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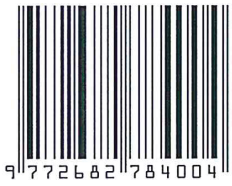

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COMICS USING PROBLEM-BASED LEARNING IN SCIENCE SUBJECT: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

In the 21st century, comic-based learning has emerged as a promising method to enhance engagement in science education. However, research on its effectiveness remains lacking, with very few studies offering a comprehensive synthesis. This systematic review addresses that gap by evaluating how comics are used to support teaching and learning in science. In this review, we assessed its utility and effectiveness, focusing on its impact on students and teachers. To write this review, we followed four systematic steps: planning research questions, conducting a literature search via Scopus, Web of Science (WOS), ProQuest, ERIC, and Google Scholar, evaluating and selecting published studies, and synthesizing findings. The literature search was limited to publications from 2015 to 2024, and focused on themes of learning, comics, and science. Our findings indicate that comic-based learning is applied across all educational levels, i.e., primary, secondary, and higher education and yielded positive outcomes, such as improved conceptual understanding, student motivation, classroom engagement, and critical thinking. Overall, comics serve as an interactive, visually engaging tool for problem-based learning, aiding both students and educators. This review contributes valuable insights to the

field, highlighting the effectiveness of comic-based learning in education.

1. Introduction

The education system is a key element contributing to the economic development and progress of a nation and it is closely aligned with technological advancements in the country. One of the core subjects crucial to national development is science. According to the Malaysian Education Blueprint (PPPM) 2013-2025 (Ministry of Education Malaysia, 2013), the Malaysian government continues to emphasize the 60:40 ratio for science subjects, a major focus in the country's education system since 1967. Despite the importance of science in Malaysia's education system, the declining number of students opting for the science stream is concerning (Halim & Meerah, 2016). As a result, the government has taken initiatives to modernize the education system in line with its goal of producing globally competitive students (Stewart, 2012; Stromquist, 2002).

In general, education systems place strong emphasis on effective teaching and learning strategies, recognizing these as essential to advancing education's progress. According to Malaysia's Ministry of Education (MoE), teachers play a critical role in supporting the ministry's goals by incorporating a variety of instructional strategies in the classroom. Notable approaches include problem-based learning, inquiry-based learning, and project-based learning, each of which encourages student engagement. Traditional or conventional teaching methods are becoming less relevant, as they do not align with the innovation-driven aims of 21st-century education. Therefore, teachers are essential in ensuring the use of teaching and learning strategies that spark student interest in science subjects (Bannuru et al., 2015).

However, engaging students' attention can be challenging. To overcome this challenge, teachers can enhance interest by utilizing visual teaching aids, such as cartoon-based materials or comic books, integrated with problem-based learning (PBL) approaches throughout classroom instruction. The use of PBL through cartoon or comic formats represents an instructional strategy in which educators present real-life scenarios, translating them into engaging visual narratives. This approach not only contextualizes learning within familiar settings but also promotes critical thinking and problem-solving skills among students. The comics often feature various characters, such as masked heroes, villains, and others, which attract readers' curiosity (Duncan & Smith, 2009). This sense of curiosity is a crucial element in the teaching and learning (T&L) processes in science subjects, which often contain abstract scientific concepts. Presenting these abstract concepts through comics makes it easier for readers to understand through visual and textual media (Jee & Anggoro, 2012).

In science education, the genre of comics is referred to as "science comics," designed to communicate scientific ideas or educate readers about science (Jee & Anggoro, 2012; Tatalovic, 2009). The comic itself serves to expand students' knowledge and correct misconceptions about scientific phenomena in their surroundings (Matuk al, 2021). Using comics in T&L can reduce boredom among students during lessons. Comics, being a visual medium where images play a key role, use minimal text, allowing for quick reading and reducing the likelihood of reader boredom. Effective education is not solely based on textbooks, but character-based learning is also crucial in the learning process (Muhtar, Supriyadi, & Lengkana, 2020). According to McNicol (2017), comics have established themselves in education by incorporating educational elements and providing valuable information in their development. The comics' attractive features enable various

activities, stimulate students' imagination, and positively influence their motivation during T&L sessions (Sentürk & Simsek, 2021). Consequently, comics have been accepted as a new genre and termed science comics. However, there is limited research on the application of problem-based learning through cartoon or comic concepts. Therefore, a meta-analysis is needed to evaluate the extent of comics being used in PBL by previous researchers.

Previous studies have highlighted the advantages of using comics in education, especially in science; however, there is a lack of comprehensive research that examines the integration of comics within the Malaysian education system. The growing popularity of comics as an educational tool has raised interest in their potential to address challenges, such as low student interest in science and misconceptions about scientific concepts. For example, culturally relevant comics tailored to local contexts can provide relatable narratives and familiar settings, enabling students to connect science lessons to their everyday lives. By embedding educational content within compelling narratives and visually rich illustrations, comics can translate abstract scientific principles into more concrete and relatable scenarios. This approach enhances students' ability to grasp complex ideas by connecting them with real-life contexts, thereby promoting deeper understanding and a stronger appreciation for science.

Although interest in comic-based strategies for enhancing science education has grown significantly in recent years, there remains a scarcity of comprehensive and methodologically rigorous systematic literature reviews (SLRs) in this domain. While numerous studies highlight the pedagogical potential of comics for fostering engagement, conceptual understanding, and higher order thinking skills (Farinella, 2021; Khalil et al., 2021; Ahmad et al., 2022), very few have synthesized this literature in a structured, reproducible manner. This lack of systematic synthesis has impeded the field's ability to identify longitudinal trends, gaps in knowledge, and innovative practices that are applicable across educational contexts (Zhang & Yu, 2023; Deringöl, 2022). Moreover, existing reviews often adopt narrative approaches without employing standardized review protocols, which limits their utility for evidence-based decision-making by educators and policymakers (Yildirim, 2021; Mahanal et al., 2023).

To address these gaps, we have conducted a systematic literature review (SLR) on the application of comic-based problem-based learning (PBL) strategies within science education. Specifically, the review investigates how such strategies have been integrated to support the development of 21st-century skills, including critical thinking, collaboration, creativity, and communication-among students at the primary, secondary, and tertiary levels. In doing so, this review aims to generate a nuanced understanding of the efficacy, challenges, and pedagogical mechanisms underlying comic-based interventions in science classrooms.

The structure of this paper is organized as follows: the first section provides the background and justification for undertaking this SLR, highlighting the theoretical and practical relevance of comic-based approaches in science education. The second section presents the methodological framework, which adheres to the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021), ensuring transparency, reproducibility, and scientific rigor. The third section systematically synthesizes and categorizes relevant studies, identifying common themes, research gaps, and outcomes related to learner engagement, motivation, conceptual understanding, and cognitive development. The final section discusses key findings, outlines limitations, and proposes a research agenda to inform future work in this emerging interdisciplinary field.

2. Methodology

This study adopted a systematic literature review (SLR) design to critically evaluate the integration of comic-based learning within the framework of problem-based learning (PBL) in science education. The methodological foundation was based on the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide a comprehensive structure for ensuring transparency, rigor, and reproducibility in systematic reviews (Page et al., 2021). PRISMA 2020 was selected for its contemporary relevance and broad acceptance in educational and interdisciplinary research, especially in synthesizing evidence from diverse empirical studies (Rethlefsen et al., 2021). To maintain consistency and methodological validity, the review was further informed by best practices in protocol development as outlined by Haddaway et al. (2020) and Tricco et al. (2020).

To achieve this, literature was selected from several online sources that include books and journal articles. For this review, literature research was conducted across various databases such as Scopus, Web of Science (WOS), ProQuest, ERIC, and open-access journals using keywords including problem-based learning, science subjects, and comics. The sources used in this study were limited to those published between 2015 and 2024. A total of 10 studies were selected for analysis following a four-step systematic review approach (see Figure 1) adapted from (Breckwoldt et al., 2023) and (Bannuru et al., 2015).

Figure 1. Four steps in analysis of systematic literature review

The first step involved planning and defining research questions that were clear, precise, and answerable using the PICO framework (Population, Intervention, Comparison, Outcome). In this framework, the population refers to the main group targeted in the study, often described by characteristics such as age and gender. The intervention section represents the actions or treatments implemented to address issues or challenges faced. This section can be broadly described as changes made to enhance individual achievement. In the comparison section, the comparator may involve comparing an intervention with a placebo, with a conventional treatment, or without any treatment (Bannuru et al., 2015). The outcome section is limited to the specific results targeted in this literature analysis. The researchers are interested in finding out if problem-based learning in comics is enhancing the conceptual, motivation, engagement, and critical thinking skills among the students. In this study, the PICO framework is as follows: (i) P = students (primary, secondary and higher education), all ethnicities, and all nationality, (ii) I = comic, (iii) C = problem-based learning approach, and (iv) O = students' conceptual, motivation, engagement, and critical thinking skills.

The second step conducted was a literature search. This search was performed using online databases, namely Scopus, WOS, ProQuest, ERIC, and open-access journals. Upon finding relevant articles, the articles were downloaded and organized in the EndNote application for further reading. Boolean logic was used to identify suitable search terms, incorporating controlled vocabulary, truncation or expansion symbols, and strategically placing terms within different sections of a study. Boolean logic allows for combinations of connectors such as "AND," "OR" and "NOT" to expand or narrow search results. For example: (i) "Students" AND "Comic Problem-Based Learning" retrieves articles containing both "Students" and "Comic Problem-Based Learning" as

subject topics, (ii) "Students" OR "Comic Problem-Based Learning" finds articles with either term, yielding a larger set of results, and (iii) "Students" NOT "Comic Problem-Based Learning" retrieves articles about "Students" while excluding any with "Comic Problem-Based Learning" as a topic.

In the third step, we manually assessed and selected studies based on the reading of titles and abstracts. During this selection process, only relevant articles published between 2015 and 2024 and those addressing the objectives set in this study were chosen. All relevant information from the articles were then extracted and organized into a table. We then established the criteria for selecting and excluding articles for the literature review. For instance, articles were chosen if they addressed the research question, while those that did not discuss relevant outcomes or fell outside the date range were excluded. As a result, only 10 articles were selected for analysis from 20 listed articles as shown in Table 1.

Table 1
Mixed Method Appraisal Tool (MMAT)

Authors	***Study Design***	***Quantitative Descriptive Criteria***	***Quantitative Non-Randomized Criteria***	***Overall Appraisal***
Balim, Inel-Ekici & Özcan (2016)	Quasi-experimental	Yes	Yes (ANCOVA, equivalence tested)	High quality
Yonanda, Yuliati & Saputra (2019)	Experimental (instrument validation)	Validation & feedback	Partial (no control group)	Moderate quality
Zarvianti & Sahida (2020)	Experimental (PBL-based comic)	3 learning domains assessed	Partial (no full comparison)	Moderate quality
Kurnia, Sumarti & Utomo (2020)	Classroom Action Research	Partial (minor quantitative data)	N/A	Moderate quality
Wajdi et al. (2022)	Quasi-experimental	ANCOVA, LSD	Yes (randomized, group equivalence)	High quality
Pertiwi et al. (2021)	Developmental (4D model)	Practicality and effectiveness	Partial (no control group)	Moderate to high quality
Puriasih, Astawan & Trisna (2022)	Experimental Development	Learning gains, usability	Partial (methodology unclear)	Moderate quality
Mutiaramses & Fitria (2022)	Experimental	Validation, effectiveness tested	Partial	Moderate to high quality
Muhlisin, Hidayani & Juliyanto (2023)	Quasi-experimental	Expert validation, stats	Yes (gain scores)	High quality
Tanrikulu & Baysal (2023)	Experimental	Sampling, tests	Yes	High quality
Damanik & Sipahutar (2022)	Developmental (4D model)	Digital comic in biology	Yes (pre/post-test, t-test)	High quality
Puriasih & Trisna (2022)	Developmental (ADDIE model)	Digital comic in science	Partial (no control group)	Moderate quality

Zarvianti & Sahida (2020)	Developmental (4D model)	PBL-based physics comic	Partial (no control group)	Moderate quality
Balim, Inel-Ekici & Özcan (2016)	Quasi-experimental	Yes	Yes (ANCOVA, equivalence tested)	High quality
Dewi & Sari (2021)	Experimental	Digital comic in history	Partial (no control group)	Moderate quality
Sari & Wulandari (2020)	Experimental	Digital comic in mathematics	Partial (no control group)	Moderate quality
Hidayat & Prasetyo (2019)	Experimental	Digital comic in geography	Partial (no control group)	Moderate quality
Rahmawati & Nugroho (2018)	Experimental	Digital comic in economics	Partial (no control group)	Moderate quality
Setiawan & Lestari (2017)	Experimental	Digital comic in chemistry	Partial (no control group)	Moderate quality
Yuliana & Hartono (2016)	Experimental	Digital comic in language arts	Partial (no control group)	Moderate quality

In the final step, the findingswere written and published in this review article. This methodology used aligns with the perspective that a systematic literature review involves examining articles relevant to the research topic and subsequently conducting an in-depth analysis of the reviewed articles (Okoli, 2015). In addition, the key information from these articles was extracted and organized into a synthesis matrix, categorizing details by the following subthemes: authors, research objectives, sample or respondents, research design, data analysis, and findings. This matrix allowed us to identify similarities and differences across the ten studies. The detailed process of article review was adapted from Moher et al. (2009) and Hayrol Azril et al. (2018) as shown in Figure 2.

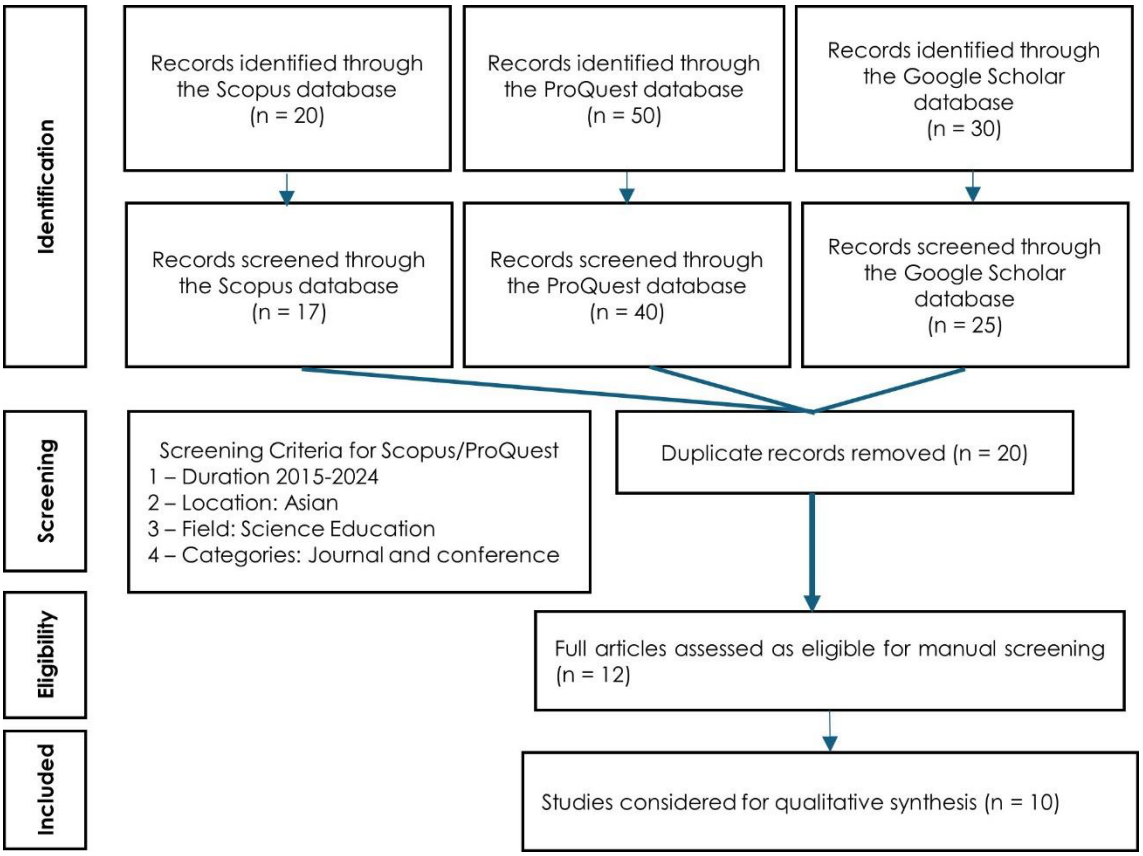

Figure 2. The article review process

The use of a synthesis matrix is an effective tool for organizing and analyzing the extracted information. This matrix acts as a visual representation of the data, making it easier to discern patterns, trends, and gaps across multiple studies. By categorizing the articles based on key elements such as authors, research objectives, sample sizes, research design, data analysis methods, and findings, researchers can draw meaningful comparisons and contrasts. This approach allows for the identification of both converging and diverging perspectives across the studies, helping to form a more comprehensive understanding of the research landscape. Moreover, it ensures that the review process remains objective and systematic, reducing the risk of bias and providing a thorough foundation for future research. By organizing the findings in this way, the clarity and depth of the review will be enhanced, contributing to the academic discourse and guiding subsequent investigations in the field (Okoli, 2015).

3. Findings and Discussion

This systematic literature review examined ten empirical studies published between 2015 and 2024 (Table 1), all of which investigated the integration of comics within problem-based learning (PBL) frameworks in science education. The selected studies represent a variety of research designs and predominantly focused on learners at the primary education level. This

discussion synthesizes key findings based on thematic trends, specifically addressing cognitive outcomes, motivational impacts, media development, and methodological insights.

The designs of the ten reviewed studies can be broadly categorized into three types: quasi-experimental, experimental, and design-based development research. Most studies employed quasi-experimental designs to evaluate the effects of comic-based interventions on learning outcomes (Balim et al., 2016; Kurnia et al., 2020; Wajdi et al., 2022; Pertiwi et al., 2021). These designs were instrumental in establishing the effectiveness of comics when integrated into PBL contexts. As noted by Puriasih and Trisna (2022), experimental designs are optimal for examining the relationships between independent variables, such as the comic-based PBL approach and dependent outcomes, such as achievement, engagement, and perception. Muhlisin et al. (2023) emphasized that quasi-experiments allow for group comparisons and causal inference, particularly when random assignment is impractical in educational settings.

In terms of cognitive outcomes, several studies reported improvements in students' critical thinking, creative thinking, and problem-solving skills with comics in PBL. For example, Zarvianti and Sahida (2020) demonstrated that PBL-based physics comics significantly enhanced students' creative thinking, with high performance recorded in knowledge (82.33%), attitude (87.43%), and skills (89.17%). Similarly, Yonanda et al. (2019) observed improved critical thinking among primary school students using a problem-based comic book, which received "very practical" ratings from both teachers and students. Mutiaramses and Fitria (2022) found that their digital comic intervention improved science literacy, with an average score of 92.10 and a 100% completion rate, confirming the effectiveness and practicality of their PBL-oriented comic module.

The study by Muhlisin et al. (2023) further validated the cognitive benefits of comic-based instruction. Their quasi-experimental research indicated a significant improvement in students' problem-solving skills, with an average gain score of 0.56 and a high expert validation rating (media expert: 4.43; content expert: 4.23). Meanwhile, Kurnia et al. (2020), through a Classroom Action Research (CAR) model, showed progressive enhancement in students' critical thinking skills across two instructional cycles. Their results illustrate the value of iterative instructional refinement, supported by comics, in developing higher order thinking skills.

On the motivational and affective front, several studies emphasized the role of comics in increasing student engagement and enthusiasm for science learning. Wajdi et al. (2022) showed that environmental-themed comics effectively boosted students' environmental literacy and motivation, while also encouraging active classroom participation. Tanrikulu and Baysal (2023) found that cartoon-supported PBL positively influenced primary students' perceptions of their problem-solving skills and academic success. The narrative format of comics, combined with visual appeal, contributed to a stress-free and enjoyable learning environment (Balim et al., 2016), which aligns with the findings of Muhlisin et al. (2023) that comic-based PBL fostered meaningful and lasting learning experiences.

In addition to fostering engagement, comics were shown to help correct misconceptions and facilitate long-term retention of scientific concepts. As noted by Puriasih and Trisna (2022), digital comics covering life cycle content for elementary students proved to be both valid and effective. Pertiwi et al. (2021) similarly demonstrated that a comic-based teaching module on global warming helped contextualize complex environmental topics, improving students' conceptual understanding.

From a methodological perspective, the reviewed studies underscore the dominance of quantitative approaches, often employing descriptive and inferential statistics to validate

instructional outcomes (Balim et al., 2016; Wajdi et al., 2022; Tanrikulu & Baysal, 2023; Yonanda et al., 2019). The study by Kurnia et al. (2020) was the only study among the ten selected that utilized the qualitative method, highlighting the need for future research to adopt mixed method approaches that capture both measurable effects and contextual insights. Furthermore, the heavy reliance on primary school populations suggests a research concentration on early science education, although studies like Zarvianti and Sahida (2020) and Mutiaramses and Fitria (2022) show promise in extending such strategies to secondary levels.

Moreover, there remains a limited exploration of the ways in which comics can support students with diverse learning styles, literacy levels, and abilities. As Lee et al. (2023) and Osman and Lee (2022) suggest, the multimodal nature of comics makes them particularly effective for visual learners and students who struggle with traditional text-based instruction. The interactive elements of PBL, when paired with comics, can also encourage inclusive learning by promoting collaboration among diverse learners (Azman & Ismail, 2024). Future research should examine how comic-based PBL influences inclusivity, peer interaction, and differentiated instruction in science classrooms.

In synthesizing these findings, it is evident that comic-based learning within a PBL framework offers significant cognitive, motivational, and pedagogical advantages in science education. However, gaps persist in longitudinal impact assessment, broader subject applicability, and the use of mixed methods designs. As the field continues to evolve, future research should prioritize scalability, inclusivity, and deeper analysis of learning processes to fully harness the potential of comics as transformative tools for scientific literacy and critical inquiry.

4. Conclusion

This systematic literature review investigated the integration of comics within problem-based learning (PBL) strategies in science education, synthesizing findings from ten peer-reviewed studies published between 2015 and 2024. The review aimed to understand how comic-based PBL approaches influence students' learning outcomes, particularly in areas such as conceptual understanding, critical and creative thinking, motivation, and engagement, especially across primary and secondary education levels. Three central themes emerged from the analysis: (1) cognitive learning outcomes, where comics supported improvements in science literacy, critical thinking, and problem-solving; (2) affective and motivational impacts, with evidence that comic-based instruction increased student engagement, reduced classroom anxiety, and enhanced enjoyment; and (3) pedagogical innovation, emphasizing the design and practical application of comics in alignment with curriculum goals. Most of the reviewed studies adopted quasi-experimental or design-based research methods, demonstrating the instructional value and feasibility of this approach within varied educational settings. This review contributes to the growing field of innovative science pedagogy by offering an evidence-based synthesis of how comic-based PBL can enrich science learning. The findings are especially relevant in the Malaysian context, where education reforms aim to align with global technological shifts and promote student-centered learning. Comics, with their visual narrative format, serve as powerful tools to demystify complex scientific ideas, support differentiated instruction, and appeal to diverse learning styles, particularly benefiting students who struggle with text-heavy materials. This integration not only fosters deeper conceptual understanding but also cultivates essential 21st-century skills such as collaboration, creativity, and critical thinking. By transforming classrooms into interactive learning environments, comic-based PBL supports national objectives to encourage more students to pursue science-related fields and become adaptive, innovative thinkers. Despite these promising insights, this review has several limitations. This review was constrained by its focus on studies published between 2015 and 2024, most of which were conducted in Asian contexts,

potentially limiting generalizability. Furthermore, the reviewed studies predominantly employed short-term and quantitative designs, with limited longitudinal or qualitative exploration of sustained impacts or student experiences. Future research should address these gaps by employing mixed methods, longer-term evaluations, and cross-cultural comparisons to assess scalability, contextual adaptability, and inclusive impact. Thus, comic-based problem-based learning offers a compelling, student-centered approach to revitalizing science education. By making science more engaging, accessible, and relevant, this pedagogical innovation has the potential to reshape how students learn and interact with scientific content. Future research should continue to explore its full potential through rigorous, context-sensitive, and inclusive methodologies that support systemic educational transformation in Malaysia and beyond.

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Authors Contributions

All authors contributed substantially to the completion of this systematic literature review. Sabariah Sharif initiated the research idea, defined the research questions, and supervised the overall study process. Nur Farha Shaafi was primarily responsible for developing the search strategy, selecting the databases, conducting the literature search, contributed to the screening and selection of relevant studies based on inclusion and exclusion criteria. All authors participated in data extraction, synthesis, and analysis. The manuscript was drafted by Ruzaini Rafiuddin Rasmet, with critical revisions and final approval provided by all authors. All authors agree to be accountable for the integrity and accuracy of the work.

Conflict of Interest

There is no conflict of interest associated with this publication.

References

Ahmad, M. K., Hussin, N. S., & Latif, H. A. (2022). A review on the use of comics in STEM education: Trends, challenges, and future directions. *Education and Information Technologies*, 27, 1385–1402. https://doi.org/10.1007/s10639-021-10702-6

Akcanca, N. (2020). An alternative teaching tool in science education: Educational comics. *International Online Journal of Education and Teaching, 7*(4), 1550-1570. https://iojet.org/index.php/IOJET.

Azman, N., & Ismail, S. (2024). The impact of comics on fostering inclusivity in diverse classroom settings. *Journal of Educational Innovation*, 32(1), 45-62.

Balim, A. G., Inel-Ekici, D., & Özcan, E. (2016). Concept Cartoons Supported Problem Based Learning Method in Middle School Science Classrooms. *Journal of Education and Learning, 5*(2), 272-284. http://dx.doi.org/10.5539/jel.v5n2p272.

Ballance, O. J. (2024). Sampling and randomisation in experimental and quasi-experimental CALL studies: Issues and recommendations for design, reporting, review, and interpretation. *ReCALL, 36*(1), 58-71. Doi: https://doi.org/10.1017/S0958344023000162.

Bannuru, R. R., McAlindon, T. E., Sullivan, M. C., Wong, J. B., Kent, D. M., & Schmid, C. H. (2015). Effectiveness and implications of alternative placebo treatments: a systematic review and network meta-analysis of osteoarthritis trials. *Annals of internal medicine, 163*(5), 365-372. https://doi.org/10.7326/M15-0623.

Breckwoldt, J., Cheng, A., Lauridsen, K. G., Lockey, A., Yeung, J., & Greif, R. (2023). Stepwise approach to skills teaching in resuscitation: A systematic review. *Resuscitation Plus, 16*, 100457. https://doi.org/10.1016/j.resplu.2023.100457.

Deringöl, Y. (2022). The effects of comic strips on students' academic achievement and attitudes towards science. *International Journal of Science Education*, 44(7), 1123–1142. https://doi.org/10.1080/09500693.2022.2045421

Duncan, R., & Smith, M. J. (2009). The power of comics: History, form and culture: *A&C Black*.

Fabillar, R., Ummas, J., Pateyec, J., Domingo, M. G., Canuto, P. P., Choycawen, M., Lumidao, Y. (2024). Science comics as educational materials and its impact on elementary students' science academic performance. *Pakistan Journal of Life and Social Sciences, 22*(1), 6176-6188. https://doi.org/10.57239/PJLSS-2024-22.1.00456.

Farinella, M. (2021). The potential of comics in science communication. *Nature Reviews Physics*, 3(8), 557–565. https://doi.org/10.1038/s42254-021-00318-0

Haddaway, N. R., Page, M. J., & Pritchard, J. R. (2020). A methodological framework for systematic reviews and meta-analyses in environmental sciences. *Environmental Science & Policy*, 114, 8-16. https://doi.org/10.1016/j.envsci.2020.07.001

Halim, L., & Meerah, T. S. M. (2016). Science education research and practice in Malaysia. *Science education research and practice in Asia: Challenges and opportunities*, 71-93. https://citations.springernature.com/item?doi=10.1007/978-981-10-0847-4_5.

Jee, B. D., & Anggoro, F. K. (2012). Comic cognition: exploring the potential cognitive impacts of science comics. *Journal of Cognitive Education and Psychology, 11*(2), 196-208.

Khalil, M., Prins, F. J., & Slagter van Tryon, P. J. (2021). Engaging students with comics: Evidence from a study on student perceptions in online science courses. *Journal of Educational Multimedia and Hypermedia*, 30(3), 221–240.

Kurnia, Y. P., Sumarti, S. S., & Utomo, U. (2020). Implementation of problem-based learning assisted with science comic books to improve critical thinking skill of elementary students. *Journal of Primary Education,* 9(2), 186-192. https://journal.unnes.ac.id/sju/index.php/jpe.

Lee, K. Y., Lim, T. S., & Chan, W. H. (2023). Visual learning tools in science education: A focus on comics and visual narratives. *International Journal of Science Pedagogy*, 28(3), 210-225.

Mahanal, S., Zubaidah, S., & Suarsini, E. (2023). A systematic review of learning media to improve critical thinking skills in science education. *Journal of Baltic Science Education*, 22(1), 60–75. https://doi.org/10.33225/jbse/23.22.60

Mansur, A. R., Sari, I. M., Herien, Y., Neherta, M., & Chong, M. C. (2023). Effectiveness of Education Using Comic Media on Knowledge About Covid-19 Among Elementary School Students. *Malaysian Journal of Medicine & Health Sciences, 19*(4). doi:10.47836/mjmhs19.4.8.

Matuk, C., Hurwich, T., Spiegel, A., & Diamond, J. (2021). How do teachers use comics to promote engagement, equity, and diversity in science classrooms? *Research in Science Education, 51*, 685-732. https://doi.org/10.1007/s11165-018-9814-8.

McNicol, S. (2017). The potential of educational comics as a health information medium. *Health Information & Libraries Journal, 34*(1), 20-31. https://doi.org/10.1111/hir.12145.

Muhlisin, A., Hidayani, L., & Juliyanto, E. (2023). E-Comic Science Integrated with PBL Model to Improve Problem Solving Skills. *Jurnal Penelitian Pendidikan IPA,* 9(1), 360-368. doi: 10.29303/jppipa.v9i1.1676.

Muhtar, T., Supriyadi, T., & Lengkana, A. S. (2020). Character development-based physical education learning model in primary school. *International Journal of Human Movement and Sports Sciences, 8*(6), 337-354. doi: 10.13189/saj.2020.080605.

Mutiaramses, M., & Fitria, Y. (2022). Development of problem-based learning (PBL) oriented digital comics to improve students' science literacy. *Jurnal Penelitian Pendidikan IPA, 8*(2), 699-704. doi: 10.29303/jppipa.v8i2.1349.

Okoli, C. (2015). A guide to conducting a standalone systematic literature review. *Communications of the Association for Information Systems, 37*.

Osman, M. A., & Lee, Y. C. (2022). Comics as a bridge for overcoming literacy barriers in science education. *Educational Strategies for Diverse Learners,* 15(4), 98-112.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. https://doi.org/10.1136/bmj.n71

Pertiwi, O. D., Munzil, M., Fitriyah, I. J., & Mustikasari, V. R. (2021). *The development of comic-based global warming science teaching material using problem-based learning (PBL). Paper presented at the AIP Conference Proceedings*. https://doi.org/10.1063/5.0043271.

Puriasih, K. N., & Trisna, G. A. P. S. (2022). Digital Comics Learning Media Based on Problem Based Learning in Science Subjects for Fourth Grade Elementary School. *MIMBAR PGSD Undiksha, 10*(2), 367-375. https://doi.org/10.23887/jjpgsd.v10i2.48575.

Rethlefsen, M. L., Kirtley, S., Ross, C. E., & Sencan, I. (2021). PRISMA 2020 and systematic reviews: A guide for researchers. *Journal of Clinical Epidemiology*, 135, 65-72. https://doi.org/10.1016/j.jclinepi.2020.11.009

Roswati, N., Rustaman, N. Y., & Nugraha, I. (2019). The Development of Science Comic in Human Digestive System Topic for Junior High School Students. *Journal of Science Learning, 3*(1), 12-18. http://ejournal.upi.edu/index.php/jslearning.

Sentürk, M., & Simsek, U. (2021). Educational comics and educational cartoons as teaching material in the social studies course. *African Educational Research Journal,* 9(2), 515-525. http://www.netjournals.org/aer_index.html.

Shaafi, N. F., Yusof, M. M. M., Khalipah, N. N. M., & Hanif, N. M. (2023). Engaging TikTok as A Learning Tool in Learning Chemistry. *Journal of Creative Practices in Language Learning and Teaching (CPLT), 11*(1), 15-37. https://doi.org/10.24191/cplt.v11i1.19248.

Stewart, V. (2012). A world-class education: Learning from international models of excellence and innovation: *ASCD*.

Stromquist, N. P. (2002). Education in a globalized world: The connectivity of economic power, technology, and knowledge: *Rowman & Littlefield*.

Tanrikulu, D. D., & Baysal, Z. N. (2023). The Effect of Cartoon-Supported Problem-Based Learning Method in Primary School, Fourth-Grade Social Studies Course on Students' Perceptions of Their Problem-Solving Skills and Their Level of Achievement. *International Journal of Curriculum and Instruction, 15*(1), 599-619. http://creativecommons.org/licenses/by-nc-nd/4.0/.

Tatalovic, M. (2009). Science comics as tools for science education and communication: a brief, exploratory study. *Journal of science communication, 8*(4), A02. https://doi.org/10.22323/2.08040202.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., & Hartling, L. (2020). A scoping review on the methods and reporting of systematic reviews and meta-analyses. *Journal of Clinical Epidemiology*, 123, 153-160. https://doi.org/10.1016/j.jclinepi.2020.03.022

Wajdi, M., Jamaluddin, A. B., Nurdiyanti, N., & Maghfirah, N. (2022). The effectiveness of problem-based learning with environmental-based comic in enhancing students' environmental literacy. *International Journal of Evaluation and Research in Education (IJERE), 11*(3), 1049-1057. Doi: 10.11591/ijere. v11i3.22140.

Yildirim, B. (2021). Using comics in science education: A systematic review of literature. *Journal of Science Education and Technology*, 30(1), 123–135. https://doi.org/10.1007/s10956-020-09864-7

Yonanda, D. A., Yuliati, Y., & Saputra, D. S. (2019). Development of Problem-Based Comic Book as Learning Media for Improving Primary School Students' Critical Thinking Ability. *Paper presented at the Elementary School Forum (Mimbar Sekolah Dasar)*. doi: http://dx.doi.org/10.17509/mimbar-sd.v6i3.22892.

Zarvianti, E., & Sahida, D. (2020). Designing Comics by Using Problem Based Learning (PBL) to Improve Student's Creative Thinking Skills. *International Journal of Social Learning (IJSL), 1*(1), 75-88. Doi: https://doi.org/10.47134/ijsl.v1i1.8.

Zhang, Q., & Yu, H. (2023). Comic-based learning in STEM education: A review of trends and effectiveness. *Education and Information Technologies*, 28, 11145–11166. https://doi.org/10.1007/s10639-023-11618-2

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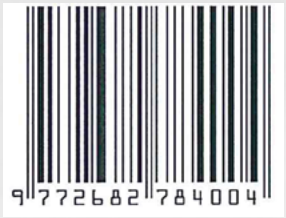

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