Interactive Multimedia Development Based on TPACK IPAS Subjects for Grade IV Elementary School Students

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Abstract: This research aimed to develop an interactive multimedia based on TPACK (Technological Pedagogical Content Knowledge) for the IPAS (Science and Social Studies) subject in Grade IV at SDN 22 Cacang Randah, Kabupaten Agam. The study employed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) for the development process. The results showed that the developed multimedia was valid, practical, and effective for use in the classroom. The validation process, carried out by education experts, indicated that the multimedia met the learning goals and was well-designed. The practical implementation of the multimedia, as assessed by both teachers and students, confirmed its ease of use and accessibility. Additionally, effectiveness tests conducted through pretests and posttests revealed a significant improvement in students' understanding of the material, with an average N-gain score of 85.90%, categorized as high. The multimedia supported the development of critical thinking and enhanced student engagement, aligning with the principles of Kurikulum Merdeka. In conclusion, the interactive multimedia based on TPACK is a valid, practical, and effective tool for enhancing the learning experience in elementary school education. Further studies with larger sample sizes and broader topics are recommended to explore its long-term effectiveness.

Keywords: Digital Learning Tools; Interactive Multimedia; IPAS; TPACK

Introduction

Education plays a crucial role in the progress of a nation and the fabric of society. In elementary school, education provides an essential foundation for daily life, with the goal of improving cognitive abilities, encouraging personal growth, and fostering students' ability to adapt to technology and social interactions (Jamil et al., 2023; Walter, 2024). As technology advances, education requires a flexible curriculum to meet the demands of the times. Information technology plays a significant role in education, streamlining the learning process and improving learning outcomes (Alenezi, 2023; Haleem et al., 2022). Learning media, as explained by Afifa & Astuti (2024); Bunari et al. (2024), serves to convey material visually and audibly, increasing student interest and motivation. In line with Borgonovi et al. (2023); Liu et al. (2022), motivation

theory, engaging media can reduce boredom and increase student engagement in the learning process. Educators must also utilize available facilities to facilitate the use of technology in learning. Interactive multimedia, which combines audio and video, can increase student interest and participation (Godsk & Møller, 2025; Navas-Bonilla et al., 2025). In elementary school, interactive multimedia is particularly beneficial because it supports the cognitive development of children at the concrete operational stage (Abdulrahaman et al., 2020; Hazrullah & Lubis, 2023).

Learning that involves visualization and hands-on experience is more effective for children at this age. Learning Natural and Social Sciences (IPAS) in elementary schools aims to develop students' critical thinking and analytical skills (Haryanti et al., 2025; Islamiati et al., 2024). It not only imparts knowledge but also shapes students' understanding of the world

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around them through a scientific approach. However, in practice, IPAS learning still faces challenges, such as limited learning media and an approach that focuses more on memorization than conceptual understanding (Diani & Wulandari, 2025; Suryani et al., 2025) . These factors contribute to low student learning outcomes, necessitating a more varied and hands-on, experiential approach to improve student understanding and interest in the subject. Based on document analysis at SD Negeri 22 Cacang Randah, Tanjung Mutiara District, student academic achievement in the even semester did not meet the established Learning Objective Completion Criteria (KKTP), which is 80. The results of the formative assessment for the IPAS subject showed that only 8 out of 20 students (40%) achieved the KKTP, while 12 (60%) did not complete the subject. This indicates the need for greater efforts to improve student understanding of the material. Observations at the school revealed that the learning methods used were still conventional, dominated by lectures and minimal use of technology. Learning media, such as visual aids and digital technology, were rarely used.

Teachers tended to rely on textbooks as the primary source, and limited facilities and time hindered the use of technology. Students reported that the lecture method felt monotonous and unengaging, preferring learning involving visual media and interactive technology. This situation presents a challenge in the implementation of the Independent Curriculum, which encourages student-centered learning. The use of effective and interactive media is essential to support more flexible and engaging learning, thereby increasing student engagement and learning outcomes (Balalle, 2024; Mhlongo et al., 2023). Researchers distributed questionnaires to 20 fourth-grade students at SD Negeri 22 Cacang Randah to gauge their perceptions of science learning. The results showed that 75% of students felt that learning was easier to understand with the use of learning media, and 65% considered printed textbooks too complex. Eighty-five percent of students stated that teachers often used the lecture method due to technological limitations, while 70% found the textbooks uninteresting (Hasan et al., 2024). Interestingly, 100% of students own mobile devices or smartphones, opening up opportunities for the use of technology-based multimedia in learning.

Based on these findings, the use of interactive multimedia based on TPACK is essential to improve student understanding, motivation, and engagement. The development of innovative learning media must be tailored to students' needs, interests, and learning styles (Charline et al., 2023), and utilize technology to create a more engaging and interactive learning experience. One application that can be used is Canva, which enables the creation of digital teaching materials that are easily accessible and flexible across various devices. Canva facilitates the creation of interactive learning content, including animations, videos, and infographics, which help students better understand concepts. The use of this application aligns with the Independent Curriculum (Kurikulum Merdeka), which supports student creativity and independence in learning. TPACK-based learning integrates technology, pedagogy, and content to create an engaging and effective classroom environment, which can improve student learning outcomes. Based on this background, researchers developed interactive TPACK-based learning media for fourth-grade elementary school students in the science subject.

Method

This research uses the Research and Development (R&D) method, which aims to develop or update products, both existing and new, to solve specific problems. This process involves expert testing to ensure the quality of the developed product. The primary focus of this method is on developing applicable products, rather than on testing theories. Development research aims to create specific products and evaluate their effectiveness.This research uses the ADDIE model, which consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because of its simplicity, systematicity, and flexibility, as well as its adaptability to various situations (Li & Cheong, 2023; Spatioti et al., 2022).

The first stage, Analysis, aims to identify problems and analyze the curriculum, learning materials, and student characteristics, which form the basis for developing learning multimedia. This stage also includes a needs analysis and a review of science and science materials, such as the water cycle. In the Design stage, the researchers designed a TPACK-based interactive multimedia product for science and science subjects, which includes components such as user instructions, learning objectives, materials, practice questions, and teacher profiles. The first prototype was created by designing engaging and easy-to-understand learning media using images, video, audio, and text. In the Development phase, the product was tested and validated by media, materials, and language experts, then revised to improve its quality.

In the Implementation phase, the product was tested at SD Negeri 22 Cacang Randah using a pretest-posttest design to measure student understanding before and after the lesson. A practicality test was conducted to assess ease of use, and an effectiveness test

was conducted through a posttest to measure student learning outcomes. The evaluation results were used to refine the product in the next phase. The final phase, Evaluation, aimed to assess the product's success in supporting the learning process. This evaluation was conducted based on feedback from students, teachers, and experts to ensure the product effectively achieved learning objectives and could be implemented in the classroom.

Results and Discussion

This study aims to develop interactive multimedia based on TPACK for Natural and Social Sciences (IPAS) for fourth-grade elementary school students, using the ADDIE model, which consists of five main stages: analysis, design, development, implementation, and evaluation. The results of the study indicate that during the analysis stage, a review of the curriculum and student characteristics indicated the importance of developing interactive learning media to enhance student understanding of the material being taught. The curriculum analysis was conducted with reference to the Independent Curriculum, specifically on the topic of the water cycle, which is the focus of the learning material. The analysis of student characteristics indicated that they require a more visual and dynamic approach, such as the use of video and animation, to facilitate their understanding of abstract concepts, such as the water cycle. The interactive multimedia developed was designed using the Canva application and includes key components, such as an engaging title slide, a clear main menu, learning objectives, user instructions, learning materials accompanied by videos, and quizzes to assess student understanding. This design ensures easy access to the learning media and provides a fun and interactive learning experience.

Product validation results by three experts (media, language, and materials) demonstrated a very high level of validity: media (94.16%), language (93.33%), and materials (89.09%). This indicates that the multimedia meets the quality standards required for learning. In the practicality stage, the product was tested by a teacher with eight years of teaching experience, with results demonstrating a very high level of practicality. The teacher's practicality assessment yielded a score of 4.92, with a percentage of 98.5%, indicating that this learning media is easy to use in the teaching process. Practicality testing was also conducted on students, with even more encouraging results, with a score of 96.56%, which falls into the very practical category. This demonstrates that this interactive multimedia is not only effective for teachers but also easy to understand and enjoyable for students. The effectiveness of this interactive

multimedia was tested using pretest and posttest methods to measure improvements in student understanding before and after using the learning media.

The effectiveness test results showed a significant increase in student understanding, with an average N-gain score of 85.90%, which is considered high. This data demonstrates that TPACK-based interactive multimedia can help improve students' understanding of science material, particularly regarding the water cycle (Marougkas et al., 2023; Natalia et al., 2024; Swarmahardika & Widiana, 2024). The high N-gain score indicates that this media is effective in supporting the achievement of learning objectives, namely improving students' understanding of the concepts taught. The development of TPACK-based interactive multimedia for science subjects aims to create a more enjoyable and effective learning experience (Aktaş & Özmen, 2020; Chan & Hu, 2023; Subagja et al., 2023). Based on the very positive validation and practical results, this learning media is expected to encourage teachers to be more creative in developing media that aligns with student characteristics and the applicable curriculum (Faizal et al., 2023; Noeryanti et al., 2023). The use of technology in learning like this is crucial in creating an engaging classroom atmosphere and supporting student competency development (Ning et al., 2024; Sailer et al., 2021; Sihanita et al., 2024).

Furthermore, the results of the effectiveness test, which showed a significant increase in student understanding, prove that the use of TPACK-based multimedia can significantly improve learning outcomes (Hillmayr et al., 2020; Lutfiana et al., 2023; Nantha et al., 2024). Therefore, the development and implementation of this interactive multimedia is expected to be applied more widely in various schools to improve the quality of learning and student competency achievement (Sumalia & Listiaji, 2024; Yeni et al., 2022). This study has several limitations, including: the media developed was only intended for fourth-grade elementary school students; the sample size was limited to 20 students at SD Negeri 22 Cacang Randah, and the study only covered one learning topic, namely the water cycle. Therefore, further research with a larger sample size and testing on various learning materials is needed to assess the sustainability and effectiveness of this multimedia in a broader context (Alam et al., 2021; Tong et al., 2022).
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Conclusion

Based on the research results, it can be concluded that the TPACK-based interactive multimedia developed for fourth-grade elementary school science

has proven valid and suitable for use in the learning process. This is based on validation results obtained from questionnaires completed by expert validators and education practitioners. The resulting media design is attractive and aligned with the research objectives, and the material presented meets the Learning Outcomes and objectives, thus facilitating student understanding. Furthermore, the development of TPACK-based interactive multimedia for fourth-grade elementary school science has demonstrated that this media is highly practical to use.

Author Contributions
Conceptualization; methodology.; R. N., validation; formalanalysis; investigation; resources; data curation: writing—original draft preparation; writing—review and editing.; visualization: R. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest.

References

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam-Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon*, *6*(11), e05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Afifa, K., & Astuti, T. (2024). The Effect of Digital Learning Media on Motivation and Learning Outcomes of IPAS. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 3155–3165. https://doi.org/10.29303/jppipa.v10i6.7513

Aktaş, İ., & Özmen, H. (2020). Investigating the impact of TPACK development course on pre-service science teachers' performances. *Asia Pacific Education Review*, *21*(4), 667–682. https://doi.org/10.1007/s12564-020-09653-x

Alam, M. M., Ahmad, N., Naveed, Q. N., Patel, A., Abohashrh, M., & Khaleel, M. A. (2021). E-Learning Services to Achieve Sustainable Learning and Academic Performance: An Empirical Study. *Sustainability*, *13*(5), 2653. https://doi.org/10.3390/su13052653

Alenezi, M. (2023). Digital Learning and Digital Institution in Higher Education. *Education Sciences*, *13*(1), 88. https://doi.org/10.3390/educsci13010088

Balalle, H. (2024). Exploring student engagement in technology-based education in relation to gamification, online/distance learning, and other factors: A systematic literature review. *Social Sciences & Humanities Open*, *9*, 100870. https://doi.org/10.1016/j.ssaho.2024.100870

Borgonovi, F., Pokropek, M., & Pokropek, A. (2023). Relations between academic boredom, academic achievement, ICT use, and teacher enthusiasm among adolescents. *Computers & Education*, *200*, 104807. https://doi.org/10.1016/j.compedu.2023.104807

Bunari, B., Setiawan, J., Ma'arif, M. A., Purnamasari, R., Hadisaputra, H., & Sudirman, S. (2024). The influence of flipbook learning media, learning interest, and learning motivation on learning outcomes. *Journal of Education and Learning (EduLearn)*, *18*(2), 313–321. https://doi.org/10.11591/edulearn.v18i2.21059

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-023-00411-8

Charline, C., Jo, S., & Frederic, E. (2023). Use of Learning Media to Increase Student Learning Motivation in Junior High Schools. *World Psychology*, *2*(3), 176–189. https://doi.org/10.55849/wp.v2i3.402

Diani, D. P., & Wulandari, D. (2025). Development of Flashcard Media Assisted by Augmented Reality in Improving Learning Outcomes in Learning IPAS. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 34–43. https://doi.org/10.29303/jppipa.v11i3.10724

Faizal, Khoirunnisa, & Hendra Budiono. (2023). Modules Based on Technological Pedagogical Content Knowledge to Improve Elementary Students' Science Domain. *International Journal of Elementary Education*, *7*(4), 616–625. https://doi.org/10.23887/ijee.v7i4.69193

Godsk, M., & Møller, K. L. (2025). Engaging students in higher education with educational technology. *Education and Information Technologies*, *30*(3), 2941–2976. https://doi.org/10.1007/s10639-024-12901-x

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Haryanti, Y. D. H., I Gusti Agung Ayu Wulandari, Ni Ketut Desia Tristiantari, Ani Rosidah, Devi Afriyuni Yonanda, & Minnatul Maula. (2025). Enhancing Project-Based Learning through Digital

E-Modules in Elementary Schools. *Jurnal Ilmiah Sekolah Dasar*, *9*(2), 263–277. https://doi.org/10.23887/jisd.v9i2.93786

Hasan, M., Karimuzzaman, Md., Abdulla, F., & Hossain, Md. M. (2024). Mobile Use in the Classroom is a Mixed Bag, and Lecturers Need to Provide Students With Guidelines. *Sage Open*, *14*(4). https://doi.org/10.1177/21582440241299481

Hazrullah, & Lubis, A. H. (2023). The Interactive Multimedia Based on Theo-Centric Approach as Learning Media during the Covid-19 Pandemic. *JPI (Jurnal Pendidikan Indonesia)*, *12*(2), 210–222. https://doi.org/10.23887/jpiundiksha.v12i2.51493

Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers & Education*, *153*, 103897. https://doi.org/10.1016/j.compedu.2020.103897

Islamiati, A., Fitria, Y., Sukma, E., Yaswinda, Fitria, E., & Oktari, S. T. (2024). The Influence of The Problem Based Learning (PBL) Model and Learning Style on the Thinking Abilities. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 1934–1940. https://doi.org/10.29303/jppipa.v10i4.6219

Jamil, N., Belkacem, A. N., & Lakas, A. (2023). On enhancing students' cognitive abilities in online learning using brain activity and eye movements. *Education and Information Technologies*, *28*(4), 4363–4397. https://doi.org/10.1007/s10639-022-11372-2

Li, H., & Cheong, J. P. G. (2023). Using the ADDIE model to design and develop physical education lessons incorporated with a functional training component. *Frontiers in Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1201228

Liu, H., Li, J., & Fang, F. (2022). Examining the Complexity between Boredom and Engagement in English Learning: Evidence from Chinese High School Students. *Sustainability*, *14*(24), 16920. https://doi.org/10.3390/su142416920

Lutfiana, R. F., Nurul Zuriah, & Saputri, D. K. N. (2023). The TPACK Approach Improves Student Collaboration Skills in 21st-Century Learning. *Jurnal Pedagogi Dan Pembelajaran*, *6*(2), 274–282. https://doi.org/10.23887/jp2.v6i2.52845

Marougkas, A., Troussas, C., Krouska, A., & Sgouropoulou, C. (2023). Virtual Reality in Education: A Review of Learning Theories, Approaches and Methodologies for the Last Decade. *Electronics*, *12*(13), 2832. https://doi.org/10.3390/electronics12132832

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in

learning environments: An iterative review. *Heliyon*, *9*(6), e16348. https://doi.org/10.1016/j.heliyon.2023.e16348

Nantha, C., Siripongdee, K., Siripongdee, S., Pimdee, P., Kantathanawat, T., & Boonsomchuae, K. (2024). Enhancing ICT Literacy and Achievement: A TPACK-Based Blended Learning Model for Thai Business Administration Students. *Education Sciences*, *14*(5), 455. https://doi.org/10.3390/educsci14050455

Natalia, N. K. D., Bayu, G. W., & Trisna, G. A. S. (2024). Animated Video-Based Learning Media on Science and Social Content on the Water Cycle Topic for Fourth Grade of Elementary Schools. *Thinking Skills and Creativity Journal*, *7*(1), 122–130. https://doi.org/10.23887/tscj.v7i1.76555

Navas-Bonilla, C. D. R., Guerra-Arango, J. A., Oviedo-Guado, D. A., & Murillo-Noriega, D. E. (2025). Inclusive education through technology: A systematic review of types, tools and characteristics. *Frontiers in Education*, *10*. https://doi.org/10.3389/feduc.2025.1527851

Ning, Y., Zhang, C., Xu, B., Zhou, Y., & Wijaya, T. T. (2024). Teachers' AI-TPACK: Exploring the Relationship between Knowledge Elements. *Sustainability*, *16*(3), 978. https://doi.org/10.3390/su16030978

Noeryanti, A. T., Rejekiningsih, T., & Sudiyanto. (2023). Learning Innovation through the Development of Interactive Multimedia Based on Local Wisdom for Sociology Learning in the Digital Era. *Jurnal Edutech Undiksha*, *11*(1), 41–53. https://doi.org/10.23887/jeu.v11i1.60441

Sailer, M., Murböck, J., & Fischer, F. (2021). Digital learning in schools: What does it take beyond digital technology? *Teaching and Teacher Education*, *103*, 103346. https://doi.org/10.1016/j.tate.2021.103346

Sihanita, Y. K., Priambodo, A., & Tuasikal, A. R. S. (2024). TPCK (Technological Pedagogical and Content Knowledge) Competence for Educator: A Literature Review. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, *5*(2), 77–92. https://doi.org/10.62775/edukasia.v5i2.851

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information*, *13*(9), 402. https://doi.org/10.3390/info13090402

Subagja, S., Rubini, B., & Kurniasih, S. (2023). Development of Interactive Multimedia Based on TPACK to Enhance Students' Science Process Skills on Living Cell Matter. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 4055–4062. https://doi.org/10.29303/jppipa.v9i5.3645

Sumalia, R., & Listiaji, P. (2024). Scratch-based Science Interactive Animation Media to Improve Concept Understanding of Junior High School Learners. *Journal for Lesson and Learning Studies*, *7*(2), 290–300. https://doi.org/10.23887/jlls.v7i2.77645

Suryani, L., Rahmadonna, S., & Dwita Haliem, T. (2025). Integration of Technology and Media in IPAS Learning in Grade IV Elementary School. *International Journal of Elementary Education*, *9*(1), 113–124. https://doi.org/10.23887/ijee.v1i1.91327

Swarmahardika, I. K. P., & Widiana, I. W. (2024). Interactive Learning Media Based on Augmented Reality to Improve Elementary School Grade V Students' Understanding of the Water Cycle Concept. *MIMBAR PGSD Undiksha*, *12*(2), 351–359. https://doi.org/10.23887/jjpgsd.v12i2.74930

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, *8*(12), e12657. https://doi.org/10.1016/j.heliyon.2022.e12657

Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: The relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00448-3

Yeni, N., Khairunisa, Y., & Kuswoyo, D. (2022). Development of Interactive Digital Learning Multimedia Applications as Independent Learning Module in 2-Dimensional Game Programming Courses. *JTP - Jurnal Teknologi Pendidikan*, *24*(3), 307–321. https://doi.org/10.21009/jtp.v24i3.29769