



Statistical Literacy: A Preliminary Research to Identify Student's Level in Solving AKM Problems Based on Watson Category

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ABSTRACT

Literacy is essential in preparing for 21st-century life and the significant data era. At the very least, people need the ability to process, analyze, read, and use the data to make decisions. This ability is known as statistical literacy. The students' statistical literacy must be diagnosed well for appropriate learning improvements. This study is qualitative research with a quantitative descriptive approach; the instruments used are AKM (Asesmen et al. - Minimum Competence Assessment) problems and Watson's statistical literacy category. The respondents were 187 students from six schools with different statuses (three state and three private schools) with different abilities (two high-level schools, two medium-level schools, and two low-level schools). The results obtained: there are no students at level 1; 3.07% of students are at level 2; 8.82% of students at level 3; 14.84% of students are at level 4; 55.61% of students are at level 5, and 17.65% of students gain level 6. Based on the result, it is evident that the students' statistical literacy spread to several levels. Most of the students are in level 5, and a few can gain the sixth level, but still, there are several students at the third level, even the second level. Those data can be used as preliminary data to improve statistical learning methods and teaching materials and for further research, especially about why and how to increase students' statistical literacy.

Keywords: *statistical literacy, numeracy-AKM, Watson*

INTRODUCTION

The COVID-19 pandemic has changed the way people interact socially. The effects of the pandemic are also expected to affect the psychology of society, the economy (LM Rachmawati et al., 2023), and education both in the short and long term (Herdayati et al., 2021; Saji, 2021). As a result, many activities have shifted to online mode (Fauza et al., 2023), for example, communicating, transacting, educating, editing, actualizing, and socializing (Kim, 2020; Rakshit, 2021). This causes society, including our students, to come into contact with data spread out in cyberspace.

Data, nowadays known as big data, has the following characteristics: volume (data size) (Connie et al., 2021), velocity (data access speed) (Satriani et al., 2021), variety (data diversity) (Gamage et al., 2019), veracity (incomplete and not always reliable) (Watson et al., 2015), and value (information contained) (Cahyadi & Ariansyah, 2023; Rachmawati et al., 2023). At least two main competencies are required for those data characteristics. The first competency is using programs/applications on a computer or mobile device. The second is the ability to process, analyze, comprehend, and apply data to draw conclusions and take suitable actions (Castelló & Lopez-Berzosa, 2023; Consultant et al., 2014). Good data literacy understanding is a component of statistical literacy (ASB Lestari et al., 2023; Muhammad et al., 2023).

Statistical literacy is the capacity to comprehend statistical data or study findings.

Statistical literacy also includes organizing data, creating tables, and interacting with various table forms (Balasopoulou et al., 2017). According to Wallman (1993), statistics literacy is the ability to interpret, assess, and criticize statistical data available in everyday life and utilize it to make decisions. According to (Van Merrienboer et al., 2016), statistical literacy is essential for students because it helps them become informed members of society and knowledgeable consumers who can criticize and make sound judgments based on the statistical information they get. Statistical literacy is also required for students to critically grasp, interpret, evaluate, and convey data (Maryani & Chotimah, 2021; Viani et al., 2020)

Assessing the students' statistical literacy can be done at four levels by having students do several activities, namely evaluating the use of statistics in a news story, estimating a quantity or making a decision in an open-ended situation, describing and comparing statistics presented in graphs or tables, and answering multiple-choice questions on specific aspects of statistical literacy (Schild, 2010). This study attempted to determine students' statistical literacy in solving the AKM (Asesmen et al. - Minimum Competence Assessment) questions using the statistical literacy category developed by Watson (2006). This research can be categorized as preliminary research, as further research based on the research result is still necessary.

LITERATURE REVIEW

Over the years, several definitions of statistical literacy have emerged in literature (Wallman, 1993; Ben-Zvi & Garfield, 2004; Watson, 2006; Yuniawatika, 2018). Some studies have also been done to measure pupils' degrees of statistical literacy. The findings of this research suggest that there is no statistically significant difference in literacy between male and female students (Yolcu, 2014). Open-ended questions can also increase Students' statistical literacy (Koparan & Güven, 2015). More specifically, it was also found that students still had difficulty understanding bar charts and line charts (Aksoy & Bostan, 2021). Unsatisfactory results regarding the statistical literacy of Indonesian students can also be known from research using PISA questions (Wildani et al., 2019) and TIMSS questions (Utomo, 2021).

Studies by Watson and Callingham (2003) reveal that statistical literacy is a hierarchical construct that can be mapped along six levels, as summarized in Table 3. Students' responses are often personal, intuitive, and non-statistical at the lowest level, involving only basic mathematics skills. As the level increases, more sophistication is shown in the student's use of the statistical procedure, greater appreciation of variation and uncertainty, and ability to transfer statistical knowledge to the context. Students at the highest level can groupally evaluate the context critically, consider uncertainty when making predictions, and apply proportional reasoning. Because creating practical tasks must include "where students start and how they progress" (Watson, 2006), statistical literacy as a hierarchical construct is vital for teachers.

Table 1. The hierarchy of statistical literacy construct Watson & Callingham (2003)

Level	Name	Characteristics of level
1	Critical-mathematical	The ability to analyze and understand the context critically and inquisitively, especially when dealing with media or situations involving chance, demonstrating a grasp of proportional reasoning, understanding the significance of uncertainty in forecasting, and appreciating the complex characteristics of language.
2	Critical	The ability to examine and challenge situations in both familiar and unexpected contexts. It may only sometimes involve proportionate thinking, but it requires correctly using terminology, qualitatively interpreting chance, and understanding the significance of variation.
3	Consistent-non-critical	The ability to engage with context in a suitable manner but not critically. Can use terminology in various aspects, recognize and appreciate the variance in change

Level	Name	Characteristics of level
4	Inconsistent	circumstances, and have statistical knowledge of mean, basic probability, and graph properties. Selectively engaging with the context in a supportive manner, acknowledging conclusions without providing justification, and utilizing statistical ideas in a qualitative rather than quantitative way.
5	Informal	Understanding contexts in a way that is intuitive and reflects non-statistical beliefs, using simple vocabulary and settings, as well as doing basic calculations with tables, graphs, and probabilities.
6	Idiosyncratic	Understanding contexts in idiosyncratic ways, repetition of language, requiring only basic mathematics abilities connected with one-to-one counting and interpreting cell values in tables.

RESEARCH METHODS

This is a qualitative study using a quantitative descriptive technique, and it aimed to characterize the students' statistical literacy successes in answering AKM questions based on the category Watson (2006). According to the characteristics of qualitative research presented by Sugiyono (2013), this study describes the meaning of the research data obtained. It is not generalized, and the research subjects were selected using a non-probability purposive sampling method. The research subjects were chosen based on school mathematics teacher suggestions. To represent junior high school students in Batu City - East Java, the selected research subjects are one class or a minimum of 30 students at six schools (three public schools and three private schools) (Akmam et al., 2018; Suadi, 2022). The schools selected are from high categories (school A), medium categories (school B), and low categories (school C), based on the 2019 national exam result published by (Akmaliyah, 2021), especially on the topic of data and uncertainty.

The data collection instruments used in this study were numeracy literacy questions in the AKM question simulation compiled by (Rijal & Sofiarini 2019; Rijal & Yurmianti, 2021). The questions used are 4th-level numeracy questions on the data and uncertainty topic, with indicator questions about using mean, median, and mode. The chosen questions grid is shown in Table 1 below, and the original question is in the appendix.

Table 2. *Question grid*

Question Number	Question Indicator	Question Type
1	Presented with a bar chart of data on patients with COVID-19 in early January 2020, students can evaluate the use of the average to describe the number of COVID-19 sufferers in ASEAN.	Essay
2	Presented bar charts and line charts regarding the state of employment in Indonesia in August 2019; students can determine whether the statements are true or false based on the diagrams.	Complex multiple choice
3	Presented table about the weight development of the fetus and pregnant women during pregnancy. Based on the diagram, students can determine whether the statements are true or false.	Complex multiple choice
4	Presented data on several parks and the nature of some tree species transpiration, students can decide which park to choose if they want a fresh garden and sufficient sunlight.	Multiple choice

This study was carried out following (Meliyanti et al., 2021; Priyadharshini & Mohamed Sahul Hameed, 2022) processes, which are summarized in four stages: planning, implementation, data processing/analysis, and reporting. For measuring the students' statistical literacy level, the researcher used Table 2 below.

Table 3. Guidelines for leveling students' statistical literacy (adapted from Watsons' Category)

Question Number	Students answer	Statistical Literacy Level
1	- No response	1
	- The answer is not related	2
	- There is an answer but no explanation	3
	- There is an answer by giving an example	4
	- Answer "correct" and explain the reason	5
	- Answering "wrong/incorrect" and explaining the reason	6
2	- No response	1
	- Did not answer or did not vote	2
	- Choose one answer, but it is still wrong	3
	- Choose more than one answer but all wrong	4
	- Choose at least one correct answer	5
	- Choose two correct answers	6
3	- No response	1
	- Did not answer or did not vote	2
	- Choose one answer, but it is still wrong	3
	- Choose more than one answer but all wrong	4
	- Choose at least one correct answer	5
	- Choose two correct answers	6
4	- No response	1
	- The answer is not related	2
	- Choose more than one answer	3
	- Answer b or d	4
	- Answer a	5
	- Answer c	6

Semi-structured interviews were done with numerous students representing high, medium, and low levels of student responses at each school to ensure the data's validity. Interviews were undertaken to elicit more information and fill the test results' gaps. Furthermore, triangulation of interview results was performed to compare the data and ensure its validity.

RESULTS AND DISCUSSION

Results

The results of the research in each school are as follows.

School A1 (High Category School)

The percentage level of statistical literacy in each question at this school is shown in the table below.

Table 4. Students' statistical literacy of School A1

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	3,23 %	6,45 %	22,6 %	67,7 %	0 %
2	0 %	0 %	3,23 %	0 %	64,5 %	32,3 %
3	0 %	0 %	0 %	9,67 %	87,1 %	3,2 %
4	0 %	0 %	6,45 %	29 %	32,3 %	32,3 %

The table above shows that there are still students at level 2, which is 0.81%, and at level 3, as many as 4.03% of students. Some students are at level 4, which is 15.23%; most are at level 5, which is 62.90%; and; some can be at level 6, which is 16.94%.

School A2 (High Category School)

At this school, the students' statistical literacy level is quite similar to school A1, and the results are as Table 5 follows.

Table 5. *Students' statistical literacy of School A2*

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	0 %	9,68 %	3,23 %	87,1 %	0 %
2	0 %	0 %	0 %	0 %	93,5 %	6,45 %
3	0 %	0 %	0 %	0 %	38,7 %	61,3 %
4	0 %	0 %	0 %	32,3 %	0 %	67,7 %

The table shows that the statistical literacy of students in A2 schools is mostly at level 5, which is 54.84%; 8.87% of students are at level 4, and; 33.87% of students can be at level 6. However, 2.42% of students still need to be at level 3.

School B1 (Medium Category School)

At this school, the results obtained are slightly different from school A because, on average, students' abilities in this school are still below school A. The results are as Table 6 below.

Table 6. *Students' statistical literacy of School B1*

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	0 %	16,1 %	19,4 %	64,5 %	0 %
2	0 %	0 %	9,68 %	0 %	67,7 %	22,6 %
3	0 %	0 %	9,68 %	0 %	90,3 %	0 %
4	0 %	0 %	16,1 %	32,3 %	22,6 %	29 %

According to the table above, most students in B1 schools are at level 5, with 61.29%, followed by an even distribution of students at levels 3, 4, and 6, with 12.9%.

School B2 (Medium Category School)

The students' statistical literacy of this school is quite similar to school B1, and the results in Table 7 follow.

Table 7. *Students' statistical literacy of School B2*

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	9,38 %	9,38 %	28,1 %	43,8 %	9,38 %
2	0 %	0 %	3,13 %	0 %	50 %	46,9 %
3	0 %	0 %	25 %	9,38 %	53,1 %	12,5 %
4	0 %	0 %	3,13 %	21,9 %	37,5 %	37,5 %

From the table, it can be seen that in school B2, some students are already at level 6, which is 26.56%, level 5 is 45.09%, level 4 is 14.84%, level 3 is 10.16%, and 2.34% of students are still at level 2.

School C1 (Low Category School)

This school is where most of the student input comes from one school because it is located very far from other villages. The statistical literacy results are as Table 8 below.

Table 8. Students' statistical literacy of School C1

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	40,6 %	15,6 %	28,1 %	15,6 %	0 %
2	0 %	0 %	9,38 %	6,25 %	75 %	9,38 %
3	0 %	0 %	3,13 %	12,5 %	75 %	9,38 %
4	0 %	9,38 %	0 %	31,3 %	43,8 %	15,6 %

From the table above, at school C1, most of the students, namely 52.34%, are at level 5, 19.53% at level 4, and; 8.59% can be at level 6. However, still, there are 7.03% of students are at level 3, and 12.5% are at level 2.

School C2 (Low Category School)

The students' statistical literacy at this school is quite similar to school C1 because of the similarity of students' competencies, and the results are shown in Table 9 below.

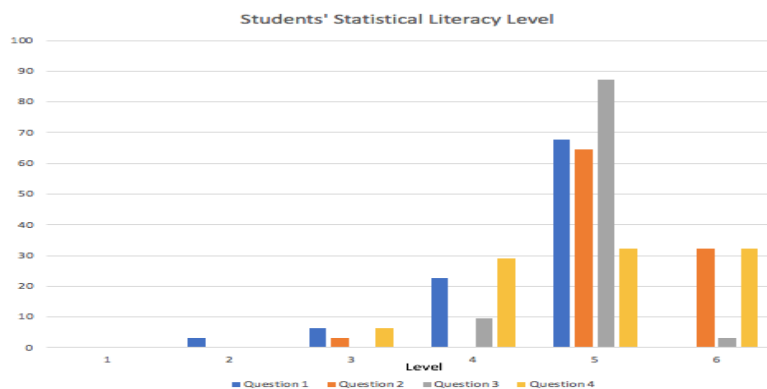
Table 9. Students' statistical literacy of School C2

Question Number	Statistical Literacy					
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1	0 %	0 %	16,7 %	30 %	53,3 %	0 %
2	0 %	0 %	10 %	0 %	73,3 %	16,7 %
3	0 %	0 %	40 %	0 %	53,3 %	6,67 %
4	0 %	10 %	0 %	40 %	46,7 %	3,33 %

According to the table, most students at school C2 are likewise at level 5, with as many as 56.67% of students at level 5, 17.5% at level 4, and 6.67% at level 6. Some pupils, as many as 16.67%, are still at level 3, and 2.5% are at level 2.

DISCUSSION

Students' statistical literacy level in solving AKM questions can be shown in the picture below.



Students' statistical literacy is different depending on the question type. For essay question (question number 1), there are still students who gain a score of 2, which is 8.87%; 12.3% of students gain a score of 3; and 21.9% of students gain a score of 4. Most of the

students are a score of 5, which is 55.3%, and just 1.56% of students were able to gain a score of 6. Usually, students need help solving mathematics essay problems because of the challenges of learning concepts, applying principles, solving verbal problems, and minimalizing it by developing critical thinking skills and students' mathematical literacy skills (Astuti & Adirakasiwi, 2019). The other factor is that students need to be more careful in observing the question given and have less understanding of statistics-related concepts (Retnowati et al., 2021; Suhendra et al., 2016).

For complex multiple-choice questions (question number 2 and number 3), most students gain a score of 5, which is 60.8%; 13.6% of students are at a score of 4; and 8.54% of students can gain a score of 6. There are still 12.6% of students with a score of 3; even 4.44% gain a score of 2. This question type is relatively new for students, but because there was guidance on how to answer it, more of them were able to gain a score of 5; if there were difficulties because they lacked understanding of the questions, lack of thoroughness in the process of working on the questions (Humaidi et al., 2022; Sugianto, 2023)

In multiple-choice questions (question number 4), the percentage of students who gain scores 4, 5, and 6 are almost the same. There 31.1% of students achieved a score of 4, 30.5% gained a score of 5, and 30.9% earned a score of 6. But still, there are 4.28% of students who score 3, and 3.23% of students only gain a score of 2. This question type is the most familiar for students, and there are no fundamental difficulties in this question type, usually just reading errors, comprehension errors, processing errors, and encoding errors (AN Vidyastuti et al., 2018; Darmayanti et al., 2022).

Those results, if related to statistical literacy theory by Watson (2006), can be concluded that the students can mainly reflect on their critical thinking skills using mathematics skills (level 5 and level 6). Some students can also reflect on their ability to understand the context even though they have yet to be critical of the content of the context, and sometimes they still need to be more consistent (level 3 and level 4). However, some students need help to reflect on their abilities and struggle to understand a context (level 1 and level 2) (Kerneža, 2016; Susilo et al., 2020).

Open Problem

According to the research findings and discussion, students' statistical literacy in solving numeracy-based statistic questions (AKM issues) is distributed over many levels depending on the question type. Overall, more than half of the students gained a score of 5, a few of them gained a score of 6, and several of them gained a score of 4, even though some still gained scores of 3 and 2. Therefore, it is necessary to improve students' statistical literacy by improving learning methods and teaching materials. Further research is also needed to find know the reason and how the best way to enhance students' statistical literacy.

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