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Enhancing Computational Thinking in Physics Labs: Synergizing STEM Multimedia with Islamic Literacy Integration

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Abstract: *This study aims to evaluate the effectiveness of Islamic literacy-based STEM (Science, Technology, Engineering, and Mathematics) multimedia in enhancing students' computational thinking skills in a basic physics practicum course. The research employed a quasi-experimental design with a mixed-methods approach, involving two groups: an experimental group that received instruction through Islamic literacy-based STEM multimedia and a control group that used conventional methods. The instruments used included a computational thinking skills test, designed to measure four primary indicators: abstraction, algorithm, decomposition, and pattern generalization, as well as in-depth interviews to explore students' learning experiences. Quantitative data were analyzed using a t-test to determine significant differences between the two groups, while qualitative data were analyzed thematically. The findings indicated a significant improvement across all computational thinking indicators in the experimental group. Qualitative analysis further revealed that integrating Islamic literacy deepened students' understanding of physics concepts, offering a spiritual context that enriched their learning experiences. These findings suggest that Islamic literacy-based STEM multimedia is not only effective in enhancing computational thinking skills but is also well-suited for educational contexts that integrate technology and spirituality. The implications of this study support the development of a holistic curriculum in STEM education aligned with spiritual values.*

Keywords: *Computational thinking, islamic literacy, multimedia, physics education, STEM*

Meningkatkan Kemampuan Berpikir Komputasional di Laboratorium Fisika: Sinergi Multimedia STEM dengan Integrasi Literasi Islam

Abstrak: Penelitian ini bertujuan untuk mengukur efektivitas multimedia STEM (*Science, Technology, Engineering, and Mathematics*) berbasis literasi Islam dalam meningkatkan kemampuan berpikir komputasional mahasiswa pada mata kuliah praktikum fisika dasar. Penelitian ini menggunakan metode kuasi-eksperimental dengan pendekatan mixed methods, melibatkan dua kelompok: kelompok eksperimen yang mendapatkan pembelajaran menggunakan multimedia STEM berbasis literasi Islam, dan kelompok kontrol yang menggunakan metode konvensional. Instrumen yang digunakan meliputi tes kemampuan berpikir komputasional untuk mengukur empat indikator utama yaitu abstraksi, algoritma, dekomposisi, dan generalisasi pola, serta wawancara mendalam untuk mendalami pengalaman belajar mahasiswa. Data kuantitatif dianalisis menggunakan uji t-test untuk melihat perbedaan signifikan antara kedua kelompok, sementara data kualitatif dianalisis menggunakan analisis tematik. Hasil penelitian menunjukkan peningkatan signifikan pada semua indikator berpikir komputasional dalam kelompok eksperimen. Analisis kualitatif juga mengungkapkan bahwa integrasi literasi Islam memperdalam pemahaman mahasiswa terhadap konsep-konsep fisika, memberikan konteks spiritual yang memperkaya pengalaman belajar. Temuan ini mengindikasikan bahwa pendekatan multimedia STEM berbasis literasi Islam tidak hanya

efektif dalam meningkatkan keterampilan berpikir komputasional, tetapi juga relevan untuk diterapkan dalam pendidikan yang menggabungkan aspek teknologi dan spiritualitas. Implikasi penelitian ini mendukung pengembangan kurikulum holistik dalam pendidikan STEM yang selaras dengan nilai-nilai spiritual.

Kata kunci: Berpikir komputasional, literasi islam, multimedia, pendidikan fisika, STEM

INTRODUCTION

Computational thinking skills have become essential competencies in today's digital era, comparable to foundational literacies such as reading and writing (Li et al., 2020; Yahya & Vitalocca, 2022). Computational thinking encompasses the ability to formulate problems, logically organize data, and design algorithms for effective problem-solving. The implementation of computational thinking in science and physics education remains limited (Irvani et al., 2024). In the context of higher education, particularly in the field of physics, mastering computational thinking is increasingly crucial (Liu et al., 2023). Students engaged in basic physics practicum courses often face challenges in solving complex problems, processing data, and creating simulations (Hershkovitz, 2019). The application of computational thinking allows students to develop the algorithmic, abstract, and problem-solving skills needed to address various physics-related issues (Carlborg et al., 2020).

The STEM (Science, Technology, Engineering, and Mathematics) approach has long been recognized as an effective method for enhancing students' computational and scientific abilities mahasiswa (Suryadi & Kurniati, 2021). Through STEM, students are encouraged not only to understand theoretical concepts but also to apply scientific knowledge to solve real-world problems (Diani et al., 2019; Fiteriani et al., 2021; Parmin et al., 2020; Rahmatika et al., 2024; Susanti et al., 2023). Integrating computational thinking within STEM education strengthens students' logical reasoning, encourages innovative solutions, and enables them to apply algorithms in practice (Yin et al., 2019). In this context, the use of STEM-based multimedia also provides students with access to visual representations, simulations, and interactive exercises that enrich their learning experience (Hidayati et al., 2019; Prayitno & Hidayati, 2021).

Moreover, this study introduces Islamic Literacy as an ethical and spiritual framework within the STEM approach. Islamic literacy provides a moral and ethical perspective, helping students not only to comprehend scientific knowledge but also to relate it to religious values (Laksono, 2021). Thus, integrating Islamic literacy into STEM education not only enhances scientific understanding but also contributes to the development of a more holistic student character (Adelia & Idi, 2024).

The use of multimedia, such as simulations, videos, and interactive applications, offers numerous benefits in deepening students' understanding of physics concepts (Mayer, 2017; Suryandaru, 2020). Through dynamic visualization, multimedia allows students to see visual representations of abstract physics phenomena, such as particle motion, force interactions, or energy transformations (Kirstein & Nordmeier, 2007; Olympiou et al., 2013; Opfermann et al., 2017). This approach makes difficult concepts, which might be challenging to grasp through text or static images, clearer and more digestible (Panjaitan et al., 2020; Sakiah & Effendi, 2021). Interactive simulations enable students to perform virtual experiments resembling real-life conditions, giving them the opportunity to explore and test physics concepts without the limitations of physical tools or laboratory settings. Consequently, students can learn independently, explore different scenarios, and understand concepts through self-driven experimentation.

Furthermore, multimedia is highly effective in facilitating computational thinking skills (Chen et al., 2022; Turchi et al., 2019). Through simulations and interactive applications, students can practice algorithmic thinking skills by designing virtual experiments and manipulating physical variables. The digital visualization of experimental results helps them analyze data and identify key patterns, which are central to computational thinking. Interactive applications also allow students to directly implement physics concepts in the form of algorithms or simulation scenarios, providing a deeper understanding of how scientific principles work in real-world contexts. This process aids students in developing skills for designing technology-based solutions to physics problems, thereby strengthening their analytical and problem-solving abilities in the digital era.

Numerous studies on the use of STEM multimedia in education have been conducted, examining, among other things, the effectiveness of STEM multimedia in enhancing critical thinking skills (Hidayati et al., 2019; Pramuji et al., 2020), the role of interactive multimedia in improving scientific literacy (Juniati et al., 2020), the impact of STEM multimedia on learning outcomes (Musdalifa & Syuhendri, 2021), and the use of interactive technology to increase engagement and conceptual understanding (Hariyono, 2023). Other studies have also shown that integrating religious values, such as Islamic literacy, into science education can deepen students' understanding (Marvavilha & Suparlan, 2018; Muspiroh, 2014).

However, there has been no research specifically examining the effectiveness of Islamic literacy-based STEM multimedia on students' computational thinking skills, particularly in the context of higher education in physics. This study aims to measure the effectiveness of this approach in enhancing computational thinking skills, focusing particularly on aspects of abstraction, algorithms, decomposition, and pattern generalization. The novelty of this research lies in integrating Islamic literacy with STEM learning through interactive multimedia, an approach that has yet to be widely explored in the context of physics education at the university level. Therefore, this study is expected to contribute to the development of a more holistic learning model that combines technological and spiritual aspects to enhance students' computational thinking skills.

RESEARCH METHOD

This study employs a mixed-methods approach, combining quantitative and qualitative methods to provide a comprehensive analysis (Chang, 2023) of the impact of STEM-based multimedia integrated with Islamic literacy on students' computational thinking skills (Waruwu, 2023). On the quantitative side, the study adopts a quasi-experimental design, dividing participants into an experimental group and a control group. The experimental group received an intervention involving learning through STEM-based multimedia integrated with Islamic literacy, while the control group continued with conventional teaching methods. The conventional method applied is the expository teaching model, which is commonly used in physics learning within laboratory practicals. This expository teaching model was chosen because it is frequently employed in practical activities to deliver concepts and procedures through direct explanations from the lecturer or instructor. In parallel, a qualitative phenomenological approach was utilized to explore students' perceptions and experiences using multimedia during practicum sessions.

The study population comprised students enrolled in the Basic Physics Practicum course in the Physics Education program at a university during the first semester of the

2022/2023 academic year. The sample was selected through purposive sampling, involving a total of 60 students, with 30 in each group, who voluntarily committed to full participation. Research instruments included computational thinking skill tests (pre-test and post-test) (Tankiz & Atman Uslu, 2023), a Likert scale to measure student responses (Retnawati, 2015), as well as in-depth interviews and observations for qualitative data (Achjar et al., 2023).

The research was conducted in three stages: implementation (pre-test, intervention, post-test), data analysis, and article writing. A t-test was applied for quantitative analysis, while thematic analysis was used for qualitative data. The validity and reliability of quantitative data were ensured through expert assessment and Cronbach's Alpha coefficient, whereas qualitative validity was maintained through triangulation and member checking. The instruments used included a computational thinking skills test, designed to measure four primary indicators: abstraction, algorithm, decomposition, and pattern generalization, as well as in-depth interviews to explore students' learning experiences. Quantitative data were analyzed using a t-test to determine significant differences between the two groups, while qualitative data were analyzed thematically.

RESULTS

Quantitative Data Findings

This study assessed students' computational thinking abilities before and after the intervention through pre-test and post-test measurements in both the experimental and control groups. The experimental group engaged in learning with STEM-based multimedia integrated with Islamic literacy, while the control group received instruction through conventional methods. The tests aimed to evaluate four key aspects of computational thinking: Abstraction, Algorithm, Decomposition, and Pattern Generalization. Pre-test results provided insight into the students' initial abilities, while post-test results measured the improvement in computational thinking following the intervention.

Table 1. The Average Pre-Test and Post-Test Scores

Indicator	Group	Average Score		Improvement
		Pre-test	Post-test	
Abstraction	Experimental	58,2	81,6	23,4
	Control	59,1	66,2	7,1
Algorithm	Experimental	61,4	84,7	23,3
	Control	60,5	69,0	8,5
Decomposition	Experimental	62,3	85,9	23,6
	Control	61,0	70,4	9,4
Pattern Generalization	Experimental	59,0	80,2	21,2
	Control	58,6	67,1	8,5

The quantitative results indicate a significant improvement in students' computational thinking abilities within the experimental group following the use of Islamic literacy-based STEM multimedia. The largest gains were observed in the decomposition indicator (23.6 points) and the algorithm indicator (23.4 points), demonstrating that this approach supports students in addressing complex problems and designing systematic solutions.

This study's findings reveal that the integration of STEM multimedia with Islamic literacy substantially enhances students' computational thinking skills compared to conventional teaching methods. This improvement is clearly evident across four key

indicators of computational thinking: abstraction, algorithm, decomposition, and pattern generalization (Gao et al., 2023; Latifah et al., 2022; Yuberti et al., 2024). Before conducting statistical tests to identify significant differences between the experimental and control groups, prerequisite tests were performed to ensure the data met basic statistical assumptions. These prerequisites included normality and homogeneity tests.

The normality test was conducted using the Kolmogorov-Smirnov test to determine if the data distribution for each computational thinking indicator conformed to a normal distribution. The results showed that p-values for all indicators, both in the pre-test and post-test, were above 0.05, indicating normal data distribution. Thus, the normality assumption was met, allowing for further analysis using parametric statistical methods.

Table 2. The Normality Test Results for Each Indicator

Indicator	Pre-test (p-value)	Post-test (p-value)
Abstraction	0,091	0,115
Algorithm	0,108	0,120
Decomposition	0,095	0,126
Pattern Generalization	0,099	0,119

Subsequently, a homogeneity of variance test was conducted using Levene's test to ensure equal variances between the experimental and control groups. The results of this test indicate that the p-values for all indicators exceed 0.05, confirming that variances in both groups are homogeneous. Table 3 presents the homogeneity test results for each indicator.

Table 3. The Homogeneity Test Result for Each Indicator

Indicator	Pre-test (p-value)	Post-test (p-value)
Abstraction	0,378	0,412
Algorithm	0,387	0,435
Decomposition	0,364	0,409
Pattern Generalization	0,372	0,429

With both normality and homogeneity assumptions met, the data were deemed suitable for further statistical testing, specifically the t-test, to evaluate significant differences between groups. This test was applied to assess the impact of the Islamic literacy-integrated STEM multimedia learning intervention on enhancing students' computational thinking skills across four indicators: Abstraction, Algorithm, Decomposition, and Pattern Generalization. Table 4 shows the results of the t-test for each indicator.

Table 4. t-Test Results

Indicator	t-Value	p-Value
Abstraction	5,98	0,000
Algorithm	5,87	0,000
Decomposition	6,23	0,000
Pattern Generalization	5,65	0,000

The t-test results reveal that all indicators have p-values below 0.05, signifying a significant difference between the experimental and control groups in the post-test

results. The high t-values, particularly for the Decomposition and Algorithm indicators, underscore that students exposed to STEM multimedia-based learning showed more substantial improvements than those receiving conventional instruction. Notably, the significant increase in the Decomposition indicator suggests that the intervention effectively aided students in breaking down complex physics problems into more manageable components.

Qualitative Results

The qualitative findings of this study provide an in-depth perspective on how STEM-based multimedia learning integrated with Islamic literacy influences students' understanding and application of computational thinking skills within a basic physics practicum context. Through interviews and observations, several key themes emerged, shedding light on students' experiences and perceptions of the learning intervention they received.

One prominent theme was the students' ability to grasp abstract concepts through an Islamic perspective. Students reported that abstract physics concepts were easier to understand when explained through the spiritual values of Islam. For instance, relating the vastness of the universe to the greatness of God's creation allowed students to feel more connected to the subject matter. As one student remarked, "Explaining physics through an Islamic lens helps me appreciate the marvels of nature and understand challenging scientific concepts better."

Another theme was the systematic approach to algorithmic problem-solving in physics, where students felt more supported in structuring algorithmic steps. They noted that the simulations and visualizations provided by multimedia helped them decompose complex problems into smaller components, enabling them to design more targeted solutions. Problem decomposition also emerged as a significant theme, as students expressed that multimedia facilitated their ability to break down complex issues into simpler sub-components, streamlining their problem-solving process.

Additionally, students reported improved abilities to generalize patterns from various physics experiments and apply these patterns in different contexts. This was evident from students' reflections after each practicum session, where they discussed patterns observed during experiments and how these could be applied in other situations.

Observations throughout the learning process indicated that students in the experimental group were more actively engaged in group discussions and in developing collaborative problem-solving algorithms. They also demonstrated a high level of collaboration in breaking down problems and collectively structuring solutions. Ultimately, these qualitative findings support the quantitative results, suggesting that Islamic literacy-based STEM multimedia learning not only enhances students' conceptual understanding but also strengthens their computational thinking skills, allowing them to approach physics problems with greater depth and structure.

Thematic Analysis

The thematic analysis results indicate that integrating Islamic literacy within STEM-based multimedia learning significantly impacts students' understanding and application of physics concepts. A central theme was how Islamic literacy deepens students' grasp of abstract physics concepts. Students reported that linking spiritual values with scientific concepts allowed them to view the connection between science and religion in a more holistic manner. This provided students with a new perspective on understanding natural phenomena, seeing physics not merely as a collection of formulas and theories but as a

manifestation of the grandeur of God's creation. This approach notably enriched students' learning experiences, with many reporting that their comprehension of abstract physics concepts became more profound and meaningful.

The positive influence of Islamic literacy was apparent in students' ability to connect abstract physics concepts with spiritual values. Students mentioned that abstract ideas such as energy, motion, and physical laws were easier to comprehend when explained through a religious lens. For example, one student noted that explaining physics phenomena in the context of God's greatness enabled them to visualize and internalize previously challenging concepts. This reflects how integrating Islamic literacy within STEM learning can create a more inclusive and meaningful learning environment for students.

The thematic analysis also demonstrated significant improvements in students' decomposition and algorithmic skills in physics problem-solving. Students utilizing STEM multimedia reported a greater ability to break down complex problems into simpler, more structured parts. They felt that the multimedia-based approach provided clear and systematic tools to tackle practicum tasks requiring problem-solving. This method allowed them to analyze each component of a problem more deeply before devising effective solution steps. With improved decomposition skills, students grew more confident in facing complex problems, both in the practicum setting and in broader applications of physics theory.

Simultaneously, students' algorithmic skills improved, as indicated by interview and observation results. They reported that multimedia learning helped them formulate algorithmic steps for solving physics problems more systematically and efficiently. This finding aligns with the quantitative results, which revealed significant improvements in algorithmic abilities. Students stated they could construct logical, structured solutions, from understanding the problem to designing a resolution algorithm. This process provided them with computational thinking skills beneficial not only for practical problem-solving but also for application in other learning contexts.

Overall, these thematic analysis results highlight the critical role of Islamic literacy-integrated STEM multimedia in enhancing students' computational thinking skills, particularly in abstraction, decomposition, and algorithmic aspects. Islamic literacy-based learning serves not only as a tool for improving conceptual understanding but also adds a moral and spiritual dimension that enriches students' learning experiences. These findings suggest that a learning approach combining technology with religious values can create a more holistic learning environment, fostering the development of critical and computational thinking skills at a deeper level.

DISCUSSION

The findings of this study demonstrate that integrating Islamic literacy-based STEM multimedia significantly enhances students' computational thinking abilities, as evidenced by both quantitative and qualitative results. Based on the t-test results, the experimental group receiving STEM-based multimedia intervention showed substantial improvements across four core computational thinking indicators: abstraction, algorithms, decomposition, and pattern generalization. This aligns with the work of Sabo (2022), who examined similar computational thinking indicators within a STEM approach (Sabo et al., 2022). In this study, the most notable gains appeared in decomposition and algorithm indicators, suggesting that this multimedia approach provides students with a clear, systematic framework for breaking down complex physics

problems and designing effective solutions. Integrated STEM allows students to develop higher-order thinking (Anggraynie et al., 2023; Nurazmi & Bancong, 2021).

The significant increase in abstraction skills indicates that students in the experimental group developed the ability to simplify abstract physics concepts into more comprehensible representations. Previous research on the integration of computational thinking in STEM education supports these findings, highlighting that STEM-based multimedia approaches markedly improve students' computational thinking abilities (Wang et al., 2022). This is further corroborated by interview results showing that students found it easier to grasp physics concepts when presented in the context of Islamic literacy. This approach allowed students not only to understand the material from a scientific perspective but also to engage spiritually, deepening their connection with natural phenomena.

The substantial improvement in algorithmic skills reflects students' enhanced capacity to devise systematic steps for solving physics problems. This aligns with qualitative findings indicating that students benefited from multimedia resources that provided visual guidance and simulations, facilitating their ability to structure and plan solutions effectively. Students reported that the multimedia approach helped them think more logically and systematically, ultimately strengthening their computational thinking skills. Algorithmic thinking aids students in structuring solutions to complex problems (Lee et al., 2023)

Moreover, decomposition skills—students' ability to break down complex problems into more manageable parts—showed the most significant improvement. This indicates that multimedia-based learning equips students with effective tools to manage complex physics problems through a structured approach. These findings are supported by research, which emphasizes that breaking down complex problems into smaller components is fundamental to successful computational thinking (Ng et al., 2023). In interviews, students expressed that multimedia resources used during practical sessions helped them identify key problem components, enabling them to solve issues in a step-by-step and more efficient manner.

Finally, with respect to pattern generalization, results reveal that students in the experimental group were better able to identify and apply patterns observed in various physics experiments to different situations. This finding aligns with research, who found that computational thinking practices aid students in understanding scientific patterns and connecting them to various physical phenomena (Dominguez et al., 2024). The use of STEM multimedia facilitated students' ability to see relationships between different physics concepts and extend this understanding to broader contexts. This underscores that a multimedia-based approach not only enhances conceptual understanding but also fosters skills for applying concepts more broadly. Additionally, Islamic literacy-based STEM multimedia effectively enhances students' computational thinking abilities. Computational thinking as an essential 21st-century skill needed across STEM fields to systematically address complex problems (Alves, 2023).

These findings indicate that Islamic literacy-integrated STEM multimedia learning is not only effective in enhancing students' computational thinking but also offers a more inclusive and meaningful framework where spiritual values support conceptual understanding and problem-solving skills. Theoretically, this research broadens perspectives on how STEM multimedia integrated with religious values can improve students' computational thinking. STEM learning theory traditionally emphasizes the role of science, technology, engineering, and mathematics in fostering critical thinking and problem-solving. However, these findings introduce a new dimension by incorporating

religious values, demonstrating that this integration supports both conceptual understanding and provides a more meaningful, holistic learning experience. Islamic literacy enriches learning theory by emphasizing the connection between science and spirituality, fostering a deeper, more relevant educational experience (Dewi et al., 2023).

In educational practice, this study offers a new instructional model that can be applied in science teaching, particularly in physics. The integration of interactive multimedia with religious values enhances student engagement and aids in developing computational thinking skills. These findings are particularly relevant in Muslim-majority countries, where combining religious values with scientific instruction provides a more effective and meaningful approach (Nasucha & Khozin, 2023). This learning model can inform the development of culturally relevant science curricula, fostering conceptual understanding and higher-order thinking skills.

This approach could also be adapted to other educational contexts, both within and beyond science, where the integration of ethical and spiritual values could enhance student motivation and engagement. Moreover, this research serves as a solid foundation for developing more innovative, value-based educational technologies, creating a more dynamic and inclusive learning environment.

The study is strengthened by its use of a mixed-methods approach, which combines quantitative and qualitative data to yield deeper insights. Integrating Islamic literacy with STEM multimedia also represents a culturally relevant innovation, particularly in Muslim-majority educational contexts. However, the study is limited by a small sample size confined to a single university, making it challenging to generalize the results. Additionally, the short intervention duration precluded an evaluation of long-term impacts.

This approach could serve as a model for STEM curriculum development in various educational contexts that integrate religious values, enhancing student engagement and conceptual understanding. Future research should expand the sample size and explore the long-term effects of STEM multimedia-based learning and its application to other fields of study.

CONCLUSION AND SUGGESTIONS

This study reveals that incorporating Islamic literacy-based STEM multimedia significantly enhances students' computational thinking abilities, particularly in abstraction, algorithms, decomposition, and pattern generalization. These findings suggest that integrating spiritual values into science education not only deepens students' conceptual understanding but also strengthens their skills in systematic problem-solving. The implications of this research point to the potential of Islamic literacy-based STEM multimedia as an effective instructional model to foster greater student engagement and comprehension, particularly in educational contexts within predominantly Muslim countries. Additionally, this approach shows promise for broader application across various academic disciplines.

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REFERENCES

Achjar, K. A. H., Rusliyadi, M., Zaenurrosyid, A., Rumata, N. A., Nirwana, I., & Abadi, A. (2023). *Metode Penelitian Kualitatif: Panduan Praktis untuk Analisis Data Kualitatif dan Studi Kasus*. PT. Sonpedia Publishing Indonesia.

Adelia, P., & Idi, W. (2024). *Analisis Sintaks Pembelajaran Pendekatan STEAM (Science, Technology, Engineering, Art, and Mathematics) dalam Mengembangkan Keterampilan Berpikir Kritis Mahasiswa PAI di Pascasarjana IAIN Curup*. Institut Agama Islam Negeri Curup.

Alves, G. (2023). Trends on Computational Thinking, Engineering Education, Technology in Medicine, Qualitative and Mixed Methods, Diversity in STEM, Lab-Based Education, Technology and Education, Gamification and Games for Learning and Smart Learning at TEEM 2022. In *Lecture Notes in Educational Technology* (pp. 1–21). https://doi.org/10.1007/978-981-99-0942-1_1

Anggraynie, R. T., Qadar, R., & Zulkarnaen, Z. (2023). The Effect of STEM-PjBL Learning on Temperature and Heat Material on Student Learning Outcomes at SMPN 2 Bontang. *Kasuari: Physics Education Journal (KPEJ)*, *6*(2), Article 2. https://doi.org/10.37891/kpej.v6i2.445

Carlborg, N., Tyrén, M., Heath, C., & Eriksson, E. (2020). *Cover sheet Publication metadata*. *September*.

Chang, W.-C. (2023). Validation of the Teaching Equity Enactment Scenario Scale in Singapore: A mixed-methods convergent study. *Quality & Quantity*, *57*(6), 5257–5282. https://doi.org/10.1007/s11135-022-01578-4

Chen, Y.-C., Tsui, P.-L., Lee, C.-S., Chiang, M.-C., & Lan, B.-K. (2022). Incorporating Multimedia Teaching Methods and Computational Thinking into the Baking Dessert Course. *Electronics*, *11*(22), Article 22. https://doi.org/10.3390/electronics11223772

Dewi, D. P., Sismulyasih, N., Putri, D. S., & Afni, N. (2023). *Pemain Bit IPAS Pengembangan Media Interaktif Berbasis IT IPAS*. Cahya Ghani Recovery.

Diani, R., Kesuma, G. C., Diana, N., Yuberti, Anggraini, R. D., & Fujiani, D. (2019). The Development Of Physics Module With The Scientific Approach Based On Islamic Literacy. *Journal of Physics: Conference Series*, *1155*(1), 012034. https://doi.org/10.1088/1742-6596/1155/1/012034

Dominguez, A., De la Garza, J., Quezada-Espinoza, M., & Zavala, G. (2024). Integration of Physics and Mathematics in STEM Education: Use of Modeling. *Education Sciences*, *14*(1). https://doi.org/10.3390/educsci14010020

Fiteriani, I., Diani, R., Hamidah, A., & Anwar, C. (2021). Project-based Learning through STEM Approach: Is it Effective to Improve Students' Creative Problem-Solving Ability and Metacognitive Skills in Physics Learning? *Journal of Physics: Conference Series*, *1796*(1), 012058. https://doi.org/10.1088/1742-6596/1796/1/012058

Gao, H., Yang, W., & Jiang, Y. (2023). Computational Thinking in Early Childhood is Underpinned by sequencing Ability and Self-regulation: A Cross-sectional Study. *Education and Information Technologies*, *28*, 14747–14765. https://doi.org/10.1007/s10639-023-11787-5

Hariyono, H. (2023). Penggunaan Teknologi Augmented Reality dalam Pembelajaran Ekonomi: Inovasi untuk Meningkatkan Keterlibatan dan Pemahaman Siswa. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, *6*(11), 9040–9050.

Hershkovitz, A. (2019). Creativity in the Acquisition of Computational Thinking. *Interactive Learning Environments*, *27*(5), 628–644. https://doi.org/10.1080/10494820.2019.1610451

Hidayati, N., Irmawati, F., & Prayitno, T. A. (2019). Peningkatan Keterampilan Berpikir Kritis Mahasiswa Biologi melalui Multimedia STEM Education. *JPBIO (Jurnal Pendidikan Biologi)*, *4*(2), 84–92.

Irvani, A. I., Rochintaniawati, D., Riandi, R., & Sinaga, P. (2024). Analyzing the Integration of Computational Thinking in Science and Physics Education within the Indonesian Curriculum. *Kasuari: Physics Education Journal (KPEJ)*, *7*(1), Article 1. https://doi.org/10.37891/kpej.v7i1.620

Juniati, N., Jufri, A. W., & Yamin, M. (2020). Penggunaan Multimedia Pembelajaran Untuk Meningkatkan Literasi Sains Siswa. *Jurnal Pijar Mipa*, *15*(4), 312–316. https://doi.org/10.29303/jpm.v15i4.1975

Kirstein, J., & Nordmeier, V. (2007). Multimedia Representation of Experiments in Physics. *European Journal of Physics*, *28*(3), S115.

Laksono, P. J. (2021). Literasi Digital Calon Guru Sains di Universitas Islam pada Masa Pandemi Covid-19. *Orbital: Jurnal Pendidikan Kimia*, *5*(2), 91–109.

Latifah, S., Diani, R., & Malik, S. L. M. (2022). ICARE Model (Introduction, Connection, Application, Reflection, Extension) in Physics Learning: Analysis of its Effect on Students' Computational Thinking Skills based on Gender. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *8*(2), Article 2. https://doi.org/10.21009/1.08205

Lee, S. W.-Y., Tu, H.-Y., Chen, G.-L., & Lin, H.-M. (2023). Exploring the Multifaceted Roles of Mathematics Learning in Predicting Students' Computational Thinking Competency. *International Journal of STEM Education*, *10*(1), 64. https://doi.org/10.1186/s40594-023-00455-2

Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2020). On Computational Thinking and STEM Education. *Journal for STEM Education Research*, *3*(2), 147–166. https://doi.org/10.1007/s41979-020-00044-w

Liu, S., Peng, C., & Srivastava, G. (2023). What Influences Computational Thinking? A Theoretical and Empirical Study based on the Influence of Learning Engagement on Computational Thinking in Higher Education. *Computer Applications in Engineering Education*, *31*(6), 1690–1704. https://doi.org/10.1002/cae.22669

Marvavilha, A., & Suparlan, S. (2018). Model Integrasi Nilai Islam dalam Pembelajaran Sains. *Humanika, Kajian Ilmiah Mata Kuliah Umum*, *18*(1), 59–80.

Mayer, R. E. (2017). Using Multimedia for E-Learning. *Journal of Computer Assisted Learning*, *33*(5), 403–423.

Musdalifa, N., & Syuhendri, S. (2021). Pengaruh Penggunaan Multimedia Interaktif Berbasis STEM Terhadap Hasil Belajar Siswa. *Jurnal Inovasi Dan Pembelajaran Fisika*, *8*(1), 73–84.

Muspiroh, N. (2014). Integrasi Nilai-Nilai Islam dalam Pembelajaran IPA di Sekolah. *Quality*, *2*(1), 168–188.

Nasucha, M. R., & Khozin, K. (2023). Synergizing Islamic Religious Education and Scientific Learning in the 21st Century: A Systematic Review of Literature. *Jurnal Pendidikan Agama Islam (Journal of Islamic Education Studies)*, *11*(1), 109–130.

Ng, O.-L., Leung, A., & Ye, H. (2023). Exploring Computational Thinking as a Boundary Object Between Mathematics and Computer Programming for STEM

Teaching and Learning. *ZDM – Mathematics Education*, *55*(7), 1315–1329. https://doi.org/10.1007/s11858-023-01509-z

Nurazmi, N., & Bancong, H. (2021). Integrated STEM-Problem Based Learning Model: Its Effect on Students' Critical Thinking. *Kasuari: Physics Education Journal (KPEJ)*, *4*(2), Article 2. https://doi.org/10.37891/kpej.v4i2.219

Olympiou, G., Zacharias, Z., & Dejong, T. (2013). Making the Invisible Visible: Enhancing Students' Conceptual Understanding by Introducing Representations of Abstract Objects in a Simulation. *Instructional Science*, *41*, 575–596.

Opfermann, M., Schmeck, A., & Fischer, H. E. (2017). *Multiple Representations in Physics and Science Education – Why Should We Use Them?* 1–22. https://doi.org/10.1007/978-3-319-58914-5_1

Panjaitan, R. G. P., Titin, T., & Putri, N. N. (2020). Multimedia Interaktif Berbasis Game Edukasi sebagai Media Pembelajaran Materi Sistem Pernapasan di Kelas XI SMA. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *8*(1), 141–151.

Parmin, P., Saregar, A., Deta, U. A., & Islami, R. A. Z. E. (2020). Indonesian Science Teachers' Views on Attitude, Knowledge, and Application of STEM. *Journal for the Education of Gifted Young Scientists*, *8*(1), Article 1. https://doi.org/10.17478/jegys.647070

Pramuji, L., Permanasari, A., & Ardianto, D. (2020). Multimedia Interaktif Berbasis STEM pada Konsep Pencemaran Lingkungan untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *JSEP (Journal of Science Education and Practice)*, *2*(1), 1–15.

Prayitno, T. A., & Hidayati, N. (2021). Developing Multimedia with STEM Education in University: Needs Analysis in Microbiology Learning. *Proceeding Biology Education Conference: Biology, Science, Enviromental, and Learning*, *17*(1), 13–21.

Rahmatika, Z., Wiliyanti, V., Diani, R., Daenuri, E., & Putri, C. A. S. A. (2024). Science, Technology, Engineering, and Mathematics (STEM) Approach in Physics Learning: Meta-analysis Study. *AIP Conference Proceedings*, *3058*(1), 020002. https://doi.org/10.1063/5.0200999

Retnawati, H. (2015). Perbandingan Akurasi Penggunaan Skala Likert dan Pilihan Ganda untuk Mengukur Self-Regulated Learning. *Jurnal Kependidikan Penelitian Inovasi Pembelajaran*, *45*(2).

Sabo, H. C., Odden, T. O. B., & Gregers, T. F. (2022). *Challenges of Preparing Secondary STEM Pre-Service Teachers in Computational Thinking*. 395–400. https://www.per-central.org/items/detail.cfm?ID=16266

Sakiah, N. A., & Effendi, K. N. S. (2021). Analisis Kebutuhan Multimedia Interaktif Berbasis Powerpoint Materi Aljabar pada Pembelajaran Matematika SMP. *JP3M (Jurnal Penelitian Pendidikan Dan Pengajaran Matematika)*, *7*(1), 39–48.

Suryadi, A., & Kurniati, E. (2021). *Teori dan Implementasi Pendidikan STEM*. Bayfa Cendekia Indonesia.

Suryandaru, N. A. (2020). Penerapan Multimedia Dalam Pembelajaran Yang Efektif. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, *3*(2), 88–91.

Susanti, A., Diani, R., Octafiona, E., & Lathifah, D. Q. (2023). Developing Physics Learning Videos with STEM Approach (Science, Technology, Engineering, Mathematics). *AIP Conference Proceedings*, *2595*(1), 020019. https://doi.org/10.1063/5.0123793

Tankiz, E., & Atman Uslu, N. (2023). Preparing Pre-Service Teachers for Computational Thinking Skills and its Teaching: A Convergent Mixed-Method Study. *Technology, Knowledge and Learning*, *28*(4), 1515–1537. https://doi.org/10.1007/s10758-022-09593-y

Turchi, T., Fogli, D., & Malizia, A. (2019). Fostering Computational Thinking through Collaborative Game-Based Learning. *Multimedia Tools and Applications*, *78*(10), 13649–13673. https://doi.org/10.1007/s11042-019-7229-9

Wang, C., Shen, J., & Chao, J. (2022). Integrating Computational Thinking in STEM Education: A Literature Review. *International Journal of Science and Mathematics Education*, *20*(8), 1949–1972. https://doi.org/10.1007/s10763-021-10227-5

Waruwu, M. (2023). Pendekatan Penelitian Pendidikan: Metode Penelitian Kualitatif, Metode Penelitian Kuantitatif dan Metode Penelitian Kombinasi (Mixed Method). *Jurnal Pendidikan Tambusai*, *7*(1), 2896–2910.

Yahya, M., & Vitalocca, D. (2022). Penerapan Kombinasi Metode Computational Thinking dan Model Emergent Learning Untuk Meningkatkan Kemampuan Problem Solving Siswa SMK. *Garuda. Kemdikbud. Go. Id*, 762–774.

Yin, Y., Hadad, R., Tang, X., & Lin, Q. (2019). *Meningkatkan dan Menilai Pemikiran Komputasi dalam Aktivitas Pembuat: Integrasi dengan Fisika dan Pembelajaran Teknik*. 189–214.

Yuberti, Diani, R., Suryani, Y., Latifah, S., Jamaluddin, W., & Widiawati, N. (2024). PjBL Model with the STEAM Approach: A Solution to Improve Computational Thinking Ability. *AIP Conference Proceedings*, *3058*(1), 020003. https://doi.org/10.1063/5.0201264