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Statistical Literacy of University Students: An Analysis of Decision-Making, Evaluating, Communicating, and Interpreting Skills

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Abstract

This study aimed to analyze university students' statistical literacy based on four indicators: decision-making, evaluating, communicating, and interpreting, as well as to examine differences in statistical literacy according to gender. A descriptive survey design was employed. The participants comprised 144 students from six universities across five provinces in Indonesia: Banten, Jakarta, East Java, Jambi, and Bengkulu, who were selected using non-probability sampling with a convenience sampling technique. Data were collected using an open-ended statistical literacy test developed based on response-skill indicators from the perspective of data consumers. The collected data were analyzed using descriptive statistics and the Mann–Whitney U test to determine whether significant differences existed between male and female students. The results revealed no statistically significant differences in statistical literacy between male and female students. Among the four indicators (decision-making (average 22.9), evaluation (75), communication (55.6), and interpretation (22.2)) students demonstrated relatively stronger performance in evaluating and communicating statistical information than in decision-making and interpreting. Analysis of students' responses indicated that the main difficulties were related to understanding the context of statistical information, accurately interpreting data, integrating multiple statistical measures when making decisions, and effectively communicating information derived from graphs and datasets. These findings highlight the importance of integrating statistical knowledge with contextual understanding to support the development of statistical literacy among university students. The limitations of this study are evident in the data collected, namely the imbalance in the number of male and female students, which means the results cannot yet be generalized; further research is needed.

Keywords: statistical literacy, higher education, decision-making, data interpretation, gender differences

INTRODUCTION

Statistical literacy has emerged as an essential competency in contemporary education, particularly in an era characterized by the widespread availability of data and evidence-based decision-making. The ability to understand, interpret, and critically evaluate statistical information enables individuals to engage effectively with quantitative evidence encountered in academic, professional, and social contexts. In Indonesia, scholarly attention to statistical literacy has continued to grow, as reflected by the increasing number of studies addressing this topic over recent years (Habibie et al., 2025). This growing interest indicates that statistical literacy is increasingly recognized as a fundamental component of educational curricula and a necessary skill for navigating data-rich environments (Sayogo et al., 2024; Schield, 2011).

The increasing integration of critical literacy competencies within higher education further highlights the importance of assessing students' statistical literacy. Universities are expected to produce graduates who not only possess disciplinary knowledge but also can critically examine quantitative information and use statistical evidence to support informed decision-making. Consequently, students must develop the capacity to interpret statistical reports, evaluate the credibility of data-based claims, and communicate statistical findings appropriately in both professional and societal settings (Hardianti, 2024; Ru, 2022; Sayogo et al., 2024; Schield, 2011).

Despite its importance, previous studies have shown that many students continue to have difficulty interpreting statistical information. Data interpretation, which represents one of the core dimensions of statistical literacy, remains a challenging skill for many learners. Such limitations may negatively affect students' academic performance not only in statistics-related courses but also in other disciplines that increasingly rely on quantitative evidence. Therefore, efforts to strengthen students' statistical literacy have become a critical educational priority (Perin & Campos, 2022).

Various interventions have been implemented to improve statistical literacy in Indonesia. These interventions commonly include the application of innovative teaching methods and learning models (Priyambodo & Maryati, 2019), as well as the development of instructional media and learning resources (Hariyanti & Wutsqa, 2020). However, the effectiveness of these approaches in addressing the complexity of authentic statistical reports remains insufficiently understood. Statistical reports often require learners to integrate multiple skills simultaneously, including interpreting data, evaluating statistical claims, drawing conclusions, and making evidence-based decisions. As a result, further investigation is needed to gain a more comprehensive understanding of students' statistical literacy.

Although previous studies have reported various instructional approaches to enhance statistical literacy, most have primarily emphasized the effectiveness of learning interventions rather than providing a comprehensive description of students' existing statistical literacy profiles. Consequently, limited empirical evidence is available regarding how university students perform across different dimensions of statistical literacy, including interpreting statistical information, evaluating statistical evidence, communicating statistical findings, and making data-driven

decisions. Such baseline information is essential for identifying students' strengths and weaknesses and for informing the design of more targeted instructional strategies.

Therefore, this study employs a survey approach to examine the statistical literacy of university students across four essential competencies: interpreting statistical information, evaluating statistical evidence, communicating statistical findings, and making evidence-based decisions. By providing a comprehensive profile of these competencies, this study offers baseline evidence that may support curriculum development and future instructional interventions aimed at improving statistical literacy in higher education.

METHODS

This study employed a descriptive survey design to investigate the statistical literacy of university students in Indonesia. The participants comprised 144 undergraduate students who were selected using non-probability sampling with a convenience sampling technique – including 28 male and 116 female students – drawn from six universities located across five provinces: Banten, Jakarta, East Java, Jambi, and Bengkulu. The study was conducted through three main stages. First, the researchers developed a statistical literacy test based on the selected indicators. Second, the instrument was administered to participants using an online platform. Finally, the collected responses were analyzed to identify students' levels of statistical literacy and examine potential differences by gender.

Data were collected via a Google Forms questionnaire consisting of four open-ended questions designed to assess students' statistical literacy from the perspective of response skills. The researcher obtained these questions from previous studies by Sharma (2013) and Kurnia (2024), whose instruments had already undergone feasibility testing. The instrument focuses on four key competencies: decision-making, evaluation, communication, and interpretation of statistical information. These competencies were selected because they reflect the essential abilities individuals need to understand and utilize statistical information in everyday contexts.

The data analysis involved both descriptive and inferential statistical techniques. Descriptive statistics, including mean scores and percentage distributions, were used to provide an overview of students' statistical literacy performance across each indicator. Subsequently, the Mann–Whitney U test was conducted in SPSS version 26 to examine whether significant differences existed in statistical literacy scores between male and female students. This non-parametric test was selected because it is appropriate for comparing two independent groups when the data do not meet the assumptions of parametric tests.

In addition to the quantitative analysis, students' written responses were examined descriptively to identify common patterns of reasoning and difficulties encountered when solving statistical literacy tasks. This analysis provided deeper insights into the specific challenges students faced in interpreting, evaluating, communicating, and making decisions based on statistical information, thereby complementing the quantitative findings.

Table 1. Statistical Literacy Test Questions

No.	Variable	Statistical Literacy Questions
1	Decision making	Observe the following table containing seven 100-meter sprint records (in seconds) by Sarah, Rita, and Maria.

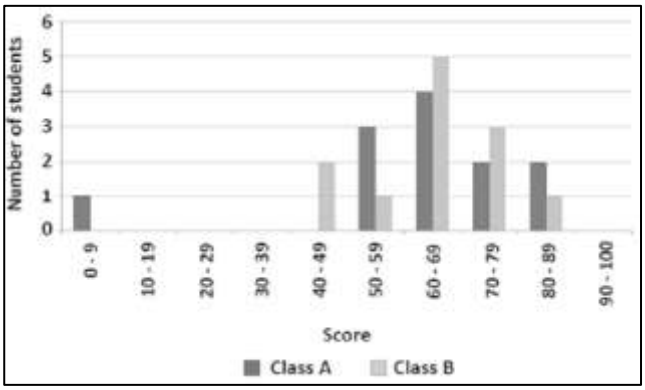
	1	2	3	4	5	6	7
Sarah	15.2	15.0	14.8	14.7	14.6	14.5	14.2
Rita	15.3	15.4	15.5	15.6	14.5	14.3	14.2
Maria	14.0	14.4	14.6	14.7	15.0	15.1	15.2

Source: adapted from Sharma (2013)

From these records, one runner will be selected to represent the school in the provincial running competition. Who do you think will represent the school? Give your opinion or explanation.

2 Evaluating

The following diagram illustrates the mathematics learning outcomes for students in Classes A and B, with a minimum passing grade of 50. The average scores for Class A and Class B are 62 and 64.5, respectively.

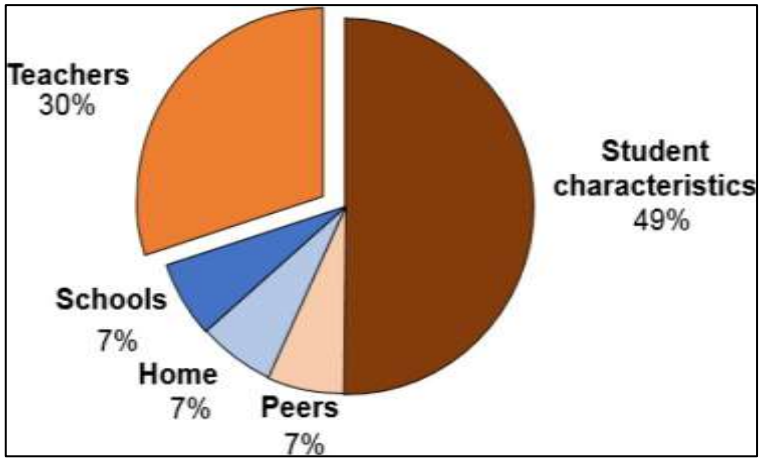


Source: Adapted from research by Kurnia et al. (2024)

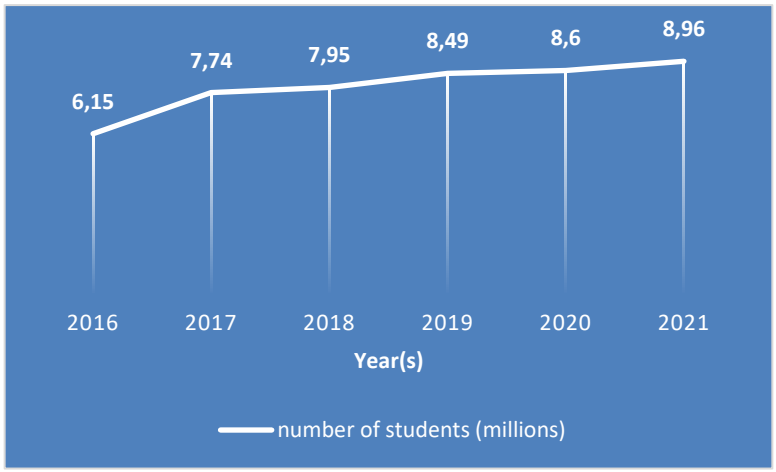
According to the diagram above, the maths teacher says that class B is better than class A. However, the students in class A disagree. They argue with their maths teacher to prove that class A is better than class B. Based on the diagram above, help the students in Class A find evidence that Class A is better than Class B.

3 Communicating

Factors Influencing Student Learning Outcomes



Sumber: data Indonesian Digital Journal of Mathematics and Education

No.	Variable	Statistical Literacy Questions
		If you are asked to explain to your friends/colleagues the factors that influence student learning outcomes in Indonesia, then based on the pie chart above, summarize the critical factors that influence student learning outcomes so that your friends/colleagues can easily understand them.
4	Interpreting	The graph below shows the increase in student numbers from 2016 to 2021.  Please give your opinion: what was the year-on-year increase in the number of university students in Indonesia between 2016 and 2021? Please also explain how you arrived at this figure.

RESULTS AND DISCUSSION

Data Description

Table 2. Results of Student Statistical Literacy Tests

Variabel	Number of Correct Answers	Number of Incorrect Answers	Male Correct Responses (n)/%	Female Correct Responses (n)/%	Average score
Decisions Making	33	111	10/36%	23/20%	22.9
Evaluating	108	36	26/93%	82/71%	75.0
Communicating	80	64	20/71%	60/52%	55.6
Interpreting	32	112	8/29%	24/21%	22.2

Table 2 presents students' performance on four statistical literacy indicators: decision making, evaluating, communicating, and interpreting. The results show considerable variation across the indicators. Among the four competencies assessed, evaluating achieved the highest performance, with 108 students answering correctly and an average score of 75.0. In contrast, decision making and interpreting recorded the lowest results, with only 33 and 32 correct responses, respectively. Both indicators had average scores below 23, indicating that many students encountered difficulties when required to use statistical information to make decisions and interpret data.

Students performed moderately on the communicating indicator. A total of 80 students provided correct responses, while 64 answered incorrectly, resulting in an average score of 55.6. Although more than half of the participants were able to

communicate statistical information appropriately, the findings suggest that this competency was not consistently demonstrated across the sample. A comparison of the four indicators reveals a notable pattern. Students appeared to be more successful when evaluating statistical information than when interpreting data or making decisions based on statistical evidence. This finding may indicate that students were relatively familiar with identifying and assessing information presented in statistical reports but experienced greater challenges when required to draw conclusions or make judgments from the data provided.

Gender-based results show that female students contributed more correct responses across all indicators. However, this pattern should be interpreted cautiously because female participants represented a substantially larger proportion of the sample (n = 116) than male participants (n = 28). When the percentages within each gender group are considered, male students demonstrated higher proportions of correct responses across the four indicators. To determine whether these differences reflected statistically significant variations in statistical literacy performance, further analysis was conducted using the Mann–Whitney U test.

Table 3. Results of the Mann-Whitney U Test by Gender

Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-tailed)
1450	1856	-1.206	0.228
1552	1958	-0.485	0.628
1592	8378	-0.188	0.851
1496	8282	-0.897	0.370

The Mann–Whitney U test results (Table 3) showed that the significance values for all statistical literacy indicators exceeded 0.05, namely decision-making ($p = 0.228$), evaluating ($p = 0.628$), communicating ($p = 0.851$), and interpreting ($p = 0.370$). This indicates that gender was not associated with statistically significant differences in students' statistical literacy performance. Furthermore, the descriptive statistics supported this finding, suggesting that male and female students demonstrated comparable levels of statistical literacy across all assessed indicators.

Analysis of Students' Responses to the Statistical Literacy Test

Decision Making

For the decision-making item, 36% of male students and 20% of female students provided correct responses. These findings indicate that the item posed a considerable challenge for a large proportion of participants, as reflected in the relatively low percentage of correct answers across both groups. Further examination of students' written responses revealed difficulties in utilizing the statistical information presented to formulate an appropriate decision. In particular, the sprinter scenario appeared to be challenging for many students, as evidenced by the response patterns presented below:

In Bahasa Indonesia
Semakin cepat pelari, maka semakin cepat pula waktu tempuhnya. S19
Semakin kecil waktu tempuhnya, semakin cepat larinya.S31
In English

The faster the runner, the faster the time. S19
The shorter the travel time, the faster it runs. S31

Students generally recognized that a faster runner has a shorter running time. Nevertheless, many participants based their decisions solely on the mean value and paid limited attention to the variability or consistency of the runner's performance. As a result, the decision-making process was often guided by a single statistical measure rather than a comprehensive evaluation of the available data. An example of this reasoning can be observed in the response of Student 32 (S32):

In Bahasa Indonesia:

Waktu rata-rata (detik) masing-masing pelari:

$$Sarah = \frac{15.2 + 15.0 + 14.8 + 14.7 + 14.6 + 14.5 + 14.4}{7} = 14.89$$

$$Sarah = \frac{15.3 + 15.4 + 15.5 + 15.6 + 15.4 + 15.3 + 15.2}{7} = 15.38$$

$$Sarah = \frac{14.0 + 14.4 + 14.6 + 14.7 + 15.0 + 15.1 + 15.2}{7} = 14,71$$

Jadi, pelari yang seharusnya mewakili sekolah dalam lomba tingkat provinsi adalah Maria karena memiliki kecepatan lari terbaik dan rata-rata waktu tercepat.

In English:

Average time (seconds) for each runner:

$$Sarah = \frac{15.2 + 15.0 + 14.8 + 14.7 + 14.6 + 14.5 + 14.4}{7} = 14.89$$

$$Sarah = \frac{15.3 + 15.4 + 15.5 + 15.6 + 15.4 + 15.3 + 15.2}{7} = 15.38$$

$$Sarah = \frac{14.0 + 14.4 + 14.6 + 14.7 + 15.0 + 15.1 + 15.2}{7} = 14,71$$

Therefore, Maria should represent the school in the provincial competition, as she has the best running speed and the fastest average time.

Students' responses suggest that many participants relied primarily on the mean to identify the fastest runner. Although the mean provides a measure of central tendency that summarizes the overall performance of a dataset, it does not fully capture the variability of individual observations. Consequently, decisions based solely on the mean may overlook important information regarding the consistency of performance. In the context of the running task, measures of dispersion, such as variance and standard deviation, are also relevant because they provide information about the stability and spread of the recorded times. Therefore, an appropriate decision requires consideration of both the central tendency and the variability of the data.

Evaluating

7% of male students and 29% of female students answered the evaluation item incorrectly. Analysis of students' responses indicated that many participants relied primarily on measures of central tendency when evaluating the data presented. Although using mean values provided a general summary of student performance, this approach alone was insufficient to meet the task's requirements. A more comprehensive evaluation required consideration of additional statistical information, particularly the distribution of scores relative to the Minimum Passing Grade Criteria (KKM). Specifically, students were expected to examine the frequency of scores falling above and below the KKM ($x \geq 50$) in order to make a more informed judgment. The tendency to focus on a single statistical measure suggests that many students experienced difficulty integrating multiple sources of statistical evidence during the evaluation process.

In addition, several students provided only a concluding statement without supporting their judgment with appropriate statistical evidence. Although they identified Class A as performing better than Class B, they did not explain the statistical basis underlying their conclusion. This pattern of reasoning is illustrated in the response from Student 99 (S99) below.

In Bahasa Indonesia
Sebagian besar siswa kelas B memperoleh nilai lebih tinggi dibandingkan dengan kelas A. Hal ini terlihat dari distribusi nilai kelas B yang lebih banyak berada di kisaran 80–100, sedangkan kelas A lebih banyak berada di kisaran 60–79. Artinya, kelas B memiliki rata-rata hasil belajar lebih baik, kemungkinan karena metode pengajaran, motivasi, atau lingkungan belajar yang lebih mendukung
In English
Most students in Class B obtained higher scores than those in Class A. This is evident from the distribution of scores in Class B, which were mostly in the range of 80–100, whereas those in Class A were mainly in the range of 60–79. This suggests that Class B had better average learning outcomes, possibly due to effective teaching methods, increased motivation, or a more supportive learning environment.

Therefore, the findings suggest that many students had difficulty integrating the concept of central tendency with other relevant statistical information when evaluating a situation. While the mean was frequently used as the basis for judgment, students often failed to consider complementary evidence, such as score distributions and frequencies, resulting in evaluations that were not fully supported by the available data.

Communicating

For the communication item, 29% of male students and 48% of female students were unable to provide correct responses. Compared with the other statistical literacy indicators, this item yielded a relatively higher proportion of correct answers, suggesting that students were generally more successful in communicating statistical information than in performing other statistical literacy tasks. An examination of students' responses indicates that many participants demonstrated a clear understanding of the context presented in the question. This pattern is illustrated in the response provided by Student 20 (S20), presented below.

In Bahasa Indonesia
Keberhasilan belajar siswa paling ditentukan oleh faktor internal dari diri siswa sendiri (49%), yang kemudian didukung oleh peran guru (30%). Sementara itu, faktor lingkungan seperti sekolah, rumah, dan teman berperan sebagai pendukung yang melengkapi dengan kontribusi masing-masing sebesar 7%. Oleh karena itu, strategi untuk meningkatkan hasil belajar harus berfokus pada pengembangan karakteristik siswa dan peningkatan kualitas guru, tanpa mengabaikan penciptaan lingkungan yang kondusif di sekolah, di rumah, dan dalam pergaulan.
In English
Student learning success is determined primarily by internal factors within students themselves (49%), with teachers playing a supporting role (30%). Meanwhile, environmental factors such as school, home, and friends play a supporting role, each contributing 7%. Therefore, strategies to improve learning outcomes must focus on developing student characteristics and enhancing teacher quality, while also creating a conducive environment at school, home, and in social circles.

Students who answered the item correctly were generally able to translate graphical information into written explanations that reflected the problem's context. Their responses suggest an ability not only to interpret the graph but also to communicate statistical information coherently. This pattern is evident in Student 20's (S20) response.

Nevertheless, analysis of the responses also revealed that some students encountered difficulties when communicating information extracted from graphical representations. Although they could identify certain elements of the graph, they struggled to express their interpretations clearly and support them with relevant information from the data. The response of Student 14 (S14) illustrates this difficulty.

In Bahasa Indonesia
Karakteristik siswa (49%) merupakan faktor terbesar. Ini mencakup motivasi belajar, minat, kemampuan diri, kedisiplinan, serta usaha yang dilakukan siswa.
Guru (30%): Cara guru mengajar, memberikan penjelasan, motivasi, dan bimbingan sangat memengaruhi hasil belajar siswa.
Peers (7%) Lingkungan pergaulan dan teman belajar juga berpengaruh; misalnya, teman yang rajin belajar dapat memotivasi.
Rumah (7%): Dukungan orang tua, kondisi rumah, dan perhatian terhadap pendidikan turut memengaruhi keberhasilan belajar.
Sekolah (7%) Fasilitas sekolah, suasana belajar, dan kebijakan sekolah juga berperan meskipun tidak sebesar faktor lainnya.
In English
Student characteristics (49%). This is the most significant factor. It includes students' motivation, interest, self-efficacy, discipline, and effort.
Teachers (30%) The way teachers teach, explain, motivate, and guide students greatly influences student learning outcomes.
Peers (7%). Social circles and study buddies also have an influence; for example, friends who study diligently can be a motivating factor.
Home (7%) Parental support, home conditions, and attention to education also influence learning success.
School (7%) School facilities, learning environment, and school policies also play a role, although not as significantly as other factors.

The student's response indicates difficulty in transforming graphical information into a coherent written explanation. Rather than interpreting and communicating the information presented in the graph, the student largely repeated details from the question and introduced statements that were not grounded in the available data. This pattern suggests a limitation in the ability to communicate statistical information accurately and contextually.

Interpreting

Compared with the other statistical literacy indicators, the interpreting item yielded the highest proportion of incorrect responses, with 71% of male students and 79% of female students answering incorrectly. The response patterns indicate that many students had difficulty connecting the statistical information presented to the problem's context. Rather than drawing conclusions based on the available evidence, several participants provided interpretations that were incomplete, unsupported, or inconsistent with the data. An example of this pattern is illustrated in the response provided by Student 56 (S56):

In Bahasa Indonesia
Dari grafik terlihat bahwa jumlah mahasiswa di Indonesia meningkat setiap tahun dari 6,15 juta (2016) menjadi 8,96 juta (2021). Total peningkatan selama 2016–2021 adalah 2,81 juta mahasiswa. Cara mendapatkannya yaitu dengan menghitung selisih antara jumlah tahun 2021 dan 2016 (8,96 – 6,15 = 2,81). Peningkatan ini menunjukkan bahwa minat masyarakat terhadap pendidikan tinggi semakin besar setiap tahun.
In English
The graph shows that the number of students in Indonesia has increased every year from 6.15 million (2016) to 8.96 million (2021). The total increase from 2016 to 2021 was 2.81 million students. This figure was obtained by calculating the difference between the 2021 and 2016 numbers (8.96 – 6.15 = 2.81). This increase indicates that public interest in higher education is increasing annually.

The response provided by Student 56 (S56) suggests a misunderstanding of the information requested in the task. The student interpreted the increase in student numbers by calculating the difference between the first and last observations (2016 and 2021). In contrast, the question required interpreting the yearly increases reflected in the data. As a result, the response captured the overall change across the period rather than the year-to-year trend. This pattern indicates difficulty in identifying the appropriate statistical information needed to support an accurate interpretation.

Furthermore, several students appeared to equate larger numerical values with greater improvement without examining the pattern of change across successive years. This tendency can be observed in the response provided by Student 68 (S68), presented below:

In Bahasa Indonesia
Dari grafik terlihat bahwa jumlah mahasiswa di Indonesia terus meningkat dari 6,15 juta pada tahun 2016 menjadi 8,96 juta pada tahun 2021. Dengan demikian, terjadi kenaikan sebanyak 2,81 juta mahasiswa dalam rentang waktu lima tahun tersebut. Secara rata-rata, peningkatan jumlah mahasiswa setiap tahunnya sekitar 0,56 juta (560 ribu) orang.
In English
The graph illustrates that the number of students in Indonesia has continued to increase, rising from 6.15 million in 2016 to 8.96 million in 2021. Thus, there has been an increase of 2.81 million students over the five years. On average, the number of students increases by around 0.56 million (560,000) people each year.

Analysis of Student 68's response indicates a tendency to focus on aggregate measures rather than the pattern represented in the data. Although the student correctly recognized that the number of students increased between 2016 and 2021, the explanation was based on the average increase over the entire period rather than the annual changes depicted in the dataset. As a result, the response did not fully address the question's interpretive requirement. This pattern suggests that some students experienced difficulty distinguishing between summary statistics and contextual interpretations of temporal data.

Discussion

Several findings emerging from the statistical literacy assessment merit further discussion in relation to the objectives of this study. *First*, the results indicate no

statistically significant difference in statistical literacy between male and female students. This finding is consistent with the OECD's emphasis on gender equality in educational outcomes (Brussino & McBrien, 2022). Although the present study focuses exclusively on statistical literacy performance rather than broader social or cultural dimensions of gender, the findings suggest that male and female students demonstrated comparable levels of competence in interpreting and using statistical information.

This result is also in line with previous studies conducted by Yolcu (2014), Kurnia et al. (2024), Riwayani et al. (2024), Weiland (2019), Helenius et al. (2020), Yusof et al. (2021), and Lesser and Santos (2023), all of which reported no significant gender differences in statistical literacy. While most of these studies were conducted at the primary and secondary school levels, the present study extends this evidence to higher education. The consistency of these findings across educational levels suggests that gender may not be a determining factor in statistical literacy achievement.

Second, the findings highlight the importance of contextual and domain-specific knowledge in understanding statistical information. Statistical literacy involves more than the ability to perform calculations or recognize statistical concepts; it also requires an understanding of the context in which data are generated and interpreted. Gal (2002) conceptualized this requirement in terms of several knowledge elements, including literacy skills, statistical knowledge, mathematical knowledge, contextual knowledge, and critical questioning. Similarly, Kurnia et al. (2024) emphasized the roles of textual and contextual understanding, representation knowledge, and statistical-mathematical knowledge as essential components of statistical literacy.

The findings of this study support both theoretical frameworks. Several students had difficulty interpreting statistical information because they focused primarily on numerical values while overlooking the data's context. This suggests that deficiencies in contextual knowledge may hinder the interpretation of statistical information, even when basic statistical procedures are understood. Considering that university students are expected to engage independently with information and construct knowledge through critical inquiry, these findings raise important questions regarding the extent to which contextual understanding is developed during higher education.

Given these findings, future research should examine the relationship between knowledge elements and response skills, particularly decision-making, evaluation, communication, and interpretation. To date, limited empirical evidence exists regarding how these dimensions interact within the broader construct of statistical literacy. Further investigation may also contribute to refining and validating the statistical literacy framework proposed by Kurnia et al. (2024).

Third, the findings indicate that reliance on the mean as the sole basis for decision-making may lead to incomplete or misleading conclusions. Although the mean is one of the most widely used measures of central tendency, its value can be substantially influenced by extreme observations. It may not adequately represent a dataset's characteristics (Bouke et al., 2025). Consequently, informed decision-making requires consideration of additional statistical measures and contextual information.

This perspective is consistent with previous studies demonstrating that decision-making often requires integrating statistical evidence with contextual knowledge. For example, assessments of regional economic conditions may require consideration of demographic, educational, and social factors alongside quantitative indicators (Chiripanhura, 2011). Similarly, policy decisions frequently involve interpreting both quantitative and qualitative evidence to support strategic actions (Umbach, 2022). Therefore, statistical literacy should not be understood as the ability to calculate statistical measures alone but rather as the capacity to evaluate multiple sources of evidence when making data-informed decisions.

Finally, the findings reveal that difficulties in interpreting graphical representations remain evident among some university students. Similar challenges have been reported in previous studies, which identified graph interpretation as a persistent obstacle in the development of statistical literacy (Azis & Dahlan, 2024; Ryder et al., 2025; Teng et al., 2024; Villarin et al., 2025). Effective graph interpretation requires foundational knowledge of data representation, including tables, diagrams, and graphs, as well as descriptive statistical measures such as the mean, median, mode, standard deviation, variance, and range (Felix et al., 2024).

The persistence of these difficulties suggests that some students may enter higher education without fully mastering fundamental statistical concepts. Such limitations can hinder their ability to interpret and communicate statistical information effectively. These findings provide empirical support for the proposition advanced by Kurnia et al. (2024) that foundational statistical knowledge is closely associated with performance in statistical literacy. Consequently, efforts to strengthen statistical literacy should begin with improvements in statistics instruction. Previous research has emphasized the need for innovative teaching approaches, including appropriate learning models, instructional strategies, educational technologies, and specialized learning materials to support students in developing meaningful statistical understanding (Forgasz et al., 2022).

CONCLUSION

This study examines students' statistical literacy from the perspectives of decision-making, evaluation, communication and interpretation of statistical information. The findings indicate no difference between male and female students across all the indicators assessed, suggesting that gender is not a determining factor in statistical literacy performance. However, students demonstrated varying levels of achievement across these four competencies. Whilst evaluation and communication were performed relatively well, decision-making and interpretation emerged as the most challenging aspects of statistical literacy. Further analysis of the students' responses revealed that many participants struggled to integrate statistical information with contextual understanding, often relying solely on a single statistical measure, such as the mean, when drawing conclusions or making decisions.

The findings highlight that statistical literacy extends beyond the ability to perform statistical calculations. Effective interpretation and evaluation of statistical information require integrating statistical knowledge, contextual understanding, and reasoning skills.

Students who demonstrated difficulties in interpreting graphs, understanding problem contexts, and justifying conclusions using statistical evidence appeared to lack one or more of these interconnected competencies. These results provide empirical support for the theoretical perspectives proposed by Gal (2002) and Kurnia et al. (2024), which emphasize the importance of knowledge elements as a foundation for statistical literacy.

From an educational perspective, the findings suggest that statistics instruction should place greater emphasis on contextualized data interpretation and evidence-based reasoning rather than focusing primarily on computational procedures. Learning experiences that involve authentic datasets, real-world problems, and opportunities to justify decisions using multiple statistical indicators may help students develop a more comprehensive understanding of statistical information. Furthermore, strengthening students' foundational understanding of data representation and graphical interpretation may contribute to the development of higher-order statistical literacy skills.

Several limitations should be acknowledged. First, the study focused exclusively on response skills and did not examine the direct contribution of knowledge elements to performance in statistical literacy. Second, the sample was limited to university students from selected institutions in Indonesia, which may limit the generalizability of the findings to other educational contexts. Future research should investigate the relationships between knowledge elements and statistical literacy skills, particularly decision-making, evaluation, communication, and interpretation. Such studies may provide further evidence to refine existing statistical literacy frameworks and inform the design of more effective instructional approaches for developing statistical literacy in higher education.

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