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Empowering Educational Researchers through Effective Data Presentation Methods: Balancing Clarity, Accuracy, and Interpretability

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Abstract

In the field of educational research, the ability to present data clearly and accurately plays an important role in ensuring that research results can be interpreted correctly. However, many novice researchers still face difficulties in choosing data presentation methods that can effectively communicate their research results. This study aims to analyze the advantages and disadvantages of several data presentation methods commonly used in educational research, with a focus on how each method supports clarity, accuracy, and interpretability. Using a qualitative descriptive approach, this study examines various examples of visual and textual data presentation, including tables, graphs, and narrative descriptions, to evaluate their effectiveness in conveying clear and easily understood information. The results of the analysis show that visual representations can improve clarity and attract readers' attention, but they can also oversimplify complex data. Conversely, presenting data in textual or tabular form may maintain accuracy, but may reduce accessibility for a wider readership. This study concludes that effective data presentation requires a balanced integration of visual and textual elements, based on the principles of transparency and reader-centered communication. These findings imply that it is important to develop data literacy and presentation skills among education researchers in order to strengthen the credibility of research, encourage collaboration, and empower the academic community in the ever-changing world of education and innovation.

1. Introduction

In a global era that increasingly relies on empirical evidence and data, the presentation of clear and accurate data is a fundamental aspect in the dissemination of scientific knowledge. In the field of education where data often comes from surveys, observations, questionnaires, or learning process analytics the ability to present data in a way that is easy to understand, remain accurate, and can be interpreted correctly by a wide range of readers (academics, practitioners, policymakers) becomes critical. However, the practice of presenting data among educational researchers, especially novice researchers, often still faces challenges: the selection of

inappropriate presentation methods can obscure the meaning of the data or make it difficult for non-statistical readers to interpret.

Although the literature on data visualization and presentation of research results has developed in recent years, many of the guidelines come from the fields of science, health or data science, rather than specifically aimed at educational research contexts. For example, conceptual reviews show that visualization is increasing in popularity due to its ability to simplify complex information into easy-to-capture patterns, trends, or insights, but also emphasizes challenges such as the need for technical expertise and the risk of oversimplifying data (Divecha et al., 2023).

In the context of education, data literacy and visual literacy are becoming increasingly important. Recent research shows that efforts to improve data literacy in schools or educational institutions, including the ability to understand, interpret, and present data appropriately, is an essential part of the transformation of education towards the era of information and innovation (Prima Sari et al., 2025) However, there have not been many studies that have systematically explored how educational researchers choose data presentation methods and how these choices affect readability, accuracy, and interpretability of research results.

Problem Formulation

Based on this background, this research is designed to answer the following questions:
1. What are the data presentation methods (visual and textual) commonly used in educational research, and what are the characteristics of each method?
2. What are the advantages and disadvantages of each data presentation method in terms of: clarity, accuracy, and interpretability?
3. How can the balance between visual and textual elements be optimized to keep research results transparent, accurate, and easy to understand for a wide audience, especially novice researchers in the field of education?

Research Objectives
This research has the following objectives:
1. Identify and describe the most prevalent data presentation methods in educational research (tables, graphs/diagrams, narratives/texts).
2. Critically analyze the advantages and limitations of each data presentation method on the aspects of clarity, accuracy, and interpretability.
3. Formulate conceptual recommendations in the form of guidelines or considerations for educational researchers in choosing and combining data presentation methods in a balanced manner based on data character, objectives, and audiences.

1.1 Literature Review
The development of data literacy in education in recent years has shown a shift in focus from just technical skills to more systemic conceptual competencies. Researchers such as Jeong and Lee (2024) and Moon et al. (2025) emphasize that data literacy at the K–12 level requires an explicit competency framework, not only regarding data comprehension but also the ability to read visualizations correctly. Similar patterns emerge in the context of higher education, for example in the agricultural sector (Šalamon et al., 2024) and public university environments (Ologbosere, 2023), which suggests that visual interpretation skills are no longer an additional skill, but a basic requirement of evidence-based thinking.

However, the literature also warns that exposure to graphs does not automatically make learners data-literate. A number of studies have shown how easily students misinterpret graphics due to scale trimming, dimensional distortion, or biased visual framing. The most often discussed are misleading graphs. The study by Driessen et al. (2022) found that graphs that are "incorrect but in context" are often not as misleading as they might think, but still have the potential to instill misconceptions if the reader does not have basic statistical knowledge. What's even more annoying is that simple visual distortions such as Y-axis cutting have proven to be

consistently deceptive (Yang et al., 2021). This research implies that visual comprehension is not enough to be taught as a technical skill, but must be instilled as a critical thinking habit. The literature on data visualization literacy emphasizes the need for a structured learning approach. Börner et al. (2019) and Hehman & Xie (2021) discuss how the ability to read graphs involves complex cognitive processes that are prone to overload, referring to the principles of Cognitive Load Theory (Sweller, 2011). If visualization is poor, the cognitive load increases, and the reader is more susceptible to misinterpretation. Stalph and Heravi's (2023) analytical framework supports this idea by showing that each visual artifact carries a design component that the user must understand. These findings connect with the latest literature that encourages education-based data visualization learning, not just software (Bach et al., 2023), as well as the efficiency of using tables and graphs so as not to confuse readers (Du et al., 2022; Divecha et al., 2023).

Data visualization has begun to be used to support dashboard-based learning, such as LearningViz (Pei et al., 2024) which shows that interactive visualizations help map learning gaps. Even in the context of community service, Excel and Quizizz training have been proven to improve teachers' ability to make visualizations (Prima Sari et al., 2025). The general pattern of these studies is: without explicit training, learners easily misread graphs; With systematic training, they level up significantly. There are some theoretical tensions in the literature. For example, some researchers believe that misleading graphs are very harmful (Yang et al., 2021), while others state that their effects are smaller than assumed (Driessen et al., 2022). Some studies argue that the competency framework should be universal (Jeong & Lee, 2024); others state that visual literacy is highly contextual and cannot be forced on all fields (Šalamon et al., 2024). This contradiction is not a flaw, but it shows that there is a blank space that needs to be bridged by research: what exactly is the pattern of visual interpretation of readers in certain contexts, including in Indonesian students.

From the overall literature, the gap that emerges is quite clear: there is a lot of research on data literacy, a lot of research on misleading graphs, but there is still a lack of context-based research on how they actually interpret graphs (especially misleading ones). The majority of studies focus on K–12 abroad, higher education in a specific sector, or the realm of journalism, while the context of general learning in Indonesian universities is rarely touched. This is where the research stands: examining how correctly students understand line, bar, and pie charts, and how they are affected when they are manipulated.

2. Research Methods

The research uses purposive sampling of the source of academic documents, because the purpose of the research requires articles that explicitly contain various forms of data presentation (tables, graphs, diagrams, and narratives). The target population of the study is scientific publications in the fields of education and social sciences published between 2021–2025. Inclusion criteria include: empirical articles with full text; contains at least one form of data presentation; published by reputable journals; Provide visuals or tables in an analyzeable quality.

Data collection was carried out through browsing academic databases such as ERIC, DOAJ, Taylor & Francis Online, SAGE Journals, MDPI, and Google Scholar. Keywords are adjusted to the focus of the research: *"data presentation", "data visualization", "tables", "graphs", "figures", "educational research".* From each article, the extracted elements include: metadata (author, year, title, DOI); entire tables, graphs, charts, and narratives of results; the context in which visualization is used (e.g., results or discussion sections); methodological descriptions relevant to data interpretation.

The main instrument of the research is a qualitative assessment rubric developed based on principles that continue to be recognized in the scientific visualization literature: clarity, accuracy, interpretability, transparency, and reader-centered communication (Hehman & Xie, 2021; Stalph & Heravi, 2023; Schriger, 2022). Rubrics include indicators of the suitability of visual forms with the data type, adequacy of statistical information (e.g. variability, scale), consistency of labels and annotations, compatibility between tables/graphs and supporting narratives, potential distortion or oversimplification. Validation is carried out through source triangulation, checking the suitability of findings with the latest methodological literature, and limited peer

debriefing. The entire process ensures the reliability and credibility of the findings. The analysis is carried out through three stages: Data reduction, encoding the essential elements of each form of data presentation. Presentation of data, compiling thematic summaries to show general patterns, strengths, and weaknesses, and drawing conclusions relate findings to the principles of clarity, accuracy, and interpretability.

3. Result and Discussion

The results section of this literature-based qualitative descriptive research presents the main finding patterns related to the effectiveness of data presentation methods in educational research. The analysis was carried out by mapping the findings in the relevant 2021–2025 literature, especially those that discuss data visualization, reporting accuracy, and scientific communication practices in the fields of education and social sciences. These results are then grouped into three main dimensions according to the focus of the research: clarity, accuracy, and interpretability.

A. General Patterns of Use of Data Presentation Methods in Educational Research

The literature shows that the three most dominant methods used by educational researchers are: Tables, Graphs/visualizations (bar charts, line charts, boxplots, heatmaps, etc.), Descriptive narratives. The study of Hehman & Xie (2021) confirms that many researchers choose graphics because they are considered more attractive and easy for readers to understand, but their design practices are often inconsistent with scientific visualization principles. These findings are in line with the report of Stalph & Heravi (2023) which shows that visualizations are still often misleading due to improper selection of chart shapes or inaccurate scale placement. Meanwhile, Du et al. (2022) found that tables remain the most accurate tool for presenting raw numerical values, especially in educational research that requires transparency and reproducibility.

B. Findings Based on the Dimensions of Clarity, Accuracy, and Interpretability

1) Clarity

Good visualization increases the reader's speed in understanding data patterns. The study of Hehman & Xie (2021) shows that graphics with full labels, clean designs, and minimal decorative elements have the highest level of readability. However, many educational articles use "beautiful" but unclear graphics, e.g. confusing legends or wicks are not adequately labeled. Driessen et al. (2022) emphasize that context determines whether or not a graph is perceived to be clear; Without adequate captions, readers often misinterpret.

2) Accuracy

Tables keep accuracy better than graphs. Du et al. (2022) recommend that tables in research should always include N, SD, and other indicators of uncertainty so that readers understand data variations, not just mean numbers. Visualizations often trim these elements for simplicity's sake. As a result, the reader can be deceived that the pattern appears more stable than it really is. Worse, graphs with truncated scales (truncation axes) can unrealistically increase the perception of difference (Yang et al., 2021).

3) Interpretability

Interpretability relies on the integration of graphics, tables, and narratives. Without a supporting narrative, graphics can be multi-interpreted. Börner et al. (2019) explain that the visual literacy of the reader determines whether the visualization can really be interpreted. If the reader is less literate, complex graphics actually obscure the information. Driessen et al. (2022) also show that the reading of graphs is strongly influenced by narrative context; When captions are directed to a specific insight, readers are more likely to follow that interpretation.

C. Best Practices and Common Mistakes

Best practices found in the literature: Harmoniously combining graphs (overview), tables (details), and narratives (interpretation) (Hehman & Xie, 2021; Du et al., 2022). Include error bars and CI on the graph to maintain statistical transparency. Use an informative caption instead of just "Figure 1: Bar Chart".

Frequent errors: Oversimplification, including graphs that eliminate variance and outliers. Misleading designs, such as excessive pie charts, cropped scales, overly contrasting colors, and the size of elements that deliberately direct the reader's perception (Yang et al., 2021). Lack of visual and statistical literacy among new researchers (Ologbosere, 2023).

D. The Meaning of Findings in the Context of Educational Scientific Communication

The results show that there is no one method of presenting data that is the most superior for all situations. Visualization excels at grabbing attention and speeding up initial understanding, but tables are superior in numerical accuracy and research replication needs. Narrative remains important to bridge the meaning between elements. This is consistent with the view of Hehman & Xie (2021) who state that visualization is not just a "decoration" but an epistemic tool that influences how scientific knowledge is produced and understood. Thus, educational researchers should not decide on the format of data presentation based only on aesthetics, but also on the accuracy and purpose of communication. The challenge that novice researchers face in choosing a data presentation method is Lack of knowledge about the trade-offs of visualization vs tables. They often choose charts because they look professional, even though sometimes charts are not suitable for high-variance data. Lack of understanding of visual literacy and scientific design principles. Stalph & Heravi (2023) show that many educational journal visuals are still stuck in journalistic or decorative design, not scientific design. Difficulty communicating uncertainty. Driessen et al. (2022) show that readers often misinterpret graphs without variability information.

E. Integration of Visuals, Tables, and Narrative as Key to Interpretability

Interpretability is not just about the form of the graph, but how it is placed in the structure of the research text. Using charts without supporting tables risks misleading. In contrast, tables without visualization can feel dry and difficult to understand for non-academic readers. In other words, graphs communicate large patterns. The table communicates accurate details. Narrative communicates meaning. The three cannot be separated if researchers want to maintain the quality of interpretation. Based on the findings, here are practical recommendations that can be immediately applied by students and educational researchers: Use graphs for overview, tables for details, narrative for context. Make sure each chart has informative captions, including key variables, data sources, and insights. Include an uncertainty indicator if the chart shows a quantitative comparison. Avoid visual distortions, especially truncation axes (Yang et al., 2021). Learn the basic principles of visual literacy such as visual hierarchy, color consistency, and aspect ratio.

F. Research Contributions to Academic Literature and Practice

This study reaffirms global findings that the quality of data presentation has a direct impact on the quality of research interpretation. By mapping out best practices and common mistakes, the study produces a practical framework that budding researchers in the field of education can use to improve the credibility of their scientific reports. In addition, this research can be a foundation for educational institutions to develop data literacy training or scientific visualization workshops.

The limitations and suggestions of further research in this study are limited to the analysis of the literature, so it does not include empirical analysis based on real datasets. Advanced research can test how students or education practitioners interpret certain graphs experimentally, develop a data visualization evaluation rubric that can be used by educational journal reviewers, and compare visualization practices between international journals and Indonesian national journals.

4. Conclusions

This study emphasizes that the presentation of data in educational research has an important role in ensuring that research results can be understood, interpreted, and evaluated accurately. The three main methods analyzed tables, graphs/visualizations, and descriptive narratives each have strategic functions that can

strengthen or even limit the quality of scientific communication when used without careful consideration. The findings show that data visualization is effective in improving clarity and reader appeal, especially when researchers want to display patterns, trends, or comparisons. However, visualization also carries the risk of oversimplification if the visual elements are not accompanied by adequate context or explanation. In contrast, tables are seen as superior in maintaining accuracy, especially for detailed data, but have the potential to reduce accessibility due to a view that tends to be dense and less attractive to the general reader. Meanwhile, descriptive narratives become an interpretive bridge that provides meaning, reason, and context to data, but can lose precision if it is not accompanied by visual support or systematic structure.

Overall, the balance between the three methods is the main key. The proper integration of visuals, tables, and narratives allows researchers to present research results that are not only methodologically correct but also communicative, transparent, and interpretive. Thus, the selection of data presentation techniques is not only an aesthetic decision, but an epistemological decision that affects the way the research findings are understood and used by the reader. This study also highlights the need to improve data literacy and the ability to present research results among educational researchers, especially beginners. These competencies are important to strengthen research credibility, expand readership, and support a more inclusive and collaboration-oriented scientific culture. In the future, increased training in visual literacy, data analysis, and scientific communication strategies needs to be an important part of developing the capacity of educational researchers.

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