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TOPICAL REVIEW

Infographics in Educational Settings: A Literature Review

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ABSTRACT Infographics are visual representations of data that utilize various graphic elements, including pie charts, bar graphs, line graphs, and histograms. Educators and designers can maximize the potential of infographics as powerful educational tools by carefully addressing challenges and capitalizing on emerging technologies. However, current education systems showcase the need for development guidelines and the best practices targeted at designing and developing infographics while exploring the major economic and social impacts of infographics on education. This study examines the concept and role of infographics in education, methodologies, trends, and obstacles. It evaluates potential economic implications and gives insights to design and development experts. The study is based on a scoping literature review methodology, uncovering the conceptual background and the role of infographics. The study emphasizes the unique functions of infographics in data visualization for educational purposes and investigates the current trends and practices in infographics creation. The key challenges associated with the use of infographics are also discussed. Furthermore, the study attempts to identify the cutting-edge frameworks for infographic creation and development while evaluating their economic implications for the role of global education. Finally, the potential recommendations for creating successful infographics while focusing on professional design and development are also covered. The guided literature review will be vital for understanding and using infographics in education.

INDEX TERMS Data visualization, design, digital tools and platforms, educational technology, frameworks, infographics, learning outcomes, visual communication.

I. INTRODUCTION

The people and the communities that inhabit the world are dynamic. People no longer use libraries to conduct research; instead, they now browse websites and use search engines to look up information that will point them in the direction of answers to their problems. Many challenges were brought on by the COVID-19 pandemic's quick shift toward online learning and e-learning technology [1], [2], [3]. Online learning remained a primary platform for delivering instruction in almost all educational institutions during the pandemic [4]. As a result, learning behaviors radically changed, and several research studies were carried out to access and enhance the quality of learning based on different learning management systems (LMS) [5]. Learners eventually formed intuitions that helped them to access, use, and perceive information utilizing a variety of mechanisms of information content delivery since it became a normal part of their everyday lives as they adapted to studying online [6]. Modern communication technologies enable people to access information and resources ubiquitously [7]. As a result, learners who use instructional technology need to comprehend and retain information from diverse educational resources.

Contemporary methods of accessing information involve using visual knowledge resources often supplemented by concise written details, providing a highly intuitive and accessible means of accessing information [8]. Information graphics or infographics are visual representations of data using graphic elements, such as pie charts, bar graphs, line graphs, and histograms. Infographics allow for conveying data and information to the intended audience more easily

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and comprehensively [9], [10]. As infographics efficiently transmit information, knowledge, and conclusions to the media and the public, they are considered visually appealing and useful in instructional technology and design [11], [12]. Infographics visualize data and information and provide information to non-academic audiences, allowing them to comprehend and memorize critical information delivered [13]. Infographics find their place in academic and scientific journals for communicating results and observations made while increasing visibility to disseminate higher-order knowledge. Learners exhibit diverse learning styles due to significant variations in their written and verbal communication abilities [14], [15]. Some learners may prefer visual or tactile learning methods, or a combination of both, as they find them more effective for their learning process [16], [17]. Infographics facilitate learners in processing information easily and according to their preferences. Infographics contain images, words, and other interactive elements that allow learners to remain focused, retain information, and reinforce learning. Additionally, infographics can include supplementary written text that enhances the learners' visual comprehension of the content, making it possible to reach a wider audience with outsourced content.

Preferential and selective use of different types of learning resource formats have a direct impact on teaching and learning activities [18], [19]. Instructors designing and developing learning resources enable learners to develop skills that allow them to select suitable resources for learning, preparation, and integration of visual learning-based content in their learning materials and to develop habits of learning based on visual content [20]. Virtual literacy involves learning skills related to infographics, significantly promoting instructional design's digitalization. Infographics are envisioned as a new and intuitive data visualization method that can enhance teaching and learning experiences. This research aims to investigate the role of infographics in enhancing teaching and learning experiences, promoting digital literacy, and facilitating effective instructional design in the context of online and digital learning environments. The study aims to review cutting-edge frameworks for infographic creation and development and evaluate their economic implications for the role of global education. Finally, the study concludes by making potential recommendations for the creation of successful infographics as well as professional infographic design and development.

The rest of the study is organized in the following sequence. Section II presents the review method adopted for conducting the study. Section III presents an in-depth literature review, reviewing information graphics (infographics) and their function in educational data visualization. Section IV discusses the state-of-the-art infographics in education. Section V presents the current trends and practices, while Section VI presents potential applications.

Section A provides distinctive roles and a detailed discussion of how infographics drive education. Section VII guides applied infographics in education while considering four dimensions. Section VIII lists the challenges and limitations concerning infographics. Section A provides possible recommendations concerning the application of infographics in education contexts. Finally Section X provides conclusions of the overall study.

TABLE 1. Search queries.

"*infographic*" AND "*review*" + "design" +"education*" AND "scoping review"	2780
("*infographic*" AND "*rubric*") AND "*scoping review*"	104
"*infographic design*" +"framework" +"scoping review"	52
("modeling" AND "infographic design*" AND "infographics ") AND" scoping review"	11
"*infographic design*" +"modelling" +"scoping review"	6

II. REVIEW METHOD

The study is based on the PRISMA Extension for Scoping Reviews (PRISMA-ScR) [21] method of research for gathering, evaluating, and synthesizing the primary studies in a systematic and rigorous manner. PRISMA-ScR provides a comprehensive overview of the current state of knowledge in the field of infographics by synthesizing findings from the literature.

A. LITERATURE SEARCH STRATEGY

To find related works, search queries were formulated for finding the relevant literature using Google Scholar search engine. Table 1 shows the queries input to the Google Scholar search engine.

B. STUDY SELECTION

Figure 1 illustrates the process for screening and selection of literature using the PRISMA-ScR model. The selection of studies for review was based on predetermined inclusion and exclusion criteria. Studies focusing on the role of infographics, frameworks, and applications guiding infographics, and articles published in the English language matched the inclusion criteria defined, whereas exclusion criteria were employed to exclude studies that deviated from the primary focus on infographics, articles with brief overviews lacking application details, and articles written in languages other than English. The selected articles were subjected to a rigorous evaluation process to ensure the quality and relevance of the included studies.

C. DATA EXTRACTION AND QUALITY ASSESSMENT

Qualitative data extraction was conducted to gather pertinent information from the selected studies, including study characteristics, research methods employed, key findings, and theoretical frameworks utilized. Relevant information, including study characteristics, research methods, key findings, and theoretical frameworks, was extracted from the selected studies.

D. DATA SYNTHESIS

The findings from the selected studies were synthesized using thematic analysis. Common themes, trends, and gaps

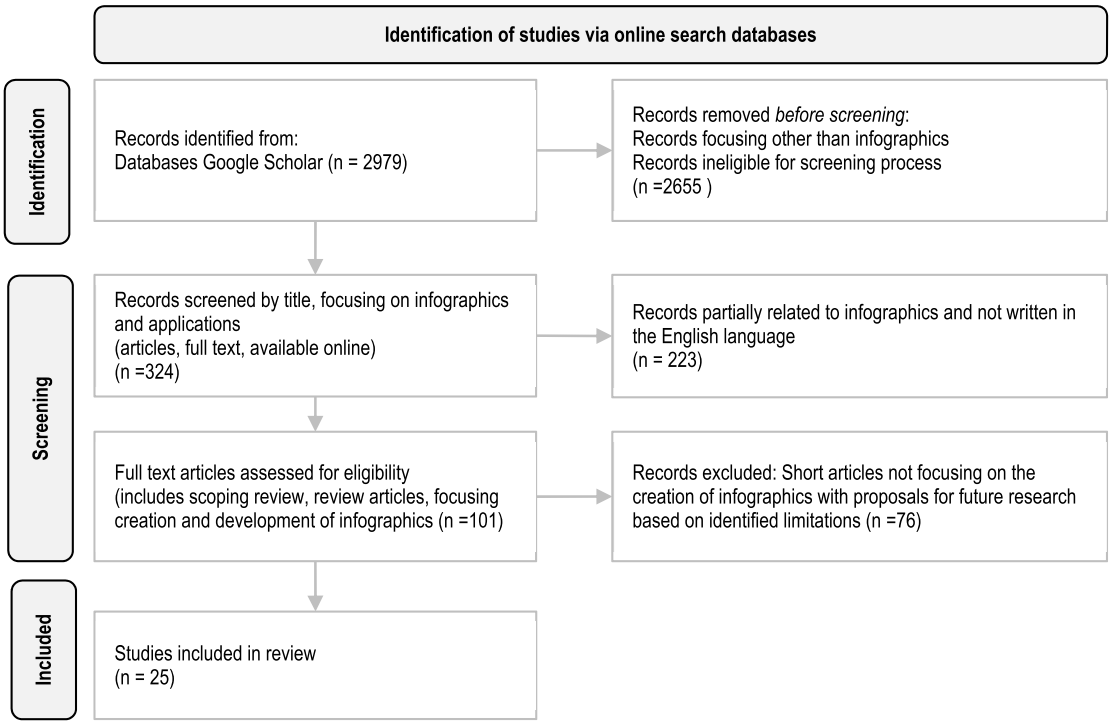

FIGURE 1. The article selection process of relevant literature based on PRISMA-ScR [21].

in the literature related to the role of infographics and frameworks in education were identified and analyzed. The findings from the selected articles were synthesized, organized, and presented coherently, aligning with the PRISMA-ScR recommendations for reporting. Defined by PRISMA-ScR, the methodology helped identify patterns, gaps, and insights across the selected studies, offering a comprehensive overview of the current state of knowledge in the field.

E. RESEARCH MOTIVATION

The study reviews the literature referenced in the Table 2. The limitations underscore the need for a comprehensive study addressing challenges in infographic education. Acknowledging variability in infographic quality and evolving tools, the study aims to explore complex formats' impact beyond basic designs. Considering the limited number of studies offering modeling and design guidance in the area of infographics, a study addressing such challenges becomes crucial.

F. RESEARCH QUESTIONS

The study aims to address the following research questions: A) What are the current trends and practices in utilizing infographics for educational purposes? B) How do infographics contribute to data visualization in the context of education? C) What are the limitations and challenges of using infographics as communication tools within educational settings? D) What are the impacts of infographics on the role of global education? and E) What are the possible challenges for future research works?

This research study presents a literature review on the idea and role of infographics as a vital resource for its use in education. The study aims to emphasize the unique functions of infographics in data visualization for educational purposes and to investigate current trends and practices in infographics creation. This study examines the concept and use of infographics in education, methodologies, trends, and obstacles. Moreover, the study evaluates potential economic implications and gives insights to design and development experts.

III. INFORMATION GRAPHICS

Infographics are crucial in achieving the goals mentioned in the prior section, as they effectively communicate intricate information and help achieve specific objectives. The historical development of infographics is worth mentioning. Sylvester is credited with coining the term ''graph'' [46]. In 1626, Christopher Scheine published the first infographic in the scientific journal Rose Ursina sive Sun, illustrating the logical relationships between mathematical qualities and chemical bonding in chemistry [47].

Peter Sullivan made significant contributions to the development of infographics by introducing the term ''infographic'' in the 1980s and 1990s [48]. The term gained popularity through The Sunday Times publication, which expressed a preference for graphics.

Furthermore, in 2000, Adobe Flash animation was utilized for creating infographics in game development and other products [49]. To improve teaching effectiveness and improve learners' performance in academic environments,

TABLE 2. Related works revealing limitations and proposed future directions.

Ref	Limitations	Proposed Future Works
[22]	Acknowledged the variability in infographic qualities, suggesting that popular infographics lack consistency across certain characteristics.	Encouraged further research to explore the power and effectiveness of infographics in educational contexts, emphasizing the importance of infographic thinking and its impact on learning and engagement.
[23]	Acknowledge the evolving nature of infographic tools and the need for continuous learning to stay updated with the latest trends and technologies.	Explore innovative ways to leverage infographics in libraries, conduct workshops and training sessions for library staff, and collaborate with graphic designers to enhance the visual appeal of library-related infographics.
[24]	Basic infographics used; need exploration of complex formats' impact.	Assess the impact of interactive infographics on enhancing designers' WHS knowledge; explore the integration of varied WHS knowledge levels into digital design processes for both novice and experienced designers.
[25]	Study limited to Canadian Emergency Medicine Physicians, potential biases due to the study design and sample population.	Explore diverse professional populations, study active review scenarios, develop valid assessment measures, and focus on optimizing infographic design for better knowledge transfer.
[26]	Limited to 15 postgraduate students, conducted over four weeks, small sample size, non-normal distribution precluded the use of parametric tests in analyses.	Investigate long-term effects, explore optimal infographic design elements, assess impact across different educational levels and subjects.
[27]	the review's language restriction to English and French and the decision not to formally assess the quality of included studies, impacting the evaluation of existing evidence strength.	Suggest further investigations focusing on specific demographic groups, contexts, or health topics to deepen the understanding of infographics' effectiveness in knowledge translation.
[28]	Potential misclassifications, subjective physician evaluations, and lack of accuracy verification.	Explore accuracy verification, audience evaluations, and collaboration with social media specialists for enhanced infographic impact.
[29]	Limitations include the review's language restriction to English and French and the decision not to formally assess the quality of included studies, impacting the evaluation of existing evidence strength.	Explore advanced infographic techniques, assess long-term impact, and investigate tailored approaches for diverse subjects and learner demographics in educational settings.
[30]	Limited the study's scope by excluding self-efficacy, utilized a small purposive sample from a single hospital area, potentially limiting the generalizability of findings.	Propose further research on user experience with infographic-based health apps, exploring novel infographic designs for diverse healthcare topics to enhance public health education comprehensibility.
[31]	Small sample size, short intervention duration; long-term effects and generalizability require further study.	Explore diverse student populations; compare effectiveness of various infographic styles; assess impact on academic performance and mental well-being.
[32]	Limited participant demographic (US workers speaking English), potential overlap between design and content, and insufficient methodology to establish causal relationships.	Further research needed on standardized methodologies, evolving features of affective design, and the consequences of affective responses in visualization.
[33]	Limited representation of diverse learner demographics and potential bias due to participant self-selection in reviewed educational practices.	Future research should explore the impact of infographics on specific disciplines, assess long-term skill retention, and investigate optimal methods for assessing infographic quality and effectiveness.
[34]	Potential copyright and privacy issues regarding the use of images, requiring careful selection and written consent for certain visuals.	Explore the impact of different color palettes and font styles on audience engagement and information retention in diverse contexts and platforms.
[35]	Limited effectiveness assessment, potential bias in guideline selection.	Evaluate the impact of the infographic on patient knowledge and health care provider counseling.
[36]	Limited scope in addressing diverse learning preferences within the visual representation.	Evaluate digital interactive maps' effectiveness, incorporate diverse learning styles, and conduct comparative studies for improvement strategies.
[37]	Limited sample size and specific university context; Possible biases in self-reporting; Generalizability restricted to similar educational settings.	Explore practical applications of emerging AI technologies in educational contexts.
[38]	Funding constraints, Covid-19 disruptions, limited participant pool, and potential challenges in stakeholder engagement and recruitment.	Conduct large-scale trials, explore cultural influences, expand stakeholder involvement, and assess long-term intervention impact for pregnant women.
[39]	Potential challenges in implementation, necessitating careful consideration of individual differences and varied responses to the framework.	Explore real-world application of Storying, examining its effectiveness in diverse OST settings, and collaborate with educators and psychologists for a comprehensive evaluation.
	Limited exposure duration (500ms) might not capture nuanced, longer-term aesthetic assessments.	Investigate extended exposure effects, explore cultural variances in aesthetic preferences, and assess real-world applicability.
[40]	Quality of studies not assessed; limited to English studies; excluded AI in medical education tools; variations in educational approaches hindered formal comparisons. Inconsistent reporting depth due to diverse study scopes.	Explore AI education's impact on patient outcomes. Develop standardized curricula. Evaluate AI's role in continuing professional development. Address language diversity.
[41]	Potential biases, data gaps, and language constraints within analyzed literature.	Explore innovative methods, enhance inclusivity, and assess long-term impact in infographic collaborations.
[42]	Limited to university students; potential variations unexplored across diverse populations and devices.	Conduct qualitative research, expand to diverse populations, and explore varied device environments for nuanced interactive infographic analysis.
[43]	Online format limited lower socioeconomic participants; pandemic context might have influenced attention and engagement levels.	Explore multimedia approaches, conduct in-person interventions, and assess long-term behavioral changes to enhance diabetic foot care campaigns.
[44]	Potential biases in surveyed practices, limited coverage of specific journalism subfields, and evolving nature of journalism challenges.	Explore visualization in emerging journalism technologies, validate proposed research agendas through empirical studies, and investigate evolving challenges in multimedia journalism.
[45]	Single-time data collection, potential selection bias, and lack of a longitudinal component limit generalizability.	Explore longitudinal knowledge retention, assess information transfer, and evaluate combined nurse-infographic education impact for comprehensive insights.

instructional design aimed to incorporate digitalization by integrating advanced tools and techniques into existing classroom instruction. Infographics meet the increasing demand for improved, interactive presentations in the academic community. Infographics utilize visual representations to simplify complex information. Infographic standards are

in place to preserve the complexity of information while reducing comprehension obstacles.

In addition, infographics offer visual depictions of data, facilitate attractive information design, and provide guidance on organizing information in specific situations. Nonetheless, the development of infographics relies on designers who conceptualize infographics with specific goals and purposes in mind. Infographics enhance visual perception, present conceptual models, reduce cognitive effort, and improve information retention [50], [51].

Combining infographics with effective data and information delivery aims to capture the audience's attention, provide information, and entertain them.

Designers use infographics to illustrate concepts, such as procedures, stories, and ideas. As such, infographic applications serve various purposes [52], [53], [54]. They effectively present underlying information structures, showcasing complex processes or information [55]. Educators and communicators can use infographics to convey complex ideas in a visually engaging and organized format. Infographics play a crucial role in education and communication, simplifying complex information, enhancing comprehension, and facilitating the effective delivery of data and knowledge.

A. INFORMATIONAL GRAPHICS'–DATA VISUALIZATION FOR EDUCATIONAL PURPOSES

Infographics play a crucial role in data visualization for educational purposes by simplifying complex information, increasing engagement, enhancing memory retention, encouraging critical thinking, promoting data literacy, supporting differentiated instruction, emphasizing key takeaways, improving communication, and stimulating creativity. Instructors use infographics to aid learners in understanding and remembering complex material, thereby increasing learning outcomes. As such, infographics enhance engagement, improve memory recall, foster critical thinking, and provide context for data. Infographics demand instructional tools that benefit both educators and learners in numerous ways. As technology and design methods continue to advance, it is expected that even more innovative and effective applications of infographics in education will emerge. Infographics are constantly evolving to meet the needs of instructors and learners, offering new ways to present and clarify complex information.

IV. INFOGRAPHICS IN EDUCATION

The potential of infographics in education is virtually limitless due to the continuous technological advancements and data visualization approaches. The role of infographics in education is constantly evolving as new techniques and approaches emerge. Infographics offer educators a versatile and successful tool for communicating complex information to learners engagingly and memorably.

A. INFOGRAPHICS DEVELOPMENTAL FRAMEWORKS

Designers and artists must keep pace with current trends and best practices to produce engaging and successful infographics. They should also be willing to embrace innovation and experimentation to differentiate themselves in a competitive field. To design efficient infographics there are many frameworks that guide the development of infographics:

According to the Data-Information-Knowledge-Wisdom (DIKW) model [56], data should be provided at the bottom of a hierarchy that includes information, knowledge, and wisdom before moving to information and then data. This approach should be used when designing infographics to give viewers context and insight that help them progress from viewing raw data to understanding the information.

In the Visual Thinking Strategies (VTS) model [57], [58] paradigm, the use of visual thinking techniques is emphasized to encourage comprehension and involvement with complex material. Images and visuals should be used in infographics created utilizing this paradigm to encourage analytical, interpreting, and critical thinking.

The Gestalt principles of design [59] conceptual framework is founded on the principles of visual perception and proposes that effective design should consider how humans naturally receive and organize visual information. The principles of closeness, similarity, and continuity should be used in infographics created using this framework to direct the viewer's eye and make information easy to interpret.

The Tufte principles of design [60] provides three guiding principles based framework—clarity, accuracy, and context—were created by data visualization pioneer Edward Tufte. With a focus on giving context that enables viewers to comprehend the relevance of the data, infographics created utilizing this framework should prioritize the clear and accurate presentation of information.

The Storytelling framework [61] approach strongly emphasizes using storytelling to convey complicated knowledge. In order to effectively convey the main idea, infographics created utilizing this framework should have a narrative structure that leads the reader through the content.

The F-Shaped Pattern framework [62] paradigm is based on research that claims web material is scanned by users in an F-shaped pattern, with the top and left of the page receiving the most attention. Important information should be placed in the top and left corners of infographics created using this structure to maximize visibility and retention.

According to the Cognitive Load Theory framework [63] concept, the viewer's cognitive burden should be considered when designing infographics. Infographics created using this framework should reduce cognitive burden by utilizing straightforward imagery, little text, and a unified design aesthetic.

The Hick's Law framework [64] is built on the idea that the longer it takes a viewer to decide, the more alternatives or elements there are in a design. In order to reduce decision-making time and increase understanding,

infographics created using this framework ought to contain a minimal number of elements, such as colors, typefaces, and shapes.

The Five Ws and One H framework [65] is based on the five Ws (who, what, when, where, and why) and one H (how) of journalism is the foundation of this framework, which should be applied to all written and spoken communications. By employing the five Ws and one H to direct the structure of the infographic, infographics created following this framework can ensure that the relevant information is delivered succinctly.

According to The Accessibility framework [66], [67] framework, infographics should be accessible to all users, including those with disabilities. To guarantee that all users can access the information, infographics created using this paradigm should include alt text for images, video captions, and descriptive language throughout all material.

According to The Visual Hierarchy framework [68], [69], [70] framework, a successful design should emphasize key information, provide a clear hierarchy of information, and employ visual cues to direct the viewer's eye across the infographic. Using the Visual Hierarchy framework paradigm in infographics can use size, color, and location to establish a distinct visual hierarchy.

Based on the fundamentals of color theory The Color Theory framework [71], [72] proposes that successful design should strategically employ color to encourage comprehension and engagement. Color should be used in infographics created using this framework to draw attention to crucial information, generate contrast, and encourage visual engagement.

The Grid System framework [73] uses a grid approach to direct the infographic's layout. This framework should be used to develop infographics with a consistent layout, a distinct visual hierarchy, and an easy-to-follow structure.

According to The Minimalism framework [9], a good design should emphasize simplicity and minimalism, utilizing just the information and images that are necessary to convey the main idea. Infographics created utilizing this framework should have a straightforward layout, little text, and clear imagery to aid comprehension.

The User-Centered Design framework [74], [75], [76] defines that the target audience's demands and preferences should be prioritized in ineffective design. The design process for infographics created using this framework should be user-centered, with a clear grasp of the audience's needs and preferences.

These frameworks can generally guide the creation of great infographics that are simple to comprehend, interesting, and memorable. Educators and designers can produce infographics that leave a lasting impression on their target audience using these frameworks as a design process guide. Moreover, these frameworks serve as a guide for creating functional, memorable infographics while also visually appealing. The guidelines presented can help create user-friendly, interesting, and memorable infographics.

TABLE 3. Classification of infographics development tasks.

Focus	Improved user experience	Approach	Accessibility
	Infographic Distribution		Branding and Identity
	Infographic Templates		Data Storytelling
	Infographics as a Marketing Tool		Mobile Optimization
	Infographics for Advocacy	Model	Data Transparency
	Infographics for Data Journalism		Personalization
	Infographics for Education	Visualization	Data Visualization Best Practices
	Infographics for Social Media		Interactive Infographics
	Storytelling Techniques		Micro-Infographics
			Infographic Videos

V. CURRENT TRENDS AND PRACTICES

The dynamic nature of technology, user preferences, and the needs of businesses, groups, and individuals are the driving forces behind the evolution of infographics. Collaborative design processes and open-source development are becoming more popular, as well as cross-disciplinary applications. Additionally, multilingual infographics and cross-platform compatibility are increasingly important in a globalized world where information is shared across different cultures and devices. Summarized in Table 3 and discussed next are the application perspectives demonstrating the applications of infographics:

A. ACCESSIBILITY

Infographics use visuals, text, and data visualization to make complex information more accessible. They are easily shared through various channels and tailored to specific audiences. Ensuring accessibility for all users is crucial, including alternative text for visuals and compatibility with assistive devices [77], [78].

B. BRANDING AND IDENTITY

Infographics support brand identity through consistent branding elements and aligned content [79], [80]. Visual elements enhance brand recognition, and infographics can highlight unique product features to stand out from competitors. The shareability of infographics on social media platforms increases brand visibility and engagement.

C. DATA STORYTELLING

Infographics simplify complex data, reveal patterns, and create compelling narratives using text, images, and graphics [81]. They are easily shared on social media, reaching a broad audience effectively.

D. DATA TRANSPARENCY

Infographics promote transparency by representing open data sets and making information accessible to the general

public [82]. They break down complex information, increasing comprehension and reducing biases or misinterpretations. Infographics build trust, promote accountability, and encourage informed decision-making.

E. DATA VISUALIZATION BEST PRACTICES

Infographics adhere to best practices, emphasizing essential information, proper scales, and reliable data [83], [84]. They follow design principles, creating a user-friendly experience with a clear hierarchy, appropriate colors, and well-designed layouts.

F. IMPROVED USER EXPERIENCE

Infographics enhance user experience by making information accessible and engaging. They highlight key details and incorporate user-centered design principles [54]. Clear visual hierarchy, appropriate color schemes, and easy navigation contribute to usability and effectiveness, ensuring a high-quality user experience.

G. INFOGRAPHICS FOR ADVOCACY

Infographics are increasingly used to educate and engage the public on important causes and policies. They condense complex information into visually appealing formats, effectively conveying messages and captivating the audience [11], [85]. By serving as a bridge between information and understanding, advocacy infographics drive awareness and support for various issues. They feature attractive visual elements such as images and illustrations, enabling advocates to communicate their message succinctly and impactful.

H. INFOGRAPHIC DISTRIBUTION

Infographics are distributed through multiple channels, including social media, email marketing, and content strategies. They can be shared in formats like JPEG, PDF, and HTML and optimized for search engines to increase visibility [86], [87], [88]. Infographics are embedded on websites and shared on social media platforms, reaching a wide audience. As part of a content marketing strategy, they attract website traffic and enhance brand awareness. The demand for visual content makes infographics an effective tool to distribute information and communicate complex data in an engaging and accessible manner.

I. INFOGRAPHIC TEMPLATES

Infographic templates are becoming popular as infographics are widely used across industries. They save time and money for businesses, organizations, and individuals who frequently create infographics [53], [89], [90]. Templates provide pre-designed visual layouts that users can easily customize. They offer a framework for presenting information, eliminating the need for advanced graphic design skills. Templates often include pre-built charts, graphs, and icons that can be edited to fit specific data and branding requirements. They serve as a starting point for creating visually appealing infographics on various topics, from marketing to scientific research and social issues.

J. INFOGRAPHIC VIDEOS

Infographic videos, or animated infographics, combine animation, video, and infographics to simplify complex information. They are short, engaging, and shareable on social media. Infographic videos enhance communication, making information memorable and more likely to be shared. They can be customized with branding and design elements. These videos are used for marketing, education, and training. They create visually captivating stories with animated graphics, narration, and music. Infographic videos are especially useful for video-based content, such as social media or internet advertising [91], [92].

K. MICRO-INFOGRAPHICS

Micro-infographics focus on providing specific information on a single topic and are designed for easy sharing on social media platforms. They are gaining popularity as a quick and straightforward way to communicate information [78], [93]. Micro-infographics are shorter and simpler than standard infographics, typically using a single image with key information and eye-catching graphics [78]. Designers select a topic, identify important information, and use visual elements like charts and icons to present it clearly and engagingly. Micro-infographics capture attention, encourage sharing, and effectively engage audiences on social media. They help organizations build brand awareness, establish thought leadership, and drive audience engagement by providing easily understandable information on specific topics.

L. MOBILE OPTIMIZATION

Infographics are valuable tools for optimizing mobile content development. With smaller screens on mobile devices, infographics present complex information visually appealing and concisely. Designers prioritize coherence and cohesion in mobile visuals. Consideration is given to file size and loading time to enhance the mobile user experience [5], [94]. Responsive design techniques are employed to optimize infographics for various mobile devices with different screen sizes.

VI. INFOGRAPHICS APPLICATIONS

Infographics are powerful tools for businesses and organizations to use in their marketing strategies [95]. They effectively communicate complex information clearly, concisely, and engagingly. Infographics are particularly effective in presenting statistics, survey results, and other data in an easy-to-understand and memorable format. They help establish brand identity and increase online visibility by incorporating inclusive branding elements such as logos and color schemes. Infographics can be shared on social media and digital platforms, reaching a wide audience [96]. They are versatile and effective marketing tools that enable businesses

and organizations to communicate their message, build brand awareness, and engage their target audience.

Infographics are powerful tools for data journalists to present complex information in a visual and easily understandable format. They help make large amounts of data more digestible by breaking it down into smaller, comprehensible pieces. Data journalists use infographics to create compelling stories that engage readers and viewers, allowing them to grasp complex issues [97]. Infographics facilitate effective communication of data journalism, promoting information sharing and discussion on social media platforms. They are widely utilized to present and analyze large datasets, enabling data journalists to tell stories and highlight specific topics or trends.

Infographics enhance learning by making complex information accessible. Visuals help learners understand diverse educational content, from data to historical events. Interactive elements increase engagement and critical thinking skills. Infographics are valuable tools, promoting education quality and improving the learning experience. They are used in classrooms and beyond, presenting information clearly and interestingly. Infographics benefit visual learners by aiding comprehension [98].

Infographics are essential for social media marketing as they effectively convey complex information in a visually captivating manner, driving audience engagement [99], [100]. Platforms like Facebook, Instagram, and Twitter have integrated infographics, enabling easy sharing and interaction. They present statistics, convey brand messages, and provide valuable information to followers. Infographics can be optimized for social media by incorporating shareable elements like hashtags and embedded links to relevant content.

Interactive infographics are a subset of infographics that allow real-time user engagement, which is particularly beneficial for learners. They offer dynamic exploration and interaction with data, enhancing understanding of complex topics. Multimedia components like videos, animations, and audio clips supplement static graphics. Designers use specialized software like Adobe Illustrator or Canva to create interactive elements and incorporate multimedia.

User experience and intuitive design are crucial considerations. Testing and feedback ensure effective information delivery. Developing interactive infographics requires design skills, technical expertise, and an understanding of the target audience [101].

Infographics offer effective personalization of information content, catering to the specific needs and preferences of the audience. Through data visualization techniques and storytelling methods, infographics present complex information in a user-centric manner. Interactive elements like animation, hyperlinks, and quizzes allow personalized and interactive information exploration. This enhances user engagement, retention, and understanding, enriching personalized experiences. Personalized infographics empower individuals to design unique visuals using their data or preferences, contributing to a more tailored and engaging experience [102]. Personalization can apply to infographics tailored to specific sectors, fields, or individual interests and preferences.

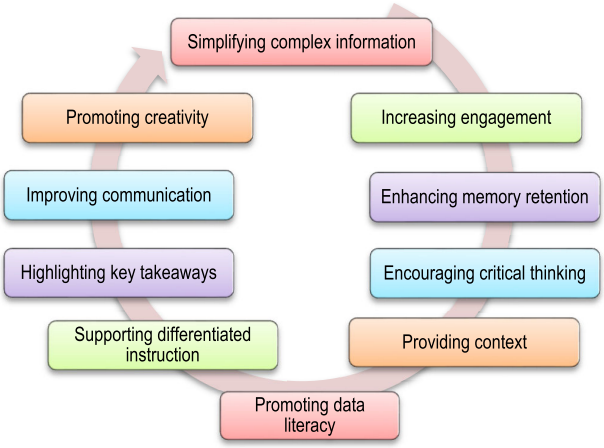

FIGURE 2. Processes enabling communication and presentation of information.

Infographics increasingly adopt storytelling strategies, particularly in longer or more complex designs. Presenting information in a narrative format makes these infographics more engaging, memorable, and effective, especially in advocacy or marketing contexts [103]. Infographics utilize storytelling techniques to captivate the audience and enhance understanding. This involves selecting a compelling story, characters, and plot that aligns with the data. Visual elements such as images and colors further enhance the storytelling experience, directing attention to key points of the narrative.

A. DISTINCTIVE ROLES

In data visualization for instructional purposes, infographics are vital. Infographics provide complex information in a visually appealing, enduring, and comprehensible way. Infographics can serve various purposes in data visualization for educational purposes (see Figure 2).

Infographics can help educators break down complex material and data by presenting it visually appealing and intelligibly [104]. Visual elements like charts, graphs, and icons in infographics can break down complicated material into smaller, easier-to-understand chunks for pupils.

Increasing Engagement: Infographics can assist students in becoming more engaged with the material because they are visually engaging. Infographics can attract students' attention and maintain their concentration by presenting data in an intriguing and aesthetically appealing way.

Enhancing Memory Retention: Students may learn information more effectively with infographics. Infographics are a powerful tool for presenting information in a way that is visually appealing and easy to recall. Research has shown that using visuals can aid in increasing memory retention.

Encouraging Critical Thinking: By presenting facts in a way that necessitates analysis and interpretation on the part of the audience, infographics help promote critical thinking abilities. Infographics help students think critically about the presented data and come to their conclusions by interestingly visualizing the material.

Providing Context: Infographics that provide context for the information being given can aid pupils in understanding data. Infographics aid students in comprehending the relevance of the information being presented by employing visual components to provide context, such as maps or timelines, to show them how the data fits into a larger framework.

Promoting Data Literacy: By presenting data in a simple way to understand and interpret, infographics can aid in promoting data literacy. Infographics can assist students in developing fundamental data literacy skills and a better understand of how to read and analyze data by employing visual components to communicate data, such as charts and graphs.

Supporting Differentiated Instruction: Infographics can promote differentiated education by offering numerous ways to communicate information. Infographics can supplement typical textual formats for pupils who may learn the material more effectively through visual or graphical representations.

Highlighting Key Takeaways: Aside from simplifying complicated information or data, infographics may also be utilized to emphasize the main points. Infographics can aid students in recognizing the most crucial data and comprehending the overall message of the presented material by employing visual clues to direct attention to vital information.

Improving Communication: By displaying information clearly and succinctly, infographics can also enhance communication between instructors and students.

Infographics can increase communication between teachers and students by presenting data to make it easier for students to grasp and ask informed questions.

Promoting Creativity: By challenging pupils to think outside the box and convey information in an aesthetically appealing way, infographics can help foster creativity.

By allowing students the opportunity to create their infographics, educators can inspire kids to be imaginative and think critically about the best methods to present information.

B. HOW INFOGRAPHICS' DRIVE EDUCATIONAL CONTEXTS?

Infographics have the ability to present complex information and ideas in an organized and simplified manner, which allows instructional designers to create learning activities, including warm-up sessions, short stories, or even reviews of previously learned topics.

Furthermore, preliminary interactions with learners regarding new topics can be conducted through brief introductory sessions [88]. Using infographics for delivering information during the training process significantly impacts academic achievement and metacognitive skills. In particular, using infographics can facilitate the management of the learning process.

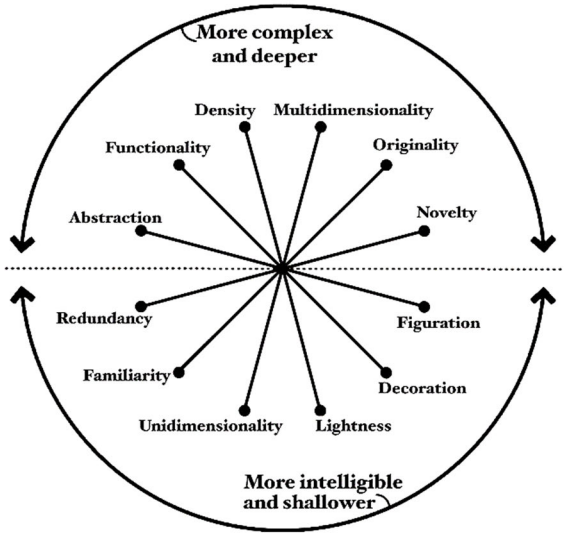

FIGURE 3. Alberto Cairo's Visualization Wheel [81].

Research studies explore non-digital ways of displaying information in public spaces. For instance, a study on chalk infographics [106] offers several advantages over digital displays. They can be deployed quickly, provide unrestricted interaction, and are more sustainable. In a study by [106], researchers developed a slow-moving robot called "Woodie" that drew on the ground using traditional chalk sticks. Woodie was designed to be perceived as a living being and evoked emotional responses among observers. The study found that Woodie successfully attracted people's attention and served as a facilitator for collaborative and creative placemaking.

Similarly, [107] presented Cairo's wheel (see Figure 3), a unified view of a multi-dimensional wheel designed to identify, analyze, and evaluate design patterns from multiple perspectives. Infographics have been found to positively affect cognition, as they reduce stress in understanding and interpreting information [108]. In a study by Cheng et al. [31], a two-phase study explored an effective growth mindset intervention for higher education settings. In the first phase, thirteen articles published between 2010 and 2021 were systematically reviewed and analyzed to showcase how the intervention was designed, conducted, and evaluated. The low number of studies analyzed shows that using visual images as a mindset intervention in existing literature is still in its infancy.

To develop a growth mindset, the authors designed a set of infographic resource materials and delivered them to thirty participants recruited from a university in the second phase of the study. The study's results [31] show significant differences between the two groups. The impacts of the study materials were observed through weekly reflections, and differences were observed between the experimental and control groups after a 6-week intervention, with the experimental group perceiving significantly more malleable

intelligence. The capability to learn throughout one's life, with the help of cognitive abilities and the skills to be creative and self-sufficient, enables learners to absorb and understand knowledge and information at a deeper level. Assigning learners to design infographics, as suggested by the author [109], enhances information delivery and facilitates visual learning. The transfer of information through visuals has increased motivation for learning [110]. Infographics deliver information and can enhance learners' cognitive abilities and visual literacy skills. By leveraging learners' strengths in visual perception, infographics can optimize their thinking, learning, and expression. As an alternative tool, infographics have been shown to support learners' academic achievements, making them valuable in educational settings [33]. Overall, infographics and associated information delivery models can create platforms that promote high-level cognizance of information and optimize learners' skills and abilities.

VII. APPLIED INFOGRAPHICS IN EDUCATION

This study describes the characteristic objectives of infographics and classifies those into the following four categories: visualization, focus, modeling, and approach. The study considers these four categories as key factors that affect infographics' processing, design, development, and applications in imparting education in various disciplines.

A. VISUALIZATION

Infographic visualization refers to using graphics, charts, and images to present complex information in an easily digestible format.

Infographics are designed to help people understand complex data and ideas quickly and easily by organizing information visually that is easy to scan and comprehend. Infographic visualization can take many forms, including timelines, maps, bar charts, pie charts, and flowcharts. The key to effective infographic visualization is choosing the right graphic or chart to communicate the information in the most effective way possible.

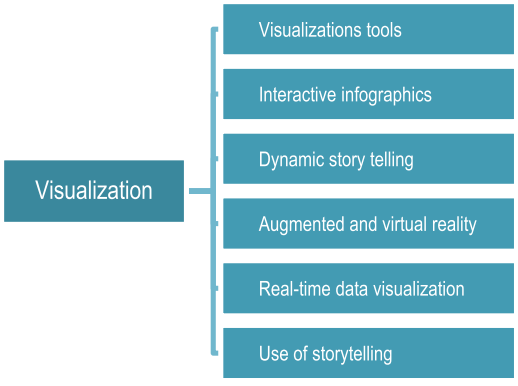

FIGURE 4. Visualization aspect at the core of the infographic development process.

The following are essential aspects concerning the data visualization via the infographic development (see Figure 4).

Use of Data Visualization Tools – Education professionals may now produce infographics that contain complex data sets because of the development of data visualization technologies. Also, these tools enable educators to rapidly and easily produce infographics without requiring sophisticated design abilities.

Interactive Infographics – Infographics that allow students to examine and interact with data in real-time are becoming more prevalent in education. These infographics frequently have films, animations, and other multimedia components that aid students in comprehending difficult subjects.

Dynamic Storytelling – Infographics are used to tell lively stories, such as interactive timelines or historical maps, enabling students to delve deeper into the narrative and connect with the subject matter in novel ways.

Augmented and virtual reality: For immersive learning experiences, infographics are being mixed with augmented and virtual reality. Students can use VR to experience historical events or scientific occurrences or AR to interact with an infographic and study various elements of the data in 3D.

Real-Time Data Visualization – Real-time data, including weather patterns, stock prices, and social media trends, are visualized using infographics. Using this method, students can observe how data changes over time, which teaches them how to evaluate and analyze dynamic data.

Use of Storytelling – In the classroom, infographics are used to present tales, aiding pupils in improved information retention.

Educators are incorporating More narrative components into infographics to clarify cause-and-effect relationships, historical events, and other difficult ideas.

B. FOCUS

Infographics focus refers to the primary objective or purpose of an infographic, which is to effectively communicate complex information in a visually appealing and easily understandable manner.

The focus of an infographic should be clear and concise, with a specific goal in mind, such as educating a target audience, presenting research findings, or marketing a product or service. To ensure that the focus of an infographic is clear, designers should begin by identifying the key message they want to convey and selecting the most appropriate data and visuals to support that message.

They should also consider the target audience, their familiarity with the subject matter, and the medium in which the infographic will be presented. The essential aspects concerning infographic development focus are described as follows (see Figure 5).

Accessibility – With features like alt-text, subtitles, and other concessions for students with disabilities, infographics are being created with accessibility in mind.

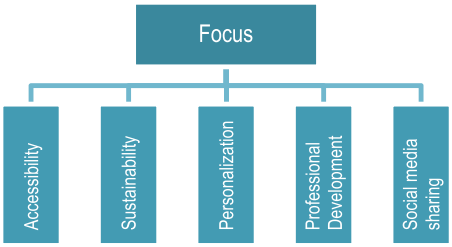

FIGURE 5. Focus aspects for developing infographics.

Sustainability – With less waste and more ecologically friendly materials, infographics are being created with sustainability in mind. Moreover, infographics are employed in education to advance sustainability, assisting students in comprehending how their actions affect the environment.

Personalization – Infographics are being created to be more individualized, considering each student's unique learning preferences and inclinations. One way to do this is to customize infographics with unique color schemes, typefaces, and other design features.

Professional Development – To help educators improve their data literacy and communication abilities, infographics are employed in professional development programs. Teachers can improve their capacity to convey complicated material to pupils by learning how to make and use infographics successfully in their lessons.

Social Media Sharing – Educators publish infographics on social media platforms to reach a larger audience and encourage participation in the topic.

In order to foster teamwork and peer-to-peer learning, social media platforms now let students share infographics with their classmates.

C. MODELING

Infographic modeling refers to designing an infographic's layout and structure, including selecting and arranging text, images, and other visual elements. A well-designed infographic should be visually appealing, easy to read and understand, and effectively communicate complex information.

To create an effective infographic model, designers must first identify the key message they want to convey and determine the most effective way to organize the information. They should also consider the target audience, their familiarity with the subject matter, and the medium in which the infographic will be presented. Infographic modeling often involves templates or frameworks to ensure a consistent layout and structure. These templates guide the designer in selecting the appropriate visual elements, such as charts, graphs, and icons, and organizing them logically and intuitively.

The design aspects concerning data modeling via the infographic development can be described as follows (see Figure 6). By paying careful attention to the modeling process, designers can create infographics that effectively communicate complex information and engage viewers in

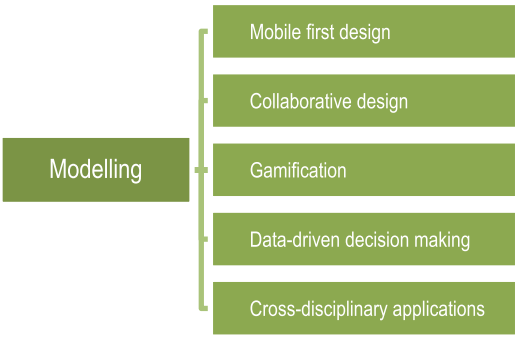

FIGURE 6. Modelling designs for the development of infographics.

a way that traditional text-based communication methods often cannot. Effective infographic modeling helps ensure that the information presented is clear, concise, and visually appealing, making it easier for viewers to understand and retain it.

Mobile-First Design – Infographics are created using mobile-first design principles as more students access instructional content on mobile devices.

It indicates that they are suitable for smaller screens and are simple to read and use on mobile devices.

Collaborative Design – Teachers and students work together to create infographics to encourage active participation and engagement in the learning process. With this strategy, students may take charge of their education and gain vital teamwork and communication skills.

Gamification – Infographics are being gamified to increase learner engagement and enjoyment. Infographics are being enhanced with gamification features like badges, leaderboards, and quizzes to encourage student engagement with the subject matter.

Data-Driven Decision Making – Students are using infographics to aid in data-driven decision-making. Students can examine and interpret data presented in infographics to help them make decisions about their academics, careers, and other parts of their lives.

Cross-Disciplinary Applications – Several academic fields, including history, literature, and mathematics, use infographics. Teachers are discovering that infographics may be a powerful tool for communicating ideas and information across various topic areas, assisting pupils in making connections between various fields of study.

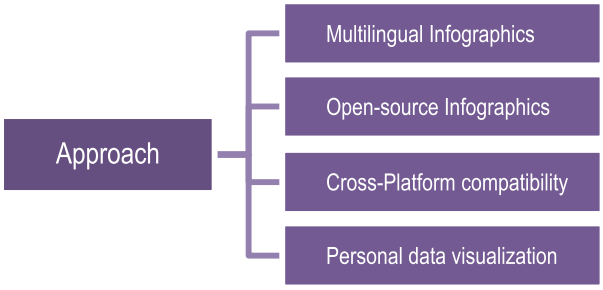

FIGURE 7. Approach to infographics development.

D. APPROACH

The Infographics development approach is a comprehensive and iterative process involving careful planning, design, and testing to create an effective infographic communicating complex information. Once the information and design elements have been selected, the development approach involves testing and refining the infographic to ensure it effectively communicates the intended message to the target audience. This may involve conducting user testing and soliciting stakeholder feedback to identify improvement areas and make necessary changes. As shown in Figure 7, this study identifies approaches concerning the development of infographics can be listed as follows.

Multilingual Infographics – Multiple-language infographics are being created, enabling instructors to reach a larger audience and accommodate pupils from various linguistic backgrounds.

Open-Source Infographics – Infographics are being distributed as open-source tools, allowing teachers to alter and modify them to suit their instructional requirements. This method encourages cooperation and innovation in education.

Cross-Platform Compatibility – Infographics may now be viewed and interacted with on various devices and operating systems thanks to cross-platform interoperability. It guarantees that students may access infographics and interact with them regardless of device or location.

Personal Data Visualization – Infographics are used to visualize personal data, such as fitness and health statistics, to make data literacy and personal data management more important to students.

VIII. ECONOMIC IMPACTS OF INFOGRAPHICS ON THE ROLE OF GLOBAL EDUCATION

Infographics boost the global education sector's economy by lowering costs, boosting productivity, raising student outcomes, generating new job opportunities, and assisting with marketing and recruitment initiatives. Infographics' economic influence on the education industry is projected to increase as they become more well-liked and often used. In the global education sector, infographics can have various economic effects. Here are a few instances:

Cost savings — By lowering the demand for printed resources like textbooks or handouts, infographics can assist educational institutions in making financial savings. Teachers can produce an infographic that communicates the same material more succinctly and attractively than printing out numerous pages of text.

Increased efficiency — By lowering the time and resources required to produce and deliver information, infographics can also help the education sector operate more effectively. Teachers can produce an infographic that provides the same information more effectively and efficiently than spending hours writing and presenting lectures.

Improved student outcomes — Through increasing student engagement, memory retention, and critical thinking abilities, infographics can help improve educational outcomes. Infographics can improve learning outcomes by making difficult material more understandable and memorable to students in a visually appealing and interesting way.

Career opportunities — In education, the popularity of infographics has opened up new job prospects. Designers with educational backgrounds can produce infographics for educational publishers or other organizations in the education sector, while educators with design abilities can produce infographics for use in their classrooms or for other educators.

Marketing and recruitment — Schools and universities utilize infographics for marketing and hiring objectives. Educational institutions can entice new students and spread the word about their products to a larger audience by producing infographics that showcase the advantages of their programs or services.

Increased revenue — Using infographics to generate new revenue streams, educational institutions can boost their income. Schools and universities, for instance, can sell infographics as digital goods or provide infographics as a component of premium instructional bundles.

Improved accessibility — By presenting information more interesting and aesthetically pleasingly, infographics can also enhance accessibility for students. It is crucial for pupils who struggle with traditional textual formats or have learning difficulties.

Increased competition — In the field of education, the popularity of infographics has increased competitiveness. Institutions that embrace infographics and other visual teaching aids may gain a competitive edge over slower adopters of new technology and teaching methods regarding student recruitment and retention.

Improved collaboration — Collaboration between teachers, students, and other education sector stakeholders can be enhanced by infographics. Infographics allow teachers and students to collaborate to present and analyze complicated information, fostering a more cooperative learning environment.

Innovation — Finally, infographics can spur innovation in the educational field by inspiring teachers to develop innovative ways to convey knowledge to pupils and keep them interested. Teachers will need to continue to be innovative and create new methods to use infographics in their teaching techniques as they improve and become more sophisticated.

Infographics have a wide range of substantial economic effects on the worldwide education sector. Infographics alter how educators and students engage with information and learn by lowering costs, boosting efficiency, enhancing student results, generating new sources of income, enhancing accessibility, boosting competition, fostering better collaboration, and stimulating creativity.

IX. EDUCATIONAL COMMUNICATIONS–CHALLENGES AND LIMITATIONS

The use of infographics may pose several limitations and challenges. The key challenges associated with the use of

infographics could be many. Infographics pose challenges in terms of accessibility for individuals with visual impairments due to their heavy reliance on visual elements. Alternative text descriptions and accessible formats are essential for inclusivity and equal access. Furthermore, misinterpretation is another limitation of infographics, as they can oversimplify complex concepts and present biased viewpoints. To minimize misinterpretation, careful content curation and clear explanations are necessary. Developing high-quality infographics also involves challenges such as determining the right dimensions and managing data size.

Graphic design skills and software expertise are required, which can be time-consuming to acquire. Choosing an appropriate coloration scheme and ensuring cross-device compatibility are additional challenges. Information overload assessment and handling computational load pose limitations in developing infographics. Implementing effective rating systems and designing age-appropriate infographics require specialized expertise. Learning software and integrating audio narration can present challenges as well. Cultural adaptability and switchable length content necessitate attention to detail. Network efficiency and modular scalability are additional limitations to be aware of. Finally, it is important to recognize that infographics may only sometimes be the most suitable format for all types of information. Alternative formats should be considered when necessary. Developing high-quality infographics involves various challenges ranging from accessibility and misinterpretation to design considerations, content management, and technical aspects. Understanding these limitations is crucial in order to create effective and inclusive infographics.

A. POSSIBLE RECOMMENDATIONS

The frameworks discussed in the prior sections represent current best practices in the creation and production of professional infographics and can be merged or modified to meet the particular requirements and objectives of each project. These frameworks are made to assist designers and developers in producing useful, interesting infographics that fit the needs of their clients or organizations. These are examples of best practices and recent infographic design and development developments. In the next section, the study presents an outline of the possible frameworks and the design and development guidelines for professional infographics development.

B. GUIDELINES FOR PROFESSIONAL INFOGRAPHICS DESIGN AND DEVELOPMENT

Infographics are trending and becoming increasingly popular tools in various fields, including education, marketing, journalism, and data analysis. Following established design principles and using appropriate tools and techniques to create effective infographics is essential. This is where professional infographic frameworks come into play. Professional infographics frameworks provide guidelines and best practices for creating high-quality infographics that effectively communicating complex information. The key possible frameworks applicable for the task of carrying out professional infographics development are:

User-Centered Design emphasizes creating with the end user in mind, using research and feedback to produce a user-friendly and effective infographic. Data Storytelling focuses on the significance of using narrative frameworks and visual design to enlighten and engage the audience while creating a captivating and coherent story with facts.

Visual Communication Design focuses on using visual communication principles like color, font, and layout to produce a clear and successful infographic. Information Design emphasizes using information design concepts, such as hierarchy, organization, and clarity, to present complicated information in a straightforward and accessible manner. Interactive Design emphasizes interactive features to engage and involve the audience, such as animations, hover effects, and clickable spots.

Brand Identity Design emphasizes using branding and visual identity components to produce an infographic with a unified and identifiable visual language. Responsive Design ensures the infographic is usable and effective on various screen sizes and devices, including desktop, tablet, and mobile. Accessibility Design emphasizes creating with inclusivity and accessibility in mind, ensuring that everyone can utilize the infographic regardless of their level of competence. Performance Optimization emphasizes employing methods like image compression and code optimization to optimize the infographic for quick loading times and slick performance.

Iterative Design emphasizes the use of an iterative design process that involves numerous iterations of input and revision to produce a high-caliber and useful infographic.

Iconography and Illustration: emphasizes using icons and drawings to simplify difficult ideas and concepts and give the infographic more visual attractiveness. Copywriting and Editing emphasizes the need for proper copywriting and Editing to make the infographic simple to read and understand. Collaborative Design emphasizes teamwork among writers, designers, and other stakeholders to guarantee that the infographic satisfies the requirements and objectives of the firm. Brand Alignment emphasizes coordinating the infographic's Design and messaging with the company's overarching brand identity and marketing plan. Data Visualization emphasizes using data visualization methods, such as maps, graphs, and charts, to display complex data interestingly and educationally.

C. EFFECTIVE PRACTICES

In addition to following established frameworks, incorporating best practices is crucial in creating effective infographics. Best practices are guidelines that have been proven effective in designing visually appealing infographics that effectively communicate information. Common best practices for creating infographics include using appropriate color schemes, clear and concise text, and charts and graphs. Other best practices for creating infographics include:

1) ensuring that the information is accurate and up-to-date,
2) using high-quality images and graphics, and
3) ensuring that the design is accessible to all users, including those with visual impairments.

By following best practices, infographic designers can create highly effective visuals communicating complex information. Listed below are the identified practices leading to the development of effective infographics:

Identify the Target Audience — Prior to creating an infographic, it is crucial to determine who the target audience is and what they require. It can assist in directing the infographic's content and design to ensure that the intended message is effectively communicated to the audience.

Keep it Simple — Infographics should be created to convey complicated information clearly and understandably. Use basic language, little text, and straightforward pictures to make the message simple to understand.

Use Visuals Effectively — The text of the infographic should be accompanied by images that reinforce its main points. Use clear and pertinent graphics, icons, and images.

Choose the Right Format — Static photos, interactive formats, and animated formats are just a few of the presentation styles in which infographics can be displayed. Select the best format that corresponds to the message and intended audience.

Design for Readability — Using the proper font sizes, spacing, and color schemes, infographics should be created with readability in mind. Make vital information pop out by using contrasting colors to accentuate it.

Use Data Effectively — Infographics should be created to effectively display data in an approachable manner. Employ graphs, charts, and other data visualization tools to communicate complex information.

Test and Refine — To verify that infographics properly convey the desired message, test them with the appropriate audience. Use comments to improve the infographic's layout and content to better suit the audience's needs.

Make it Shareable — Infographics should be created to be shared quickly and simply on social media sites and other internet channels. Use social media to embed codes and buttons to encourage sharing and interaction with the content.

These guidelines help create infographics that efficiently convey complicated information clearly and interestingly. Educators and designers can make infographics that have a long-lasting effect on their intended audience by keeping these concepts in mind.

X. CONCLUSION

In conclusion, this study highlighted the significant role of infographics in education. Infographics enhance data visualization and promote effective communication in educational contexts by providing a visual representation of complex information. The analysis of current trends and practices sheds light on infographics' diverse applications and creative possibilities in delivering educational content. However, the study also acknowledges the limitations and challenges associated with their use, including the need for accessibility considerations, the risk of oversimplification, and the importance of maintaining accuracy and avoiding bias. Future advancements in tools and software, along with the integration of data analytics, present promising opportunities for further leveraging infographics in education. By carefully addressing challenges and capitalizing on emerging technologies, educators and designers can maximize the potential of infographics as powerful educational tools.

Future research directions in infographics and education include exploring the potential of new technologies, such as virtual and augmented reality, to enhance the visualization and understanding of complex data. Additionally, there is a need for further investigation into the effectiveness of infographics as a teaching tool in different educational settings and with diverse student populations. Research can also focus on the impact of cultural and linguistic factors on the design and interpretation of infographics. Finally, there is a need to develop guidelines and best practices for the design and development of infographics, as well as to explore the potential economic and social impacts of infographics on education and society.

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