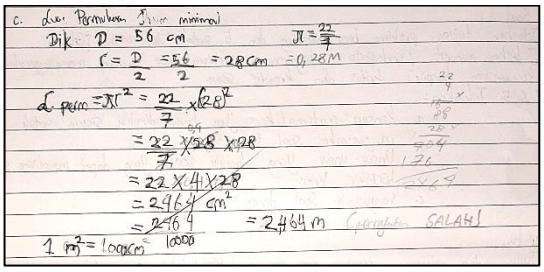

Figure 4. Participant B's answer on Item 2

For the next item, participant B did not answer the question correctly. He/she calculated the number of members manually by listing it in the table. In the interview, the participant stated that he/she recognized that the geometric sequence concept was needed to solve the problem. However, he/she stated that he forgot the formula. Therefore, he/she counted it manually with the help of a table. Despite the fact that he/she understood the mathematical concept needed, the participant made a mistake in the calculation. Participant B put the first term (the month of January) of the geometric sequence in the first line of the matrix (referred to Figure 2) when it was supposed to be in the third line of the matrix. Based on the interview, we found out that the participant understood the mathematical facts, procedures, and tools that were needed to apply in answering the question.

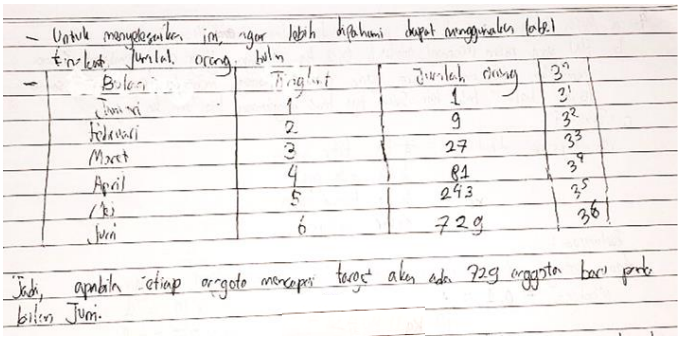

Figure 5. Participant B's answer on Item 3

Participant C

For item 1, in the interview, the three participants agreed that this question is the easiest among the three items. As we could observe from the answer sheet, we found that participant C's answers were correct. But compared to other participants' strategy, participant C chose to convert all decimals to fractions then added them all. In the interview, he/she stated that he/she found it more comfortable to convert decimals to fractions than the other way around. We also found out that participant C comprehended the question very well and understood the context. The participant recognized that concepts of fractions and decimals operation needed to solve the problem in item 1. The participant also understood the mathematical facts, procedures, and tools that were needed to apply in answering the question.

Moreover, participant C did not answer the second question correctly. As participant B did, participant C used the formula of the area of a circle to find the surface area of a cylinder. When asked about it during the interview, the participant stated that he/she reckoned that the formula was correct. Then, we informed him/her that it was the wrong formula. He/she then told the researcher that he/she cannot remember the formula of finding the surface area of a cylinder.

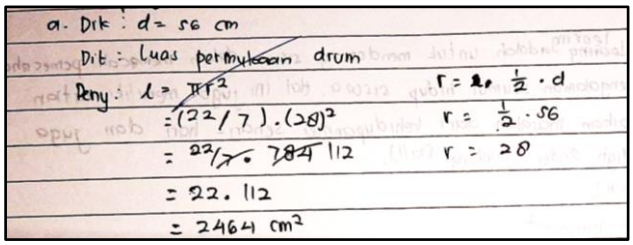

Figure 6. Participant C's Answer for Item 2

Next, for the third question, participant C made a mistake. He/she recognized the mathematical tool and mathematical concept related to the question. However, he/she did not write down the correct formula to find a term in a geometric sequence. The participant ended up using the wrong formula which led to the wrong answer.

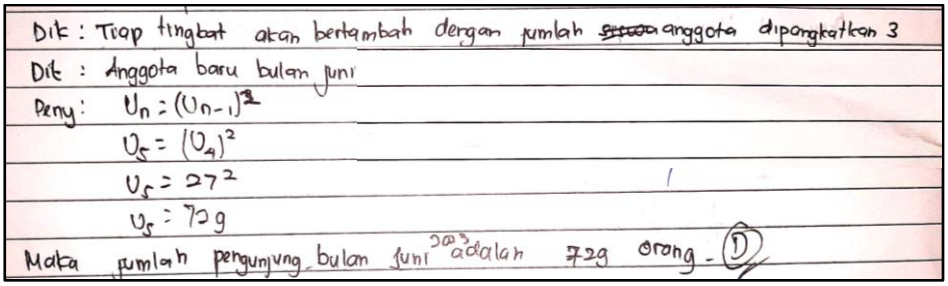

Figure 7. Participant C's Answer for Item 3

CONCLUSIONS

In Indonesia, all teachers are required to explicitly address numeracy inherent in the subjects they teach. Education students, therefore, need to begin to develop the capacity to do so during their study and training in the Education Institution for Teachers (*Lembaga Pendidikan Tenaga Kependidikan*). The study reported in this paper investigated the education students' numeracy skills. The aim of the study was to analyze which part of numeracy became the weakness of the education students. Based on the study, we found that education students involved in the study are having problems in the comprehending mathematics concept. All the three still understand mathematics as a subject that needs to memorize the formula rather than understanding how it is developed. The findings in the study also highlight that education students need design of courses in their training and learning in the university which can support the education students to embed numeracy in the subjects they will teach. Therefore, the challenge remains to encourage further study to grow the research in this topic to improve the numeracy skills of the future teachers in Indonesia.

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