



INTERNATIONAL JOURNAL OF
MODERN EDUCATION
(IJMOE)
www.ijmoe.com



THE EFFECTIVENESS OF RASPBERRY PI- BASED ELECTRIC PRACTICAL LEARNING IN ENHANCING INTEREST TOWARDS PHYSICS AMONG PRE-UNIVERSITY STUDENTS

Aslindawati Abdullah¹, Nurul Syafiqah Yap Abdullah², Mohd Ikhwan Hadi Yaacob³

¹ Department of Physics, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia
Email: bm-1710@moe-dl.edu.my

² Department of Physics, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia
Email: syafiqah@fsmt.upsi.edu.my

³ Department of Physics, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia
Email: ikhwan.hadi@fsmt.upsi.edu.my

* Corresponding Author

Article Info:

Article history:

Received date: 23.06.2025

Revised date: 15.07.2025

Accepted date: 21.08.2025

Published date: 12.09.2025

To cite this document:

Abdullah, A., Abdullah, N. S. Y., & Yaacob, M. I. H. (2025). The Effectiveness of Raspberry Pi-Based Electric Practical Learning in Enhancing Interest Towards Physics Among Pre-University Students. *International Journal of Modern Education*, 7 (26), 871-880.

DOI: 10.35631/IJMOE.726058

This work is licensed under [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)



Abstract:

This study investigates the effectiveness of a Raspberry Pi-Based Electric Practical Learning, supported by the use of Rasphy Comic as a practical manual in improving Pre-University students' interest in Physics laboratory learning. The quasi-experimental research involved 134 students and applied pre-test and post-test measures to assess the impact of the intervention. Wilcoxon Signed-Ranks Test revealed that the median score for students' interest in Physics laboratory learning after the implementation of Raspberry Pi (Med = 83) was significantly higher than the median score before the intervention (Med = 59), with $Z = -9.763$, $p = .000$. Based on the significance level set at $\alpha = 0.05$, the data analysis indicates a statistically significant difference in students' levels of interest in Physics laboratory learning before and after the Raspberry Pi-Based Electric Practical Learning intervention. These findings suggest that the application of Raspberry Pi had a positive impact on enhancing students' interest in learning Physics laboratory activities.

Keywords:

Educational Comics, Experiential Learning, Interest, Physics Education, Raspberry Pi, STEM

Introduction

Physics education at the Malaysian Pre-University level typically includes lectures, tutorials and hands-on laboratory sessions. Nonetheless, traditional laboratory practices are often limited in terms of engaging students as well as connecting with integrated STEM learning. This study proposes a novel instructional method that incorporates Raspberry Pi technology alongside a comic-based learning module named Rasphy Comic, grounded in Experiential Learning Theory. The approach aims to boost students' intrinsic motivation and interest in Physics by embedding narrative elements, interactivity and inquiry-driven activities. Despite the curricular emphasis on practical work, students continue to display low enthusiasm that leads to poor achievement in Physics. Lee and Sulaiman (2018) reported that the integration of practical work did not show significant improvements in either student motivation or comprehension of key concepts. According to La Braca, F., & Kalman, C. S. (2021), this is largely due to the procedural nature of conventional lab sessions, which leave little room for meaningful inquiry or real-world connections. Prior research highlights that passive instructional strategies tend to reduce student engagement, which in turn diminishes their interest in the subject (Phang et al., 2017). Furthermore, the lack of interdisciplinary links and practical application limits students' understanding of Physics beyond the classroom environment. Waters and Orange (2022) argue that STEM education must offer context-rich and integrated experiences to stimulate students' curiosity and develop their problem-solving abilities. Unfortunately, standard lab manuals often neglect this dimension, focusing instead on mechanical procedures that do not support conceptual reasoning or scientific inquiry.

This issue is compounded by a shortage of teaching materials that can bridge the gap between theoretical Physics and students' everyday experiences. Research has shown that visual and interactive resources can enhance cognitive engagement and memory retention, especially when dealing with abstract or complex scientific topics (Chiu et al., 2015; Chang et al., 2008). Although educational comics hold potential for addressing this gap, many educators remain hesitant, perceiving comics as informal or entertainment-based (White, A., 2024). Resources such as Rasphy Comic present a promising alternative by integrating storytelling, relatable characters and contextualized STEM content. They align with constructivist pedagogy and multimedia learning theory by offering dual-channel communication textual and visual which supports deeper comprehension and sustained engagement. However, such tools remain underdeveloped and underutilized in the current Physics education setting.

Therefore, this study aims to transform practical learning in Physics through the development and evaluation of an innovative intervention combining Raspberry Pi activities with a comic-based instructional format. The goal is to investigate whether this integrated strategy can effectively enhance students' interest in Physics laboratory learning and promote more meaningful and personal engagement with the subject.

Literature Review

The growing emphasis on delivering high-quality STEM education has encouraged educational institutions to adopt innovative tools that foster inquiry-driven and project-oriented learning approaches. Among these, microcomputer platforms like the Raspberry Pi have gained popularity as cost-effective, versatile and robust solutions for embedding programming, electronics and data acquisition into Physics instruction. According to Balon and Simić (2019), incorporating Raspberry Pi into teaching can significantly enhance students' practical abilities and interest by offering experiential learning opportunities that reflect real-world scenarios.

This technology supports experiential and constructivist pedagogy as it empowers learners to build understanding through the exploration and manipulation of electronic components. Hatta and Budiyanto (2021) further point out that the Raspberry Pi enables the development of microcomputer-based laboratories (MBL), which allow learners to visualize data and engage in open-ended experimental tasks. This pedagogical alignment corresponds with Kolb's Experiential Learning Theory, which emphasizes the cyclical process of active involvement, reflection and conceptualization.

Concurrently, the use of comics as an instructional medium has gained recognition in science education. Mayer's (2001) Cognitive Theory of Multimedia Learning suggests that students absorb information more effectively when it is presented through a combination of text and visuals, rather than text alone. Empirical evidence such as the study by Spiegel et al. (2013) supports this notion, showing that comics make scientific concepts more engaging and easier to understand by framing them within relatable narratives. Trumper and Gelbman (2001) explored how digital laboratory environments enhance technological literacy and found that students who used these tools displayed increased comprehension and enthusiasm for science topics. Additionally, research has shown that educational comics significantly boost emotional engagement and learning motivation. Sukmahidayanti (2015) discovered that comic-based instruction positively influences students' attitudes toward science and supports the development of conceptual understanding. Comics are particularly effective for visual learners, offering narrative structures that help bridge theoretical concepts with real-life examples. Asiah (2020) observed that comics can effectively stimulate students' imaginations and present scientific ideas with humor, making them especially useful for learners with lower academic performance. *Rasphy Comic* incorporates these educational strategies by embedding STEM themes and emphasizing essential 21st-century skills. Moreover, studies by Purzer et al. (2015) and Hosler and Boomer (2011) advocate for the integration of STEM subjects into creative media formats, noting that such strategies enhance cognitive involvement and promote long-term knowledge retention. The collective literature emphasizes the value of combining experiential learning with multimedia resources to cultivate inclusive, motivating and effective science learning environments.

Methodology

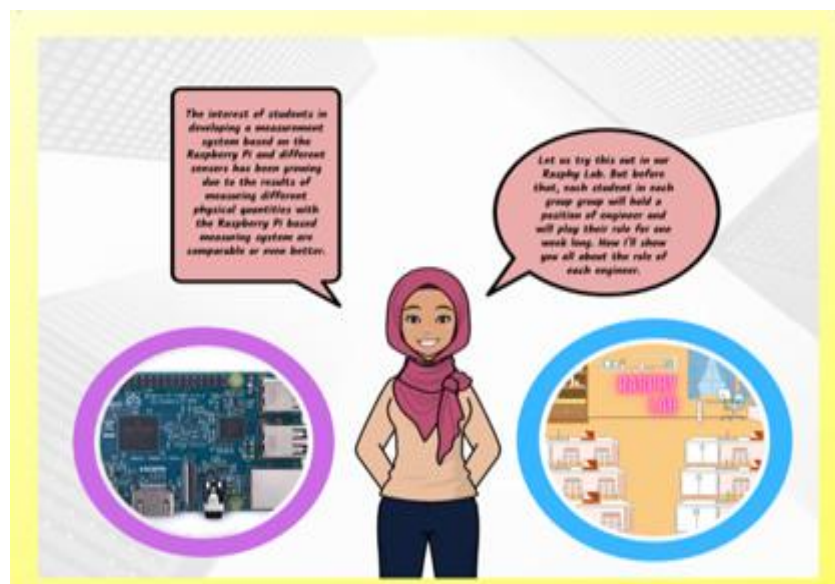
This study employed a quasi-experimental design using a one-group pre-test and post-test format, targeting 134 Pre-University students. Participants were selected through purposive sampling, followed by convenience sampling to finalize the group. The intervention spanned twelve weeks and involved a sequence of structured Physics lab sessions utilizing Raspberry Pi technology, with *Rasphy Comic* serving as the primary instructional guide.

To assess students' interest in Physics laboratory learning before and after the intervention, the Intrinsic Motivation Inventory (IMI) was utilized. The IMI is a comprehensive tool used to assess subjective experiences associated with specific tasks, especially within experimental research. This study specifically focused on the "Interest or Enjoyment" dimension, which directly reflects students' intrinsic motivation. By focusing on how engaged and enthusiastic students feel during laboratory sessions, the instrument provides insights into the effectiveness of the learning environment in fostering meaningful participation

The Raspberry Pi-Based Electric Practical Learning or Rasphy included five curriculum aligned laboratory experiments. Each activity followed a guided inquiry framework, complemented by narrative features from *Rasphy Comic*. Learning experiences were scaffolded to include collaborative tasks, reflective journaling via digital platforms and elements of gamification. Practical sessions were delivered through a blend of face-to-face and asynchronous formats to accommodate standard academic timetables. *Rasphy Comic* was developed to overcome the abstract and disconnected nature of conventional lab manuals by embedding storytelling, character-based dialogue and detailed visual aids to guide learners through electronic and Raspberry Pi-based experiments. The comic integrates Mayer's Multimedia Learning Theory by presenting dual-channel information text paired with visuals to enhance comprehension and long-term retention.

- i. The comic manual was co-developed alongside the Raspberry Pi kits and organized as follows:
- ii. Each chapter corresponds to a specific lab task.
- iii. A central character, portrayed as a student-mentor, narrates the storyline.
- iv. Illustrations depict hardware setups and data outcomes.
- v. QR codes are embedded to provide access to supplementary videos, notes, and interactive quizzes (e.g., via Genially).
- vi. Scenes are designed to portray real-world applications of concepts such as smart electronics.

In addition, the comic aims to foster students' STEM identity by including scenarios where characters explore potential careers in science and engineering. This motivational aspect was intended to support learners at varying levels of proficiency by offering both instructional scaffolding and cognitive challenges. Figures 1 and 2 provide visual examples of *Rasphy Comic* in use as a lab manual within the Raspberry Pi experimental framework.



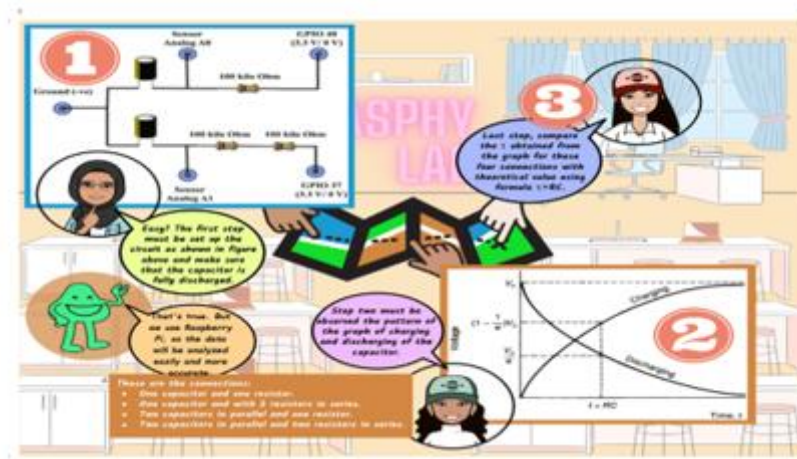


Figure 1: Rasphy Comic Display Featuring Engaging Graphics and Storyline

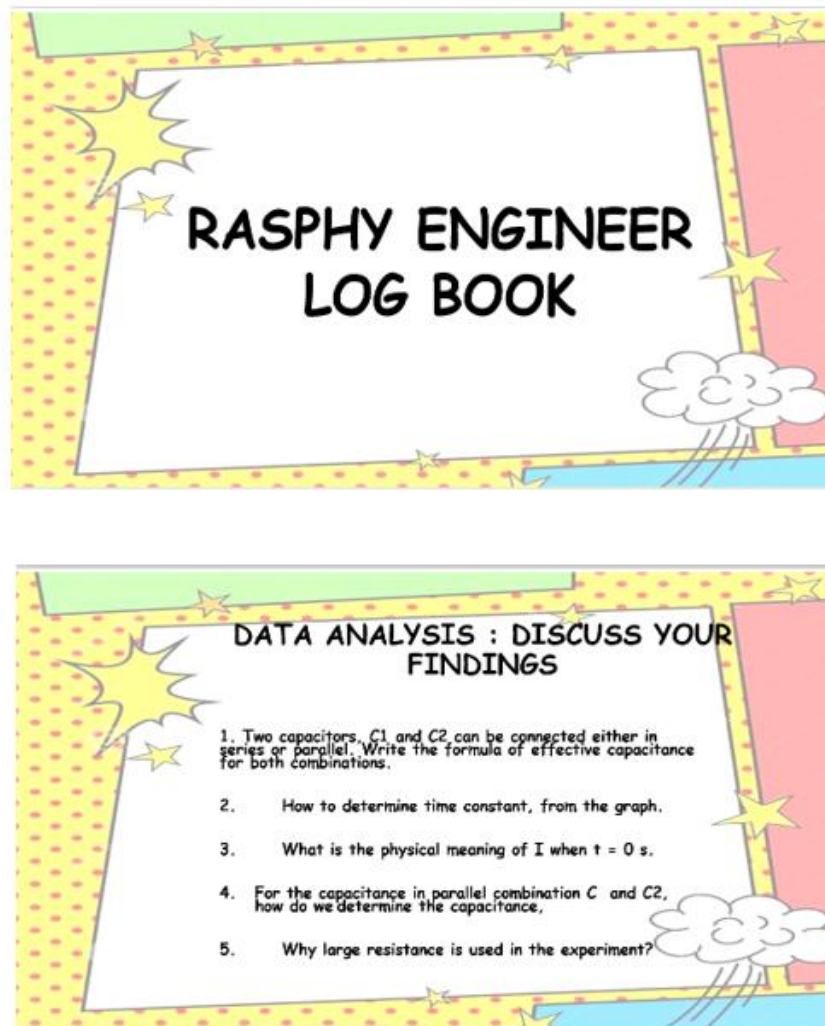


Figure 2: Rasphy Comic Display Incorporating an Experiential Learning Approach

Results

Table 1: Comparison of Novice and Expert Levels

Pre-Level (Interest)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Novice	74	55.2	55.2	55.2
	Expert	60	44.8	44.8	100.0
	Total	134	100.0	100.0	

Post-Level (Interest)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Novice	19	14.2	14.2	14.2
	Expert	115	85.8	85.8	100.0
	Total	134	100.0	100.0	

To address the research question concerning the effect of differences in students' interest in Physics practical work, the respondents were classified into two interest-level groups: novice and expert, based on their pre-test scores from the Intrinsic Motivation Inventory (IMI). Table 1 presents the distribution of novice and expert respondents in relation to Physics learning, based on their enrolment at Pre-University Colleges and the instructional module in general. Comparative statistics further indicate a significant change in the proportion of novice and expert respondents before and after the Raspberry Pi-Based Electric Practical Learning intervention. Students with novice-level interest often require additional support in the form of structured guidance, scaffolding, and rich visual enhancements to sustain their engagement. In contrast, students with expert-level interest tend to be highly motivated and are more inclined to participate in problem-based or design project learning, which allows them to challenge and expand their potential. Data analysis shows the percentage of students classified as novices decreased by 31%, from 55.2% to 14.2%. Conversely, the percentage of students categorized as experts increased by 41%, from 44.8% to 85.8%. These results suggest a marked improvement in students' intrinsic interest in Physics laboratory activities as a result of the Raspberry Pi-based learning approach.

Table 2: Descriptive Analysis of Interest Levels in Physics

	Pre-Test Score (Interest)	Post-Test Score (Interest)
N	134	134
Mean	61.46	79.06
Standard Deviation	5.82	4.87
Minimum	41.00	52.00
Maximum	86.00	99.00
Skewness	0.880	-0.853
Kurtosis	1.824	-0.434

Table 2 presents descriptive statistical analysis that was conducted to examine the mean, standard deviation, maximum, minimum, skewness and kurtosis values of students' interest in Physics. A noticeable increase was observed in the minimum and maximum scores post-intervention with the minimum score rising by 11 points (from 41 to 52) and the maximum increasing by 13 points (from 86 to 99). This demonstrates a positive shift in students' interest levels following the implementation of the Raspberry Pi-Based Electric Practical Learning instructional intervention. The maximum pre-test score for the *Interest in Physics* Laboratory learning variable was 86, and the minimum score was 41.

The obtained skewness and kurtosis values were close to zero. Referring to the acceptable range of skewness and kurtosis between -1 and +1 as suggested by George and Mallery (2003), the findings indicate that the distribution of pre-test mean scores for the interest in Physics questionnaire approximates a normal distribution. Post-test analysis revealed an increase in both the maximum and minimum scores. The maximum score reached 99 while the minimum increased to 52, resulting in a higher mean score of 79.06 for the post-test compared to the mean score of 61.46 for the pre-test. These results reflect an overall enhancement in students' interest in Physics following the intervention.

Table 3: Wilcoxon Signed-Ranks Test Results

Descriptive Statistics

						Percentiles		
		N	Mean	Std. Deviation	Minimum	Maximum	25th	50th (Median)
Pre-Test Score (Interest)		134	59	5.82018	46.00	86.00	58.0000	59.0000
Post-Test Score (Interest)		134	83	11.87035	52.00	99.00	71.0000	83.0000

Test Statistics

	Pre-Test Score (Interest)- Post-Test Score (Interest)
Z	-9.763a
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

Table 3 shows Wilcoxon Signed-Ranks Test revealed that the median score for students' interest in experiential learning in the Physics laboratory after the implementation of Raspberry Pi (Med = 83) was significantly higher than the median score before the intervention (Med=59) with $Z = -9.763$, $p = .000$. Based on the significance level set at $\alpha = 0.05$, the data analysis indicates a statistically significant difference in students' levels of interest in Physics laboratory learning before and after the Raspberry Pi-Based Electric Practical Learning intervention. These findings suggest that the application of Raspberry Pi had a positive impact on enhancing students' interest in learning Physics.

Discussion

The findings of this research highlight the beneficial impact of merging experiential learning methods with visual media in promoting motivation toward STEM subjects. The Raspberry Pi-Based Electric Practical Learning, enhanced through the use of Rasphy Comic, not only supported students' grasp of key concepts but also heightened their sense of curiosity and self-assurance. This aligns with the notion that active learning, when coupled with emotional and cognitive engagement, leads to more meaningful knowledge construction. Students showed a strong positive response to the integration of familiar characters and narrative elements, which made the learning experience feel more approachable and relevant.

The incorporation of visual diagrams helped to lessen cognitive overload and improved students' ability to remember and apply learned concepts. The observed progression in interest from beginner to more advanced levels suggest an increase in self-efficacy, a factor known to influence long-term retention and sustained engagement in STEM disciplines (Wang & Degol, 2013). Furthermore, the comic-based format demonstrated inclusivity by effectively engaging both high-achieving and lower-performing students. This reflects the principles of constructivist learning, where individuals make meaning based on personal experiences and underscores the strength of narrative-based approaches in science education.

Conclusion

This study presents strong evidence that integrating Raspberry Pi-Based Electric Practical Learning with Rasphy Comic can significantly boost Pre-University students' interest in Physics laboratory learning activities. By combining microcomputer technology and story-driven learning materials, the intervention created a synergistic educational experience that deepened understanding and nurtured intrinsic motivation. The notable increase in interest scores after the program supports the idea that well-designed, contextually relevant learning environments can meaningfully shift students' attitudes toward STEM. These results hold several important implications for the future of STEM education. From a curricular standpoint, it is recommended that policymakers and educators consider incorporating narrative-infused modules and Raspberry Pi-based activities into broader STEM curriculum design. Such integration can help transform complex or abstract scientific ideas into more tangible, engaging experiences especially in subjects like Physics, which are often seen as difficult and detached from everyday life.

Equally important is the need to prepare teachers to implement these strategies effectively. Educators must be equipped not only with the technical skills to operate digital tools but also with the pedagogical expertise to scaffold experiential learning using visual storytelling and contextual frameworks. The successful implementation of Rasphy Comic in this study illustrates its potential to serve as an effective engagement tool, making Physics education more accessible, enjoyable and culturally relevant. This could be particularly beneficial for students who initially show low levels of interest or confidence in science-related subjects. Looking forward, future research should examine the long-term impact of such interventions. Longitudinal studies could evaluate whether the increase in interest persists over time and whether it leads to improved academic outcomes or greater participation in STEM-related fields. Additional areas for exploration include the intervention's effectiveness across gender, its role in supporting cognitive development, and its contribution to digital literacy. These insights would further inform how technology-enhanced, inquiry-based learning models can be adapted for diverse student populations. In conclusion, this study supports the integration of

microcomputer technologies and educational comics within Experiential Learning Theory as a promising pathway for reshaping the way Physics is taught and experienced by Pre-University learners.

Acknowledgements

Full appreciation is given to the Ministry of Education Malaysia on the sponsorship of the "Hadihah Latihan Persekutuan" (HLPS) and Universiti Pendidikan Sultan Idris (UPSI) to enable this study to be implemented successful.

Reference

- Asiah, N. (2020). The Use of Comics in the Teaching and Learning of Science in Secondary Schools. Published by Universiti Pendidikan Sultan Idris PressPI
- Balon, S., & Simić, G. (2019). Application Of Raspberry Pi In Physics Education. *European Journal Of Engineering And Formal Sciences*, 3(1), 13–19. <https://doi.org/10.26417/Ejef.V3i1.P13-19>
- Bouquet, F., Bobroff, J., & Fuchs-Gallezot, M. (2016). Teaching Contemporary Physics Through Comics. *The Physics Teacher*, 54(2), 101–104. <https://doi.org/10.1119/1.4942158>
- Chang, C. Y., Yeh, T. K., & Barufaldi, J. P. (2008). A Comparison Of Science Teaching Practices In Taiwan And The United States. *International Journal Of Science Education*, 30(3), 351–375.
- Chiu, M. H., Lin, J. W., & Tsai, C. C. (2015). The Nature Of Science And Science Learning: A Review Of Twenty Years Of Science Education Research. *International Journal Of Science Education*, 37(15), 2433–2459.
- Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, And Mixed Methods Approaches* (3rd Ed.). SAGE Publications.
- George, D., & Mallery, P. (2003). *SPSS For Windows Step By Step: A Simple Guide And Reference* (11.0 Update, 4th Ed.). Allyn & Bacon.
- Handayani, L. (2020). Effectiveness Of Using Comic Media To Increase Interest In Science Learning. *Journal Of Physics: Conference Series*, 1465, 012002. <https://doi.org/10.1088/1742-6596/1465/1/012002>
- Hatta, P., & Budiyo, C. W. (2021). Development Of Microcomputer-Based Laboratory (MBL) In Physics Education Using Raspberry Pi And Sensors. *Journal Of Physics: Conference Series*, 1806(1), 012059. <https://doi.org/10.1088/1742-6596/1806/1/012059>
- Hosler, J., & Boomer, K. B. (2011). Are Comic Books An Effective Way To Engage Nonmajors In Learning And Appreciating Science? *CBE—Life Sciences Education*, 10(3), 309–317.
- Kolb, D. A. (1984). *Experiential Learning: Experience As The Source Of Learning And Development*. Prentice Hall.
- La Braca, F., & Kalman, C. S. (2021). Comparison of laboratorials and traditional labs: The impacts of instructional scaffolding on the student experience and conceptual understanding. *Physical Review Physics Education Research*, 17(1), 010131.
- Lee, M. C., & Sulaiman, F. (2018). The effectiveness of practical work on students' motivation and understanding towards learning Physics. *International Journal of Humanities and Social Science Invention*, 7(8), 2319-7714.

- Lin, S. S. J., Lee, Y. H., & Liang, J. C. (2015). Exploring The Relationships Between Cognitive Load And Learning Achievement In A Science Comic-Based Course. *Journal Of Educational Computing Research*, 53(2), 275–295.
- Maison, M. (2020). Students' Attitude And Motivation In Science Learning: A Literature Review. *Journal Of Physics: Conference Series*, 1521(2), 022051. <https://doi.org/10.1088/1742-6596/1521/2/022051>
- Mayer, R. E. (2001). *Multimedia Learning*. Cambridge University Press.
- Phang, F. A., Musa, N., & Yusof, N. (2017). Kajian Keberkesanan Pengajaran Amali Dalam Makmal Fizik. *Jurnal Pendidikan Malaysia*, 42(2), 101–112.
- Purzer, Ş., Goldstein, M. H., Adams, R. S., Xie, C., & Nourian, S. (2015). An Exploratory Study Of Informed Engineering Design Behaviors Associated With Scientific Explanations. *International Journal Of STEM Education*, 2(1), 1–12.
- Rasdi, R., Zaid, M., & Noraini, A. (2021). Quasi-Experimental Design In STEM Education Research: A Malaysian Perspective. *Jurnal Pendidikan Malaysia*, 46(1), 23–30.
- Ryan, R. M. (1982). Control And Information In The Intrapersonal Sphere: An Extension Of Cognitive Evaluation Theory. *Journal Of Personality And Social Psychology*, 43(3), 450–461.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic And Extrinsic Motivations: Classic Definitions And New Directions. *Contemporary Educational Psychology*, 25(1), 54–67.
- Spiegel, A. N., Mcquillan, J., Halpin, P. A., Matuk, C. F., & Diamond, J. (2013). Engaging Teenagers With Science Through Comics. *Research In Science Education*, 43(6), 2309–2326.
- Sukmahidayanti, S. (2015). The Use Of Comic Strips To Improve Students' Reading Comprehension. *English Review: Journal Of English Education*, 3(1), 1–11.
- Trumper, R., & Gelbman, M. (2001). A Microcomputer-Based Contribution To Scientific And Technological Literacy. *Journal Of Science Education And Technology*, 10(3), 213–221.
- Uno, H. B., & Umar, M. K. (2023). Effectiveness Of Comics In Enhancing Students' Learning Outcomes And Motivation. *International Journal Of Instruction*, 16(1), 77–90.
- Wang, M. T., & Degol, J. L. (2013). Motivational Pathways To STEM Career Choices: The Role Of Identity, Interest, And Self-Efficacy. *Educational Psychologist*, 49(3), 162–185. <https://doi.org/10.1080/00461520.2014.921607>
- Waters, C. C., & Orange, A. (2022). STEM And The Real World: Preparing Students For Success Through Project-Based Learning. *Journal Of STEM Education Research*, 3(2), 65–82
- White, A. (2024). *How Comics Impact the Process of Instructional Design* (Doctoral dissertation, Indiana State University).