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CASE STUDY OF STATISTICAL REASONING ON INTEGRATED LEARNING NEEDS OF STATISTICS IN COMIC DIGITAL TEACHING MATERIALS

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ABSTRACT
The low statistical reasoning ability of students and limited contextual learning media that are interesting and easy to understand are two of the weaknesses in learning statistics material. This study aims to examine students' statistical reasoning in the context of learning needs integrated with digital teaching materials, Statistics Comics. This study uses a case study approach involving high school students, teachers, and vice principals as subjects, as well as qualitative data analysis of the results of interviews with the three subjects. The results of the study, which were analyzed qualitatively with the help of Atlasti 8, showed that statistical reasoning learning requires a contextual and digital-based approach. This finding indicates that the development of digital teaching materials based on comics is needed as an innovative alternative in learning statistics that supports improving students' statistical literacy and reasoning in the digital era.
Keywords : Statistical Reasoning, Comic Digital Teaching Materials.

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PRELIMINARY

The abundance of data requires precision in interpreting it so that it can be used appropriately in solving problems. Therefore, providing students with how to deal with problems related to the many sources of data is very important. In dealing with the phenomenon of big data, it is necessary to develop a framework that can guide students in managing and utilizing data effectively in their learning. Thus, they will have strong provisions to face various data problems in life (Gil & Gibbs, 2017).

However, students still face obstacles in understanding data, especially at the secondary school level. The difficulty is often caused by a lack of deep conceptual understanding. Many students can follow a procedure or formula but do not understand the concept behind it, making it difficult to apply it in real situations or connect concepts effectively. (Smith, J., & Brown, 2025).

Teachers need to understand students' ability to interpret data in order to synthesize and evaluate the structure, content, and effectiveness of data-based learning (Hasheminejad & Sarvmili, 2018). One of the abilities that students must have to understand data well is statistical reasoning. This ability includes skills in reading, analyzing, and drawing conclusions from various forms of data representation.

According to delMas (2002), statistical reasoning is categorized as a statistical thinking process that includes three stages, namely, why, how, and explain. The "Why?" stage refers to the understanding of statistical concepts and rules and the ability to express reasons for data. The "How?" stage relates to providing alternative solutions based on statistical concepts and processes. Meanwhile, the Explain sstage focuses on drawing conclusions based on statistical concepts, rules, and processes.

Meanwhile, according to Shin (2021), statistical reasoning is a way of thinking for students that involves statistical ideas, statistical understanding, and statistical thinking in understanding the reasons and ways of solving problems related to statistics. Students' statistical ideas are formed from their understanding of studying statistics. Therefore, the use of statistical reasoning is important to guide students in facing future challenges (Shin, 2021), so that they can sort information or data wisely.

In line with the mathematics learning standards developed by the National Council of Teachers of Mathematics (NCTM), statistical reasoning is an important skill in understanding, analyzing, and interpreting statistical data. These standards are problem-solving, communication, connections, reasoning, and representation. Reasoning is essential to learning statistics because it helps students interpret data and make decisions based on the statistical information they have (Ganesan & Leong, 2020).

Furthermore, in dealing with these reasoning problems, integrated digital learning and learning that relates to students' daily contexts are needed. Mascia et al., (2018) The use of digital tools in learning mathematics skills has had a positive impact. Digitalization in mathematics learning is integrated into certain teaching materials, resulting in the latest forms of teaching materials, such as the digitalization of statistical comics.

Meanwhile, comics consisting of simple and concise illustrations as a superior learning tool can help learning in the context of students' daily lives (Kim et al., 2017). If combining digital teaching materials with comics in the learning system, it becomes one of the teaching materials that supports students to be active in learning.

However, the development of digital teaching materials needs to be based on an analysis of learning needs that departs from real case studies so that the materials compiled

are truly relevant and in line with the conditions and problems faced in the field. The needs analysis process is carried out by involving teachers and students and exploring the suitability of the curriculum to become the basis for developing digital technology-based mathematics teaching materials that are in accordance with the characteristics and needs of students (Andang & Subhan, 2023).

The purpose of this study is to identify and analyze the forms and levels of statistical reasoning that emerge in the context of learning needs integrated with digital teaching materials based on statistical comics. This study also aims to examine how the characteristics of students' statistical reasoning can be accommodated and improved through visual and narrative learning media packaged in the form of digital comics. Thus, the results of this study are expected to provide an empirical basis for the development of digital teaching materials that are not only interesting but also effective in building statistical thinking skills conceptually and contextually.

METHODS

The case study method is a qualitative research approach used to understand phenomena in depth in a real context, especially when the boundaries between phenomena and context are not clear. According to (Magnoni, 2018) , case studies allow researchers to explore complex phenomena through multiple data sources. In the context of education, this method is effective for studying thinking processes, such as statistical reasoning, because it allows researchers to explore learning dynamics contextually and in depth.

The case study research design follows an exploratory approach with a focus on one or several participants who represent certain characteristics (purposive sampling). The steps in this study include (1) identification of subjects or target groups that are relevant to the needs of statistical learning, (2) data collection through observation, interviews, and analysis of learning documents such as student assignment results, (3) development and application of digital teaching materials based on statistical comics in an integrated manner in learning activities, (4) analysis of the statistical reasoning process demonstrated by students during the use of teaching materials, and (5) holistic interpretation of the results to conclude the contribution of teaching materials to improving students' statistical reasoning. The entire process is carried out in the real context of learning and emphasizes data triangulation to maintain the validity of the findings.

The indicators in the field notes, teacher interviews, and student interviews will be explained in the following section.

Table 1. Field Notes Indicators.

Indicators	
Students Profile	**School Conditions**
Student Characteristics	Statistics Material
Number of Students	Technology Resources
Student Learning Experience	Learning Facilities
Student Interaction	Teacher Resources

Modified from Pacheco-Vega (2019)

Table 2. Teacher Interview Guidelines Indicators

Indicators	Number of Questions
How to Teach Statistics Material	4 Questions
Students' Abilities	4 Questions
Use of Media in Statistics Learning	4 Questions
Need for Digital Teaching Materials	4 Questions

Modified from Roos (2022)

Table 3. Student Interview Guidelines

Indicators	Number of Questions
Student Perception in Understanding Statistics	5 Questions
Student Techniques in Answering Questions	5 Questions
Student perception in learning statistics	7 Questions

Modified from Hasma et al., (2023)

In the data analysis process, researchers used the help of Atlas.ti 8 software to manage and interpret qualitative data systematically. The use of this software makes it easier to identify main themes, group categories, and trace the relationships between data. The results of the analysis are then used as a basis for drawing conclusions that represent research findings comprehensively and objectively.

RESULT AND DISCUSSION

The interview was conducted on March 1, 2024, at a cafe located near MA Negeri 1 Indramayu. The selection of this location aims to create a comfortable atmosphere so that the subject can provide information openly and honestly. Relaxed conditions are expected to encourage effective communication and produce relevant data for the development of digital teaching materials.

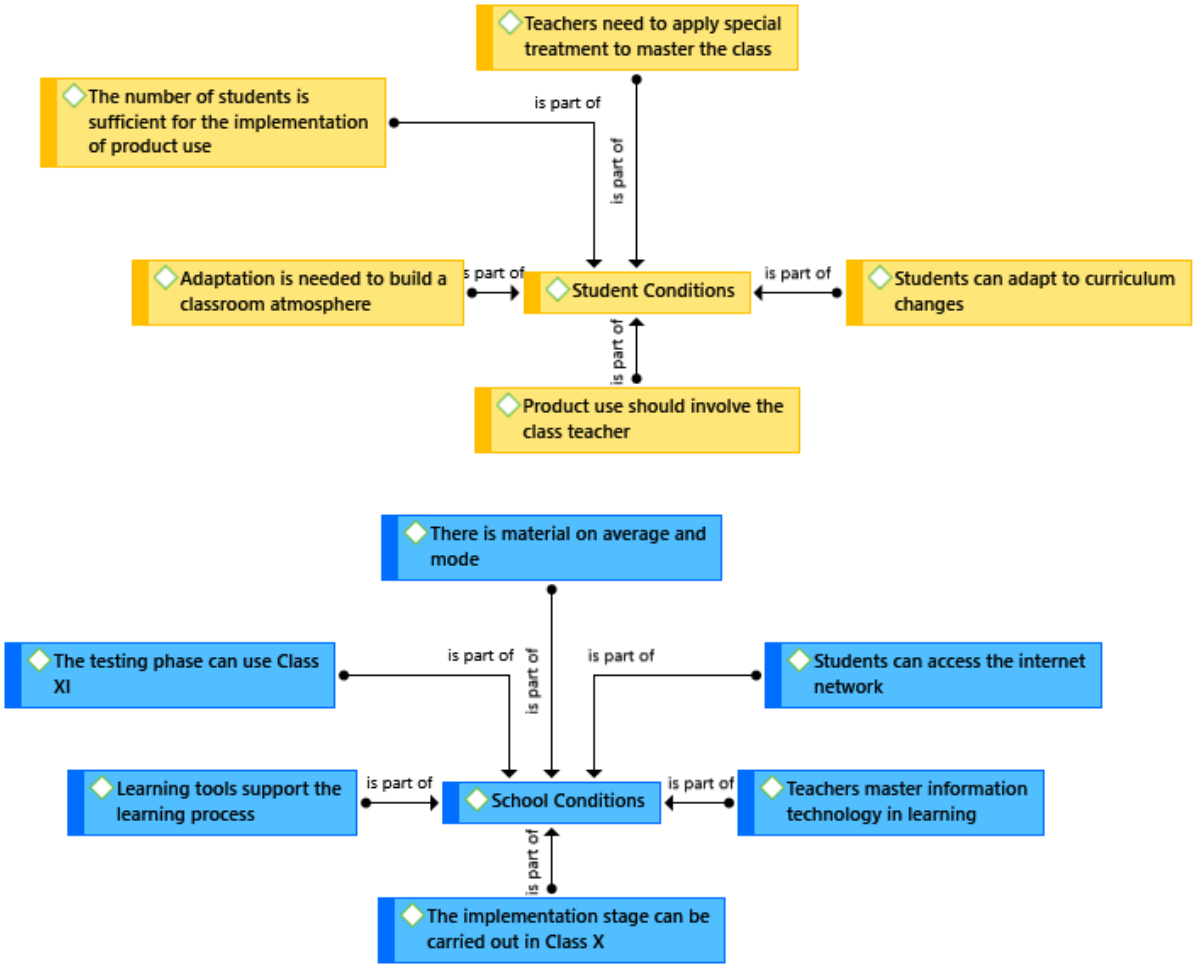

Figure 1. Field Notes

Based on Figure 1, which comes from field notes, the development of digital teaching material products on statistics material, especially on the average and mode material, can be developed by considering two main aspects, namely student conditions and school conditions.

In terms of student conditions, there are several things that need to be considered so that the use of comic digital teaching material products runs effectively. First, the number of students must be sufficient to support the implementation of product use. Second, students need to be able to adapt to changes in the curriculum, which shows readiness for new materials, including the use of digital media. In addition, the classroom atmosphere must also be conducive, which requires adaptation from all parties, including special treatment from teachers in managing the class. Therefore, it is better if the class teacher is directly involved in the use of the product so that class control and the learning process run optimally.

Meanwhile, in terms of school conditions, the development of digital teaching material products must also be supported by school infrastructure and policies. Product

testing can be done in grade XI, while the implementation stage can start from grade X. Support for facilities such as adequate learning equipment and internet network access that can be reached by students are important factors. In addition, the ability of teachers to master information technology is also a requirement so that digital teaching materials can be utilised optimally.

By taking into account the conditions of both students and the school environment that have been discussed, the development of digital teaching materials for statistics can be carried out in a more relevant and effective manner, thereby enhancing the learning process.

Furthermore, teacher interviews were also conducted at the same place and time as the vice principal. The results of the interviews are as follows.

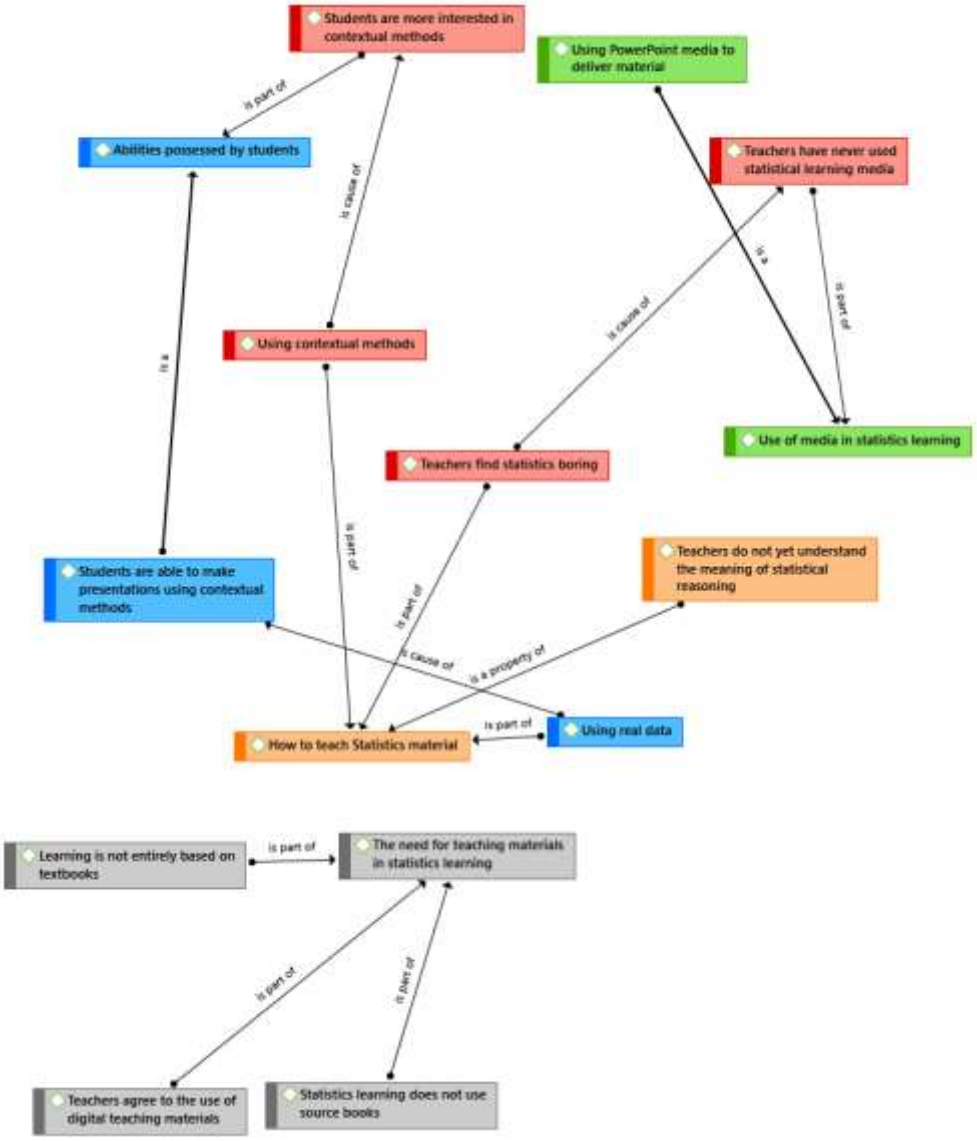

Figure 2 Results of Teacher Interview Analysis

Figure 2 explains that the abilities possessed by students, it can be seen that students are more interested and able to present material if using contextual methods based on the use of real data. This contextual method is part of how to teach Statistics material. Unfortunately, in practice, teachers consider Statistics material boring, which is caused by the teacher's lack of understanding of the concept of Statistical reasoning.

In addition, teachers have never used learning media in teaching statistics. This is closely related to the use of media in statistics learning, which is currently limited to the use of media such as PowerPoint to explain the material. This condition shows the less-than-optimal media innovation in the learning process.

Regarding the need for teaching materials, teachers prefer to use digital teaching materials rather than traditional source books in statistics learning. This is because the existing textbooks cannot be used as a full reference for the learning process, so additional teaching materials are needed that are more relevant and applicable.

Through the relationship flow shown in the figure, it can be concluded that the creation of digital teaching materials on statistics material is very much needed. This digital teaching material is expected to be able to accommodate the use of contextual methods based on real data, increase student interest and abilities, and support teachers in understanding the concept of statistical reasoning better. In addition, digital teaching materials can enrich previously limited learning media, thus creating statistics learning that is more interesting, effective, and relevant to the needs of the times.

While the student interviews took place on February 12, 2024, the activities continued the following day with additional interviews. This subsequent interview aims to clarify the responses provided by students and to delve deeper into their experiences and perceptions regarding the learning of statistics.

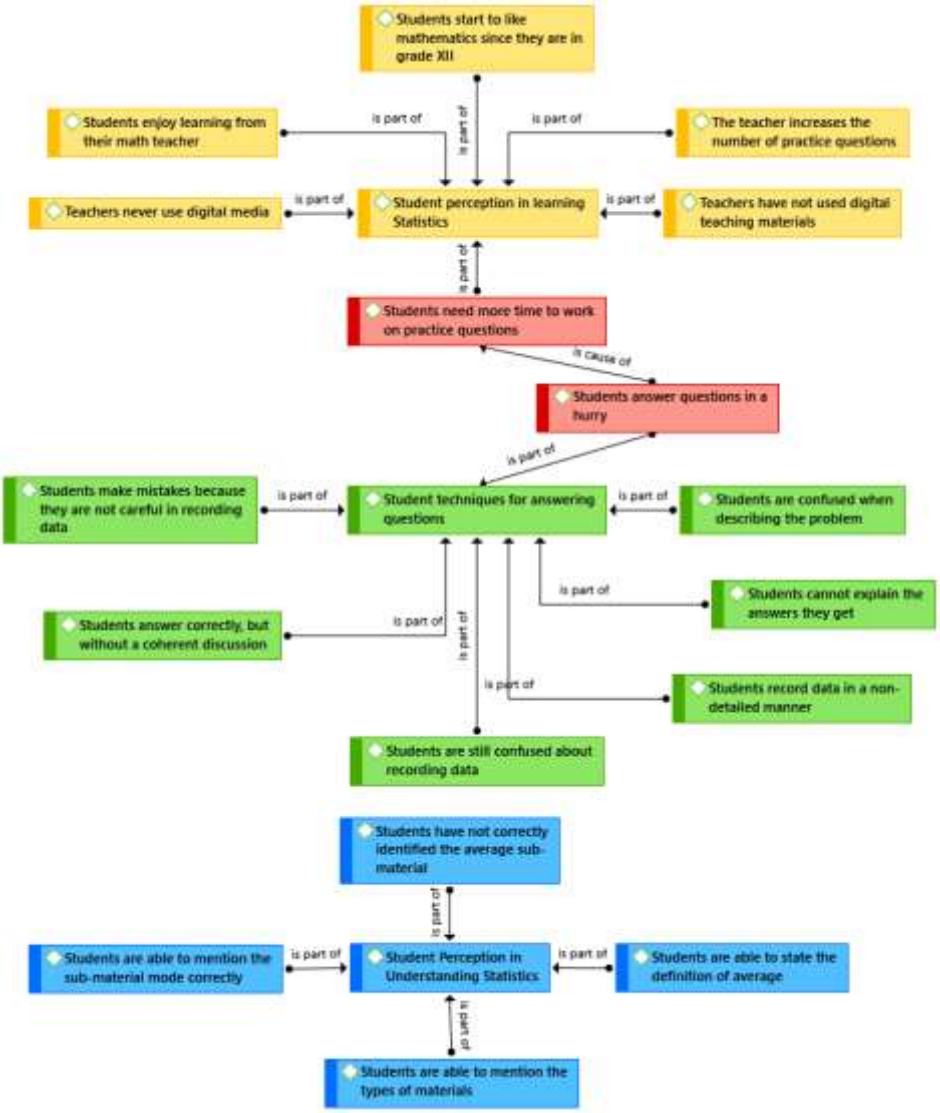

Figure 3 Results of Student Interview Analysis

Figure 3 describes students' perceptions of statistics learning and the challenges faced in understanding the material and answering questions. Students only like mathematics when they are in grade XII, one of the reasons is because they like their math teacher. The teacher tends to give more practice questions but does not use digital media or teaching materials in the learning process. This affects students' perceptions of statistics learning, especially in terms of effectiveness and how to understand the material.

Due to the lack of utilisation of digital media and appropriate teaching materials, students need a long time to work on practice questions. In fact, in certain conditions, students tend to rush, causing errors in recording data, confusion in describing questions, and an inability to explain the answers obtained. Some students also mention the correct answers but without a clear sequence and are unable to register data correctly. This shows that students' techniques in answering questions are still weak and unsystematic.

Furthermore, students' understanding of statistics material is also not fully mature. Some students have not been able to mention the average sub-material correctly, although some have been able to mention the definition of the average, mention the type of material, and mention the mode sub-material correctly. This shows an imbalance in the understanding of the overall concept of statistics.

Based on the data in the image, it can be concluded that students need more systematic, interactive, and structured statistics learning. Therefore, the creation of digital teaching materials is very important to bridge the limitations of conventional methods. Digital teaching materials can help clarify concepts, facilitate understanding of definitions and sub-materials, and improve students' techniques in answering questions through higher visualisation and interactivity. This has the potential to accelerate student understanding, reduce technical errors, and increase accuracy and independence in solving statistics problems.

Results of interviews with the vice principal and subject teachers. The interview showed that the condition of the school and students at MA Negeri 1 Indramayu was quite ready to support digital learning innovations. Statistics materials were fully available, and the fulfilment of support from the technology side and teacher resources. The condition of the students also showed high readiness, especially in terms of characteristics, learning experiences, and the number of students relevant to statistics materials.

However, despite the readiness of infrastructure and human resources, the learning methods used so far are still conventional. Experienced teachers, for example, still rely on lecture methods and manual poster media in delivering statistics material. This is contrary to the needs of students who want learning that is more interesting, varied, and relevant to everyday life. Teachers also said that statistics is often considered boring due to a lack of understanding of the contextual approach to statistical reasoning.

Interviews with teachers showed that there are no digital teaching materials used in statistics learning, even though there is an urgent need for more applicable and easy-to-understand learning media. Teachers expressed interest in using digital teaching materials based on real data because they are more suitable for contextual methods that actively involve students. This shows that the development of digital teaching materials is not only important but also very much needed to support more effective and enjoyable teaching strategies.

From the students' perspective, students said that statistics learning becomes more enjoyable when delivered with a contextual approach and based on real activities.

Unfortunately, the methods used by teachers are often passive and boring. The absence of digital media used during learning makes it difficult for students to understand the material thoroughly, especially in the aspects of reasoning and problem-solving strategies.

Nuriah at al., (2021) So far, the teaching materials used by teachers have not been integrated with a contextual approach, and the teacher's response to the development of teaching materials in the form of contextual-based e-modules is quite good. This is in line with the results of teacher interviews in this study, which show that not many teachers use digital teaching materials by involving student problems. In addition, Logan at al., (2021) stated that by involving students in the content of digital teaching materials, they will be more active in their learning. Discussion of material through students' daily lives will have a good impact on the students' activeness itself.

These findings make it clear that the development of comic-based digital teaching materials is needed as an innovative alternative in statistics learning that supports improving students' statistical literacy and reasoning in the digital era. These digital teaching materials must be able to bridge the gap between conventional learning methods and students' needs for a more enjoyable and relevant learning experience. In addition, digital teaching materials are also expected to help teachers master the statistical reasoning approach that has not been optimally developed in the classroom.

Digital teaching materials designed based on the results of this needs assessment have great potential to increase student engagement, conceptual understanding, and critical and systematic thinking skills. By integrating visual stories through comics and problem-based approaches, students will find it easier to understand data, answer questions in the correct order, and avoid mistakes in the thinking process. This also allows teachers to make optimal use of technology in supporting learning)

CONCLUSION

Based on the results of the study, it can be concluded that the statistical reasoning case study shows a real need for more contextual, interesting, and student-orientated statistical learning. The purpose of this study to reveal the characteristics of students' statistical reasoning in the context of needs-based learning was successfully achieved through an in-depth analysis of students' thinking patterns and difficulties in understanding statistical concepts. This study shows that the integration of digital teaching materials in the form of comics can stimulate students' cognitive involvement, facilitate understanding of concepts, and support the development of statistical reasoning gradually.

These findings have important implications for the development of statistics learning strategies in schools. The use of digital teaching materials based on statistical comics can be an innovative alternative in designing learning media that are adaptive to students' needs and learning styles. Teachers and teaching material developers are advised to consider case study-based approaches and narrative visual media in delivering statistical materials in order to increase the appeal and effectiveness of learning. In addition, these findings open up opportunities for further research related to the influence of visual media on other aspects of students' statistical literacy.

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