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Data Visualization as a Tool for Public Understanding Education

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ABSTRACT

Data visualization is a graphical representation of information designed to facilitate understanding and decision making. The purpose of this study is to explore the importance of data visualization as an educational tool in improving public understanding of complex information. This study uses a qualitative descriptive approach with a literature study method. Secondary data collected comes from various trusted sources such as scientific journals, articles, books, and other research documents. The results of this study are that data visualization has proven to be a very effective educational tool in improving public understanding of complex information. The use of visualization techniques, such as graphs, diagrams, and animations, makes difficult information can be presented in a concise and more attractive form. The principles that must be possessed by good data visualization are simplicity, relevance, readability, and visual appeal. So, the information to be conveyed can be understood by all members of the general public.

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1. INTRODUCTION

In the modern era marked by advances in information technology, data has become a crucial element in meeting the needs of society for clear and easy-to-understand information. Wider access to data and information, supported by various applications and information systems, allows individuals to gain a better understanding of various issues. Research conducted by Amir and Christian (2022) shows that grouping data in the form of visualizations, such as graphs and tables, can speed up the process of understanding information by users. This confirms that visual representation of data not only increases the speed of understanding, but also the effectiveness in conveying complex information.

In the context of education, the use of data is increasing along with the need for evidence-based decision making. Data serves as a foundation for improving the quality of education through appropriate analysis and informative planning. Wartoni (2024) emphasized that data-based education reports are an important basis for more targeted planning, allowing stakeholders to formulate more effective policies. In addition, Schildkamp (2019) showed that data literacy and effective leadership greatly influence the use of data in decision making for school improvement. Thus, data integration in education not only contributes to more accurate evaluations but also to innovations in teaching methods that are more relevant and engaging for students. Delivering complex information to the general public in an educational context is a significant challenge. Various factors, such as educational background, level of understanding, and the individual's ability to digest technical information, contribute to this difficulty. Therefore, it is important to identify and overcome these barriers so that information can be delivered in a more effective and understandable way for all groups.

To facilitate data interpretation, data visualization can be used as an effective educational tool to improve public understanding, especially in the context of education and information communication. Data visualization, which integrates graphical elements with quantitative information, has proven to be an efficient method of conveying complex information in a way that is easier for the general public to understand. By utilizing visualization, complex information can be presented in a more attractive and intuitive format, thus facilitating the audience's understanding of the data presented.

One of the main advantages of data visualization is its ability to simplify complex information. According to research by Minshall et al. (2022), data visualization can facilitate discussion, improve understanding, and assist in pattern recognition. Through the use of graphs, maps, and diagrams, difficult-to-understand information can be presented in a clearer way, making it easier for students and the general public to digest the data. In addition, data visualization also has the potential to increase user engagement. Kasumba et al. (2022) noted that during the COVID-19 pandemic, data visualization became very popular on social media, indicating that people were more interested and engaged with information presented visually. This engagement is important because when people feel connected, they are more likely to understand and remember the information presented.

The purpose of this study was to explore the importance of data visualization as an educational tool in increasing public understanding of complex information. In a world dominated by data, the ability to present information clearly is very important, especially for audiences who do not have a technical background. Data visualization aims to bridge the gap between complex information and lay audiences by simplifying data through graphical elements such as graphs, diagrams, or animations (Franconeri, 2021; Minshall et al., 2022). This study also attempts to identify important principles such as simplicity, relevance,

readability, and visual appeal to create effective data visualizations, which can ultimately improve people's data literacy (Chen et al., 2021).

2. METHODS

This study uses a qualitative descriptive approach with a literature study method. Secondary data collected comes from various trusted sources such as scientific journals, articles, books, and other research documents. This method allows for in-depth exploration of data visualization concepts, design techniques, and data-based educational approaches (Amir and Christian, 2022). Literature studies were chosen to provide a strong theoretical foundation and evaluate best practices in data visualization for education. This approach aims to explore in-depth and detailed information about data visualization as an educational tool. The qualitative descriptive method was chosen because its main focus is on understanding phenomena or concepts in a particular context, in this case the role of data visualization in improving public understanding of complex information. Secondary data provides a strong theoretical foundation to support analysis and interpretation of data visualization. This technique makes it easier to identify important principles in creating effective data visualizations, such as simplicity, relevance, readability, and visual appeal (Amir and Christian, 2022; Franconeri, 2021).

3. FINDINGS AND DISCUSSIONS

3.1 Findings

Data visualization is a graphical representation of information designed to facilitate understanding and decision-making. It involves combining visual elements such as color, shape, size, and layout to highlight patterns, trends, and relationships in data (Backonja et al., 2016). Unlike tables or text, data visualization allows complex information to be presented in a more intuitive way, thereby increasing people's absorption. According to research by Minshall et al. (2022), good visualizations must combine aesthetically pleasing design with high readability to enhance comprehension. In addition, data visualization is an effective tool in various fields, including education, health, and data-driven decision-making. In the context of education, data visualization facilitates evidence-based learning, allowing students to understand abstract concepts through concrete visual representations (Anindya, 2024). In the health sector, data visualization helps people understand their health data, such as health trend graphs, which can encourage healthier behaviors (Backonja et al., 2016).

Data visualization plays an important role in presenting information in a clear and understandable way. By using graphs, charts, and images, students can more easily understand patterns, trends, and relationships in data. For example, through bar or pie charts, students can quickly compare data and see differences between categories. The use of color, size, and shape can help distinguish different information and highlight important points. In addition, data visualization can help students in the analysis process. By actively involving students in creating data visualizations, they can develop problem-solving and critical thinking skills. Through hands-on experience with data and visualization tools, students can learn to interpret information, draw conclusions, and communicate their findings. The application of data visualization in education not only improves students' understanding of the subject matter but also helps them develop skills that are relevant to the real world. In an era where data is increasingly abundant, the ability to understand, analyze, and communicate

information effectively through data visualization is becoming increasingly important. Thus, the use of data visualization in education is an important step in supporting student-centered learning and preparing them for future challenges (Anindya, 2024). In the realm of guidance and counseling, media is defined as anything used to convey messages that aim to stimulate the client's thoughts, feelings, interests and attention so that he can understand his condition, direct himself to make decisions from every problem faced (Basyid et al., 2024). One of the media that can be used in guidance and counseling services is poster media. Posters have the power to be digested by people who see them because posters emphasize the power of messages, visuals and colors. Graphics are images composed of coordinates. Thus, the source of the image that appears on the computer monitor screen consists of points that have coordinate values. It can be concluded that graphic media is a visual media that presents facts, ideas or ideas through the presentation of words, sentences, numbers, and symbols or images.

According to Chen et al. (2021), well-designed data visualization can accelerate the learning process of people about data analysis and interpretation. With visualization, the audience is more motivated to learn and more confident in using data. The results of this study also underline the importance of effective design principles in data visualization: simplicity, relevance, readability, and visual appeal. Simplicity ensures that people can understand the core message without being distracted by irrelevant visual elements. Relevance increases the connection between the data displayed and the audience's needs, while readability ensures that information can be easily accessed. Visual appeal increases community engagement, as evidenced by Kasumba et al. (2022) during the COVID-19 pandemic, when data visualization became the main communication tool to improve public understanding of health data. In addition, innovations such as animation and interactive technology further strengthen the role of data visualization. Tarida (2021) noted that the use of animation in mathematics learning helps students understand complex concepts more easily. This confirms that visualization not only conveys information but also encourages a deeper learning experience.

In the context of health, data visualization also shows significant benefits. Backonja et al. (2016) revealed that the visualization approach can help individuals understand their health data better. By presenting health information in an easy-to-understand graphical form, people can more easily identify trends and patterns that are relevant to their health. This shows that data visualization is not only useful in formal education, but also in the context of public health, where a good understanding of health data is essential for informed decision-making. Furthermore, data visualization can serve as a tool to improve data literacy among the public. Chen et al. (2021) emphasized that visualization can help people understand complex information in a clearer and more engaging way, thereby improving their ability to analyze and use data in their daily lives. With increased data literacy, people will be better prepared to face the challenges of information in the digital era. However, the effectiveness of data visualization is highly dependent on the design and delivery of information. Franconeri (2021) stated that understanding and creating good visualizations are important skills that modern society must have. Therefore, training and education on how to read and understand data visualizations should be an integral part of educational programs.

The large number of students in schools sometimes causes the BK to have difficulty in determining whether the student is selected to be able to take the SNMPTN pathway to continue their education. In addition, the database which is usually in the form of numbers will be more difficult for guidance and counseling teachers to interpret than data visualized in graphical form (Hayati et al., 2021). The increasingly massive development of digital

technology has had a changing impact on human life. Through this development, society wants all activities to be carried out more easily and quickly through technology in various areas of community life. One of them is in the field of education, learning activities are carried out with the help of technology (Ifdil et al., 2022). There are various kinds of technological tools that can be used for better counseling services. One of the uses of technology by BK teachers is through needs assessment activities. For guidance and counseling services, assessment is important. To find out the understanding and development needs of students, an assessment is carried out.

One of the main challenges is the complexity of the information itself. When information is presented in a format that is too technical or complicated, the general public can feel confused and alienated, which in turn reduces the effectiveness of delivering the information. Therefore, simplifying information and using more easily understood language is essential to bridge this gap. In addition, accessibility of information is also a significant challenge; Firdaus and Lawati (2020) showed that the accessibility of information in public services greatly affects public understanding. In the context of education, if information is not easily accessible or is delivered through unfamiliar channels, the public will have difficulty understanding and applying the information. Therefore, it is important to utilize various communication media that are appropriate and familiar to the public, such as social media or mobile applications, to increase the accessibility of information.

Another challenge that needs to be considered is stigma and distrust of the information conveyed. Pratama and Rahmat (2018) emphasized that the younger generation often lacks a sense of social responsibility, which can affect the way they receive information. Distrust of information sources can hinder the acceptance of messages, especially if the information is considered irrelevant or does not match their experiences. Building trust through transparent communication and involving the community in the information delivery process is very important. In addition, training and education for the community should not be ignored. Mulyani et al. (2022) showed that proper training can help the community understand complex information better. Providing training to teachers and educators on how to convey information in a more interesting and interactive way can improve student understanding. With the right approach, the challenges in conveying complex information can be overcome, so that the information can be better understood by the community.

The results of the study showed that data visualization is a very effective tool for conveying complex information to the community. Visual elements such as graphs, charts, animations, and maps enable audiences to understand patterns, trends, and relationships in data more quickly than traditional text or tables (Franconeri, 2021; Minshall et al., 2022). Data visualization also has a significant impact in education. Anindya (2024) noted that students find it easier to understand abstract information through engaging and interactive graphical representations. Visualization helps reduce the cognitive load in processing information, allowing students to focus on interpreting and analyzing data. In the health sector, data visualization provides significant benefits by helping individuals understand their health data. Backonja et al. (2016) showed that health graphs and diagrams can make it easier for people to identify trends in their health risks or patterns, which encourages better data-based decision-making. In addition, data visualization plays a significant role in improving people's data literacy. Data literacy, which includes the ability to read, understand, and use data in everyday decision-making, is increasingly important in the digital information age.

3.2 Discussions

3.2.1 The Effectiveness of Data Visualization as an Educational Tool

Data visualization has become an important tool in education to improve student understanding. In this context, data visualization refers to the graphical representation of information and concepts that enable students to understand and analyze data more effectively. The development of data literacy in education is very important because it encourages students to become critical thinkers, independent, and better prepared to face challenges in the information age (Dasmo and Wati, 2023). Data literacy is very important to learn because it includes basic data analysis skills, graph interpretation, and statistical understanding. Data literacy is now considered a key component in lifelong education. Data literacy is the ability to understand, interpret, and make decisions based on data. Data literacy is related to the ability to read, analyze, and make conclusions based on data and information (big data) obtained. The importance of data literacy cannot be ignored in an increasingly connected and information-driven world. Guidance and counseling teachers can gain knowledge about data visualization by conducting training on AUM processing (Ifdil et al., 2022). The use of attractive poster media will motivate clients, poster media is designed as attractively as possible, it can be in the form of slogans containing words of invitation or appeal to do an activity. This media helps explain the material, provides an overview of a process or emphasizes certain values and ethics (Basyid et al., 2024). Guidance and Counseling Services require posters that can help provide information services for clients. The use of attractive posters in information services can create good interactions between counselors and clients. The counselor acts as a motivator or guide while the client acts as a recipient or being guided so that with attractive posters educational interactions can be created. The advantages of digital poster media include: (1) Easy to change and update; (2) Save production and distribution costs; (3) Wider and targeted audience reach. The advantages of using printed poster media are: (1) Easier to remember and understand because it is physical (real); (2) Suitable for areas without internet access or electronic devices; (3) Can have its own artistic and collectible value.

3.2.2 Simplicity, Relevance, Readability, and Visual Appeal

Simplicity is a very important principle in data visualization. This relates to the ability to present complex information in an easy-to-understand form. According to Andzani (2024), simple visualizations can help build an attractive destination image, where storytelling plays an important role in creating an emotional connection with the audience. By reducing unnecessary elements, visualizations can focus more on the main message to be conveyed, thereby increasing the audience's understanding of the data presented. Relevance is also a crucial aspect in data visualization. The data displayed must be relevant to the context and purpose of the visualization. Huda et al. (2022) emphasize that the visual appeal of a product can be enhanced with appropriate packaging, indicating that the relevance between content and format is very important in attracting the audience's attention. In the context of tourism, Sari states that authenticity and cultural relevance are the main attractions for tourists, indicating that relevant information can increase audience interest and engagement (Qur'ani, 2024).

Readability is another equally important principle. Complex data must be presented in a way that is easy to read and understand. Pratiwi identified that good accessibility and facilities

contribute to tourist satisfaction, which also reflects the importance of readability in presenting information (Sari, 2023). Readability can be achieved through the use of clear fonts, contrasting colors, and good layout arrangements, so that the audience can quickly understand the information presented. Visual appeal is a factor that can increase audience interest in the data presented. According to Rahmadayanti and Murtadlo, good visual appeal can influence visitors' decisions to come, which shows that attractive visualizations can increase audience engagement (Pratiwi, 2023). In this context, the use of attractive design elements, such as colorful graphics and relevant illustrations, can make data more interesting and memorable. Overall, the application of these principles in data visualization not only improves audience understanding but can also encourage desired actions, such as increasing visits to tourist destinations or increasing engagement in a product. Therefore, it is important for researchers and practitioners to consider simplicity, relevance, readability, and visual appeal in every data visualization effort.

3.2.3 Challenges in Implementation

Three major challenges that are often faced are technical barriers, bias in data presentation, and public accessibility to visualization. Technical barriers are often a barrier to the implementation of effective data visualization. In this context, challenges can include problems in data collection and processing, as well as limitations of the software and hardware used. Petrick et al. (2023) identified that in the development of AI and machine learning tools, challenges related to data governance and algorithm strength are very important to note. In addition, technical issues such as system integration and infrastructure maintenance can also hinder the ability to produce high-quality and accurate visualizations.
Bias in data presentation is another significant challenge. This bias can arise from a variety of sources, including unrepresentative data, unfair algorithms, and the way information is presented that can influence audience perception. Liang et al. (2019) showed that systematic bias in brain age estimation can affect the interpretation of results, reflecting how bias can affect the understanding of data. Additionally, research by Pagano et al. (2023) highlights the importance of understanding the various forms of bias in machine learning models, including data bias and user interaction, that can influence visualization results. Therefore, it is important to implement effective bias mitigation methods to ensure that data visualizations do not mislead audiences.

Public accessibility to visualizations is also a challenge that needs to be addressed. Although visualization technology has advanced rapidly, not all groups of people have equal access to the tools and resources needed to understand these visualizations. This can create gaps in understanding and using information. Zalesińska (2015) notes that factors such as lighting and visual design can affect an individual's ability to access and understand the information presented. Therefore, it is important to design visualizations that are not only visually appealing but also accessible to a wide range of people, including those with physical or cognitive disabilities.The challenges in implementing data visualization require serious attention from researchers and practitioners. By overcoming technical barriers, reducing bias in data presentation, and increasing accessibility, data visualization can become a more effective tool in conveying information and supporting data-driven decision making.

3.2.4 Innovation in data visualization

The use of animation in data visualization not only increases audience engagement but also helps in conveying information in a more interesting and understandable way. One way animation increases engagement is through the delivery of information that is more dynamic and interactive. Noorhidayah (2024) showed that animated video-based learning media can improve student learning outcomes, which shows that animation can make content more interesting and easy to digest. In addition, Saputra et al. (2021) emphasized that the use of animated videos in learning can reduce student boredom and improve their understanding of the material. Thus, animation not only functions as a visual tool but also as an effective method to increase audience engagement and understanding.

Innovation in data visualization also involves the use of the latest tools and technologies. Novianti (2022) noted that the development of digital technology has driven innovation in educational media, which can facilitate the learning process. This is in line with research by Huda et al., (2022) which shows that training in making animations can improve students' skills in creating attractive visual content. By utilizing the latest technology, data visualization can be presented in a more interesting and interactive way, thereby increasing audience interest and engagement.

Animation can be used to convey complex messages in a simpler and more understandable way. In this context, Tarida (2021) showed that the use of GeoGebra-based learning videos can help students understand mathematical applications better. This shows that animation can serve as a bridge to convey difficult information in a more digestible way. In addition, Darman (2018) emphasized the importance of data visualization in the form of graphs and maps to help better decision making. Thus, animation not only increases visual appeal but also increases the effectiveness of information delivery. Innovation in data visualization through the use of animation provides many benefits, including increased audience engagement, more effective information delivery, and the use of cutting-edge technology. By utilizing animation, data presenters can create a more engaging and informative experience for their audience, which in turn can improve comprehension and retention of information.

4. CONCLUSION AND RECOMMENDATION

Data visualization has proven to be a highly effective educational tool in increasing public understanding of complex information. By utilizing various visualization techniques, such as graphs, charts, and animations, difficult-to-understand information can be presented in a more intuitive and engaging way. This allows audiences to quickly grasp patterns, trends, and relationships in data that may not be apparent in traditional text or numeric formats. Data visualization is not just a tool for presenting information, but also a powerful tool for educating the public, increasing data literacy, and fostering a better understanding of the complex issues facing society today.

To increase the effectiveness of data visualization as a public education tool, it is important to develop clear and consistent visualization standards. These standards should include guidelines for the use of graphic elements, colors, and layouts that make the information easier for the general public to understand. In addition, collaboration between data scientists, designers, and educators is essential to creating more inclusive and effective visualizations. By involving multiple disciplines, the resulting visualizations can meet the needs of diverse audiences, thereby conveying information in a more engaging and understandable way.

Furthermore, training and education for the public on how to read and understand data visualizations should be an integral part of educational programs. The public needs to be given the skills to analyze and interpret data presented visually, so that they are better prepared to face the challenges of information in the digital era. In addition, it is important to ensure that data visualization is accessible to all groups, including those with physical or cognitive disabilities. By paying attention to the accessibility aspect, data visualization will not only be an effective tool in conveying information, but also create an inclusive environment for the entire community.

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