ENHANCING MATHEMATICS AND SCIENCE LEARNING THROUGH IMPROVED READING COMPREHENSION: A SYSTEMATIC LITERATURE REVIEW

Jay L. Galimpin

College of Education, Holy Name University, Tagbilaran City, Bohol, Philippines

ABSTRACT

This literature review explores the critical role of reading comprehension in enhancing mathematics and science learning outcomes. Proficiency in reading comprehension is foundational for understanding complex concepts and technical texts, crucial in interdisciplinary education. Theoretical frameworks and empirical evidences, highlight the influence of factors like family income and parental education on reading comprehension. Educational strategies integrating diverse learning styles and collaborative approaches aim to support individual student needs. Methodologically, a systematic literature review identified key theoretical frameworks and empirical studies, synthesizing recurring themes and gaps in current research. Results underscored the effectiveness of scaffolding, motivation strategies, and explicit instruction in enhancing comprehension. Strategies such as vocabulary scaffolds and multimodal presentations cater to diverse learning preferences, supported by Thorndike's Laws of Exercise and Effect and Vygotsky's social constructivism. Collaborative Strategic Reading and parental involvement further enrich comprehension development. This review concludes with recommendations for educators to adopt research-based interventions that foster inclusive learning environments and enhance students' reading comprehension abilities.
KEYWORDS: *mathematics, science, reading comprehension, systematic literature review*

INTRODUCTION

Proficiency in reading comprehension is foundational to success in mathematics and science education. As emphasized by various studies (IMU, n.d.; Centre for Education in Science & Technology, n.d.; Akbasli et al., 2016; Bcarnard-Brak et al., 2017; Karacaoglu & Kasap, 2023), strong reading comprehension skills enable students to understand complex concepts, interpret technical texts, and solve mathematical problems effectively. This capability is pivotal in fostering interdisciplinary understanding across subjects, as noted in recent assessments like PISA (Chi, 2023), which highlight the Philippines' need for improvement in these areas.

Theoretical frameworks (Vygotsky, n.d.; Bandura, 1994; Rumelhart & McClelland, 1986) and empirical evidence (Mustikasari & Maysarah, 2020; Manguilimotan et al., 2024; Kennedy & Trong, 2006) underscore that factors such as family income levels, parental education, and learning environments significantly influence reading comprehension outcomes. Addressing psychological barriers (Mustikasari & Maysarah, 2020) and enhancing motivational factors (Taylor & Hart, 2014) are crucial steps towards improving these skills.

Educational strategies should integrate diverse learning styles (Learnings About Learning Styles, 2023) and collaborative learning approaches (Andreev, 2024), aligning with theories such as Vygotsky's Zone of Proximal Development (Billings & Walqui, n.d.) and Bruner's Modes of Representation (Main, 2023) to support varied student needs. By applying these insights, educators can create inclusive instructional practices that cater to individual strengths, thereby enhancing overall academic achievement in mathematics and science.

METHODS

The study employed a systematic literature review and theoretical analysis to investigate the learning need through a theoretical lens, a systematic literature review was conducted, targeting academic databases. Selection criteria included peer-reviewed articles published within the last decade, focusing on relevant theoretical frameworks and empirical studies addressing similar learning needs. Thematic analysis was employed to synthesize the literature, revealing recurring themes, patterns, and gaps in current research. This process facilitated the development of a comprehensive theoretical framework, integrating diverse perspectives and findings. Critical analysis was performed to evaluate the strengths and limitations of the existing literature, guiding the interpretation of results. Based on these synthesized insights, we proposed intervention strategies, justified through the theoretical and empirical evidence gathered.

RESULT AND DISCUSSION
Thematic Analysis of Literature
Scaffolding and vocabulary supports are crucial elements in enhancing reading comprehension, as evidenced by Diprossimo et al. (2023). Their study highlights the

effectiveness of scaffolds, particularly vocabulary scaffolds, in digital reading settings. These supports provide contextual clues that aid learners in understanding and retaining information, thereby narrowing performance gaps among diverse student populations. This approach not only facilitates comprehension but also promotes independence in reading, as students learn to apply strategies effectively in varying contexts.

A conducive learning environment plays a pivotal role in student success, according to Shrestha et al. (2019). They emphasize the importance of classrooms being quiet, comfortable, and free from distractions. Such environments are conducive to focused reading tasks and support deep engagement with texts. Additionally, a supportive classroom atmosphere that encourages questions and collaboration enhances motivation and participation, ultimately fostering a positive learning experience.

Motivation is a critical factor in teaching and learning, influencing both engagement and learning outcomes (Filgona et al., 2020). Strategies such as setting achievable goals and offering choices in reading materials help cultivate intrinsic motivation. When students are motivated, they are more likely to invest effort in understanding texts, persist through challenges, and actively participate in learning activities. This intrinsic drive enhances comprehension by encouraging students to connect personally with the material and see its relevance to their own lives and interests.

Recognizing and addressing diverse learning styles is essential in scaffolding reading comprehension effectively (Rezaeinejad et al., 2015). Visual aids, auditory supports, and multimodal presentations cater to different learning preferences, ensuring that all students have access to information in ways that resonate with their strengths. By tailoring interventions to accommodate these variations, educators can enhance comprehension and retention of information across a broader spectrum of learners, promoting inclusivity and equity in education.

The laws of learning by Edward Thorndike underscore foundational principles in education that apply directly to reading comprehension (Oxford University Press, 2007; Kyonka, 2011). The Law of Exercise highlights the importance of regular practice in reinforcing comprehension skills, suggesting that repeated exposure to varied texts and contexts strengthens understanding. Meanwhile, the Law of Effect emphasizes the role of positive reinforcement in motivating continued engagement with reading tasks, thereby fostering a positive attitude towards learning.

Explicit instruction provides a structured approach to teaching reading comprehension strategies (Lexia, n.d.). By systematically guiding students through the process of applying strategies like summarizing, predicting, and questioning, educators empower learners to actively monitor their understanding and make meaning from texts. This method aligns with Vygotsky's theory of social constructivism, which emphasizes the role of social interaction and collaboration in cognitive development, underscoring the importance of classroom discourse and shared learning experiences (Rogoff, 1990; Ben-Ari & Kedem-Friedrich, 2000, as cited in Alharbi, 2015).

Effective instructional elements identified through research provide further insights into optimizing reading comprehension interventions (Archer & Hughes, 2011). Skill sequencing ensures that students master prerequisite skills before advancing to more complex tasks, establishing a solid foundation for comprehension. Segmenting reading comprehension skills into manageable components facilitates mastery and application. Additionally, providing multiple practice opportunities with constructive feedback reinforces learning and corrects misconceptions, promoting deeper understanding over time.

Collaborative Strategic Reading (CSR) integrates multiple components to enhance reading comprehension (IRIS | Page 3: Introduction to CSR, n.d.). By incorporating prior knowledge activation, vocabulary development, effective questioning techniques, and ample practice opportunities, CSR promotes active engagement and deepens understanding. This comprehensive approach not only supports comprehension during reading but also encourages critical thinking and reflection, aligning with research-based strategies endorsed by the National Reading Panel (n.d., as cited in Lexia Learning, 2023).

Comprehensive Theoretical Framework
In constructing a theoretical framework for enhancing reading comprehension, cognitive constructivism provides a foundational perspective. Vygotsky's social constructivism emphasizes the role of social interaction in cognitive development (Rogoff, 1990; Ben-Ari & Kedem-Friedrich, 2000, as cited in Alharbi, 2015). This theory underscores the importance of explicit instruction and collaborative learning strategies in scaffolding comprehension skills, suggesting that learning is optimized through meaningful interactions and shared experiences in the classroom.

Behaviorist theories, particularly Thorndike's Laws of Exercise and Effect, contribute principles that inform instructional practices in reading comprehension (Oxford University Press, 2007; Kyonka, 2011). The Law of Exercise supports the value of repeated practice in reinforcing comprehension skills, highlighting the benefit of varied and consistent exposure to texts. Meanwhile, the Law of Effect underscores the motivational impact of positive reinforcement, advocating for strategies that celebrate student successes and foster a supportive learning environment.

Motivational theories, such as Self-Determination Theory, further enrich the theoretical framework by emphasizing the importance of intrinsic motivation in learning (Filgona et al., 2020). Strategies that empower students to set goals, make choices in their learning, and connect personally with reading materials promote engagement and persistence. By tapping into intrinsic motivations, educators can cultivate a deeper appreciation for reading and its relevance in students' lives, thereby enhancing comprehension outcomes.

Considering diverse learning styles and modalities is essential in designing effective reading comprehension interventions (Rezaeinejad et al., 2015). Howard Gardner's Multiple Intelligences theory posits that learners have varied strengths and preferences for processing information. Utilizing multimodal presentations that combine text with visuals, audio elements, and interactive tools accommodates these differences, ensuring that all students can access and comprehend information effectively. This approach promotes inclusivity and supports personalized learning experiences in diverse classroom settings.

Critical Analysis of Existing Research

The strengths of current research on reading comprehension interventions lie in their empirical support and comprehensive approach. Studies consistently demonstrate the effectiveness of scaffolding techniques, explicit instruction, and collaborative reading strategies in enhancing comprehension across diverse student populations. By integrating cognitive, behaviorist, and motivational theories, educators can implement evidence-based practices that address the complex interplay of factors influencing reading comprehension.

However, limitations exist, primarily related to the context-specific nature of some findings. While vocabulary scaffolds and specific instructional methods show promise in digital and traditional settings, their applicability across all educational contexts requires further investigation. Longitudinal studies are needed to assess the sustained impact of these interventions on students' reading abilities over time, providing insights into the durability and transferability of comprehension skills beyond immediate instructional settings.

Proposed Intervention Strategies

Integrated scaffolding approaches that combine vocabulary supports with comprehension strategies offer a promising avenue for improving reading comprehension (Diprossimo et al., 2023). By embedding vocabulary scaffolds within broader instructional frameworks, educators can enhance students' ability to derive meaning from texts while fostering independence in reading comprehension skills.

Creating a conducive learning environment involves designing classrooms that support focused reading activities and encourage student engagement (Shrestha et al., 2019). Quiet, comfortable spaces free from distractions facilitate deep comprehension and sustained attention to reading tasks. Moreover, cultivating a supportive classroom atmosphere that values inquiry, collaboration, and active participation enhances motivation and promotes a positive learning experience for all students.

Enhancing intrinsic motivation through goal setting, choice in reading materials, and personal connections to content motivates students to invest in their reading comprehension (Filgona et al., 2020). By aligning instructional goals with students' interests and aspirations, educators can foster a sense of ownership and purpose in learning, thereby increasing engagement and persistence in reading activities.

Addressing diverse learning styles requires implementing multimodal presentations that appeal to visual, auditory, and kinesthetic learners (Rezaeinejad et al., 2015). Utilizing graphic organizers, interactive digital tools, and differentiated instruction accommodates varied learning preferences, ensuring that all students can access and comprehend information effectively. This inclusive approach promotes equity in education and supports personalized learning experiences tailored to individual strengths and needs.

Implementing explicit instruction in reading comprehension strategies involves systematically teaching skills such as summarizing, predicting, and questioning (Lexia, n.d.). By providing clear, step-by-step guidance and opportunities for guided practice, educators empower students to monitor their understanding and apply strategies independently. This methodological approach aligns with Vygotsky's theory of social constructivism, emphasizing the role of collaborative learning and shared experiences in cognitive development (Rogoff, 1990; Ben-Ari & Kedem-Friedrich, 2000, as cited in Alharbi, 2015).

Utilizing Collaborative Strategic Reading (CSR) and reciprocal teaching techniques offers structured frameworks for enhancing reading comprehension (IRIS | Page 3: Introduction to CSR, n.d.; Palincsar & Brown, 1984, as cited in Ardiansyah & Ujhanti, 2018). By incorporating prior knowledge activation, vocabulary development, effective questioning techniques, and ample practice opportunities, CSR promotes active engagement and deepens understanding. Reciprocal teaching strategies such as summarizing, predicting, clarifying, and questioning empower students to actively monitor their comprehension and engage in meaningful dialogue about texts, fostering critical thinking and collaborative learning experiences.

Engaging parents in literacy activities through home literacy interventions enhances students' reading comprehension (Farrel, 2014; Dong et al., 2020). By involving parents in reading routines, setting literacy expectations, and providing strategies for supporting reading at home, educators extend learning beyond the classroom. Parental involvement strengthens the connection between school and home environments, reinforcing literacy skills and promoting a culture of reading within families.

By integrating these evidenced-based strategies into instructional practices, educators can create a comprehensive framework for enhancing reading comprehension. Addressing diverse learning needs, leveraging motivational factors, and fostering collaborative learning environments are key components in promoting lifelong literacy skills and academic success among students.

CONCLUSION

In conclusion, enhancing students' reading comprehension skills requires a multifaceted, research-based approach that incorporates scaffolding, a conducive learning environment, motivation, recognition of diverse learning styles, and explicit instruction. Evidence demonstrates that vocabulary scaffolds

significantly improve comprehension, particularly in digital settings. Creating supportive, distraction-free learning spaces, along with strategies to boost intrinsic motivation, can enhance engagement and academic success. Tailoring interventions to diverse learning preferences, including the use of multimodal presentations, further reinforces understanding. Thorndike's principles of regular practice and positive reinforcement underscore the need for consistent reading activities and encouraging feedback. Explicit, systematic instruction in reading strategies, supported by collaborative and reciprocal teaching methods, effectively builds comprehension skills. Finally, involving parents in literacy activities amplifies the impact of these interventions. By adopting these comprehensive strategies, educators can effectively address diverse student needs and create an optimal environment for reading comprehension development.

ACKNOWLEDGEMENT

REFERENCES

1. Alharbi, M. A. (2015, November 7). Reading Strategies, Learning Styles and Reading Comprehension: A Correlation Study. Journal of Language Teaching and Research. https://doi.org/10.17507/jltr.0606.13
2. Akbasli, S., Sahin, M., & Yaykiran, Z. (2016). The Effect of Reading Comprehension on the Performance in Science and Mathematics. https://shorturl.at/hlZ68
3. Andreev, I. (2024, April 5). What Is Collaborative Learning? Theory, Examples of Activities. Valamis. https://www.valamis.com/hub/collaborative-learning
4. Archer, A. L., & Hughes, C. A. (2011) Explicit Instructions | Effective and Efficient Teaching. https://explicitinstruction.org/
5. Ardiansyah, W. & Ujihanti, M. (2018). Social constructivist learning theory and reciprocal teaching to teach reading comprehension. International Journal of Learning and Teaching. 10(1), 70-77
6. Barnard-Brak, L., Stevens, T., & Ritter, W. (2017). Reading and mathematics equally important to science achievement: results from nationally-representative data. Learning and Individual Differences, 58, 1-9. https://doi.org/10.1016/j.lindif.2017.07.001
7. Billings, E., & Walqui, A. (n.d.). Zone of Proximal Development: An Affirmative Perspective in Teaching ELLs. WestEd. https://www.wested.org/resources/zone-of-proximal-development/#:~:text=The%20Zone%20of%20Proximal%20Development,collaboration%20with%20more%20capable%20peers.
8. Çigdemir, S., & Akyol, H. (n.d.). The Relationship between Environmental Factors and Reading Comprehension. https://eric.ed.gov/?id=EJ1351925
9. Cherry, K. (2022, October 14). How Social Learning Theory Works. Verywell Mind. https://www.verywellmind.com/social-learning-theory-2795074#:~:text=Social%20learning%20theory%2C%20introduced%20by,motivation%2C%20attitudes%2C%20and%20emotions.
10. Cherry, K. (2022, November 8). What Is Sociocultural Theory? Verywell Mind. https://www.verywellmind.com/what-is-sociocultural-theory-2795088#:~:text=Sociocultural%20theory%20stresses%20the%20role,who%20are%20%22more%20skilled.%22
11. Cherry, K. (2022, November 8). What Is Self-Determination Theory? Verywell Mind. https://www.verywellmind.com/what-is-self-determination-theory-2795387
12. Chi, C. (2023, December 9). Philippines still lags behind world in math, reading and science — PISA 2022. Philstar.com. https://shorturl.at/ntS58
13. Cronin, V., Farrell, D., & Delaney, M. (1999). Environmental print and word reading. Journal of Research in Reading, 22(3), 271–282. https://doi.org/10.1111/1467-9817.00090
14. DeFrance, N., Khasnabis, D., & Palincsar, A. S. (2010, January 1). Reading and Technology. Elsevier eBooks. https://doi.org/10.1016/b978-0-08-044894-7.00736-3
15. Diprossimo, L., Ushakova, A., Zoski, J., Gamble, H., Irey, R., & Cain, K. (2023, April 1). The associations between child and item characteristics, use of vocabulary scaffolds, and reading comprehension in a digital environment: Insights from a big data approach. Contemporary Educational Psychology. https://doi.org/10.1016/j.cedpsych.2023.102165
16. Dong, Y., Wu, S. X.-Y., Dong, W.-Y., & Tang, Y. (2020). The effects of home literacy environment on children's reading comprehension development: A meta-analysis. Educational Sciences: Theory and Practice, 20(2), 63 - 82. http://dx.doi.org/10.12738/jestp.2020.2.005
17. Farrel, L., Hunter, M., Davidson, M., & Osenga, T. (n.d.). The Simple View of Reading | Reading Rockets. Reading Rockets. https://www.readingrockets.org/topics/about-reading/articles/simple-view-reading
18. Farrell, Holly Bond, "A Home Literacy Intervention To Improve Student Reading and Parental Self-Efficacy" (2014). Theses, Dissertations and Capstones. Paper 824.
19. Filgona, J., Sakiyo, J., Gwany, D. M., & Okoronka, A. U. (2020, September 9). Motivation in Learning. Asian Journal of Education and Social Studies. https://doi.org/10.9734/ajess/2020/v10i430273
20. Glanz, K. (2001, January 1). Current Theoretical Bases for Nutrition Intervention and Their Uses. Elsevier eBooks. https://doi.org/10.1016/b978-012193155-1/50008-8
21. Guy-Evans, O. (2024). Bronfenbrenner's Ecological Systems Theory. (2024, January 17). Simply Psychology. https://www.simplypsychology.org/bronfenbrenner.html
22. Importance of science in schools – Centre for Education in Science & Technology. (n.d.). https://shorturl.at/qyHI9
23. IRIS | Page 3: Introduction to CSR. (n.d.). https://iris.peabody.vanderbilt.edu/module/csr/cresource/q2/p03/#content
24. Islam, M. H. (2015, June 1). Thorndike Theory and It's Application in Learning. CORE. https://core.ac.uk/display/288101368?utm_source=pdf&utm_medium=banner&utm_campaign=pdf-decoration-v1
25. Karacaoglu, O.C. & Kasap, Y. (2023). The Effect of Reading Comprehension Skills on Mathematics and Science.
26. Kennedy, A.M., & Trong, K.L. (2006). Influence of the Home Literacy Environment on Reading Motivation and Reading Comprehension.

https://www.iea.nl/sites/default/files/2019-04/IRC2010_Kennedy_Trong.pdf

27. Kyonka, E.G.E. (2011). Law of Effect. In: Goldstein, S., Naglieri, J.A. (eds) Encyclopedia of Child Behavior and Development. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-79061-9_1624

28. Learnings About Learning Styles. (2023, November 13). Western Governors University. https://www.wgu.edu/blog/learnings-about-learning-styles2201.html

29. Main, P. (2023, May 3). Jerome Bruner's Theories. Structural Learning. https://www.structural-learning.com/post/jerome-bruners-theories

30. Manguilimotan, R. P., Zabala, J. T., Encog, C. A., Padillo, G. G., & Capuno, R. G. (2024, March 1). Factors Affecting the Reading Comprehension Skills of Grade 3 Learners. International Journal of Social Science Research and Review. https://doi.org/10.47814/ijssrr.v7i3.1930

31. Mullis, I.V., Martin, M.O., & Foy, P. (2011). The impact of reading ability on TIMSS mathematics and science achievement at the fourth grade demands: An analysis by item reading. TIMSS and PIRLS, 67-108. https://timssandpirls.bc.edu/timsspirls2011/downloads/TP11_Chapter_2.pdf

32. Mustikasari, Maysarah (2020) Psychological Barriers In Reading Comprehension Encoutered by the Students at fourth semester of English Education Study Program of University of Muhammadiyah Kotabumi Academic Year 2019/2020.

33. Neri, N. C., & Retelsdorf, J. (2022, June 1). The role of linguistic features in science and math comprehension and performance: A systematic review and desiderata for future research. Educational Research Review. https://doi.org/10.1016/j.edurev.2022.100460

34. Nickerson, C. (2024, February 2). Schema Theory In Psychology. Simply Psychology. https://www.simplypsychology.org/what-is-a-schema.html

35. Niklas, F., Wirth, A., Guffler, S., Drescher, N., & Ehmig, S. C. (2020, July 21). The Home Literacy Environment as a Mediator Between Parental Attitudes Toward Shared Reading and Children's Linguistic Competencies. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2020.01628

36. Obalı, B. (2009). The relationship between students' science and technology academic achievement and their reading comprehension and mathematics achievement in Turkish [Master's thesis]. Sakarya University.

37. Oxford University Press. (2007). Law of exercise. Oxford Reference. https://doi.org/10.1093/acref/9780198568506.013.3906

38. Potot, A., Kyamko, L. N., Reponte-Sereño, R. R., & Bustrillo, H. (2023, November 4). Differentiated Instruction as Strategy in Improving Reading Comprehension. Journal of English Language Teaching and Applied Linguistics. https://doi.org/10.32996/jeltal.2023.5.4.12

39. Pratiwi, A. (2022, June 20). The Relationship between Learning Strategies and Learning Style Preferences toward Learners' Reading Comprehension. Jurnal Sustainable. https://doi.org/10.32923/kjmp.v5i1.2293

40. Rosenblatt, L. M. (1994). The transactional theory of reading and writing. In R. B. Ruddell, M. R. Ruddell, & H. Singer (Eds.), Theoretical models and processes of reading (4th ed., pp. 1057–1092). International Reading Association.

41. Rumelhart, D. E., & McClelland, J. L. (1986, January 1). Parallel Distributed Processing. https://doi.org/10.7551/mitpress/5236.001.0001

42. Shrestha, E., Mehta, R. S., Mandal, G., Chaudhary, K., & Pradhan, N. (2019, October 21). Perception of the learning environment among the students in a nursing college in Eastern Nepal. BMC Medical Education. https://doi.org/10.1186/s12909-019-1835-0

43. Stanovich, K. E. (1984). The Interactive-Compensatory Model of Reading. Remedial and Special Education. https://doi.org/10.1177/074193258400500306

44. Sweller, J. (2011, January 1). Cognitive Load Theory. ˜ the œPsychology of Learning and Motivation/˜ the œPsychology of Learning and Motivation. https://doi.org/10.1016/b978-0-12-387691-1.00002-8

45. Soysal, T. (n.d.). The Relationship of Reading Attitude with Reading Speed and Reading Comprehension. https://eric.ed.gov/?id=EJ1363084

46. Taylor, J., & Hart, S. A. (2014, October 1). A chaotic home environment accounts for the association between respect for rules disposition and reading comprehension: A twin study. Learning and Individual Differences. https://doi.org/10.1016/j.lindif.2014.07.020

47. The role of mathematics in the overall curriculum | International Mathematical Union (IMU). (n.d.) https://shorturl.at/aMNR0

48. Top 5 Intervention Strategies for Reading Comprehension | Lexia. (2023). Lexia Learning Systems. https://www.lexialearning.com/blog/top-5-intervention-strategies-for-reading-comprehension

49. Torres, R. (2019). Factors Affecting the Reading Comprehension of Intermediate Level Learners: Basis for An Intervention Program. http://dx.doi.org/10.13140/RG.2.2.25114.77766