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Research Artikel

INFORMATION COMMUNICATION TECHNOLOGY (ICT) BASED SCIENCE LEARNING TO INCREASE STUDENT CREATIVITY

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Abstract

This research aims to explore the use of Information and Communication Technology (ICT) in science learning to enhance student creativity, focusing on analyzing electronic teaching materials used at the secondary education level. Through a Systematic Literature Review (SLR) approach following PRISMA guidelines, this study identified and analyzed 32 scientific articles from Sinta, Scopus, and ScienceDirect databases relevant to the topic. The analysis showed that e-modules were the most widely used electronic teaching materials, with significant contributions to the improvement of 21st century skills, including creativity, critical thinking, and collaboration. This research also highlights the effectiveness of the project-based learning model in supporting students' creative skills development. By providing deep insight into the mechanisms of enhancing creativity through ICT integration in science learning, this study contributes to a better understanding of the role of technology in education and offers recommendations for more innovative teaching practices in the future.

Keywords*: Creativity; learning science; ICT; 21st century skills.*

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INTRODUCTION

Information communication and technology (ICT) is increasingly developing to make teaching and learning methods carried out, designed and implemented according to the wishes and needs of students (Falloon, 2024) Information Technology (Information Technology) or the term information communication and technology (ICT) or better known as ICT is a technology that is needed to manage, process, and convey information regardless of place and time. ICT is also characterized as a form of facilitation that allows the flow of information to be very easy to obtain (Dini et al., 2024). Communication technology and information are also very influential on the world of education to create creativity, interest, motivation in learning (Bayram-Jacobs et al., 2019).

ICT stands for information, communication, and technology. Mobile devices like computers, laptops, cell phones, audio players, and electronic books are used in electronic learning and education. One of them has an impact in the teaching materials used such as PPT, pictures, e-books, e-modules, e-LKPD, animated videos and others. With the aid of the internet and technical advancements, ICT enables students to study cooperatively with one another and exchange ideas without regard to time or location constraints (Encabo-Fernández et al., 2023) The application of ICT in science learning can help educators to further minimize the use of learning media that is applied especially in the delivery of learning materials that require a better process. Science is a branch of science whose focus of study is nature and the processes that exist in it (Ariani, 2020).

Learning made possible by technology can aid in removing obstacles between the classroom and real life. It's quite appealing for introducing students to new places, eras, and geographies in the classroom (Zhang et al., 2024). Some academics claim that technology-enabled learning can serve as a link between formal and informal learning, allowing one to compare and contrast the two depending on features and context. The majority of the literature discusses how affordable it is to use teacher-centered mobile learning techniques, strategies, and applications. There are basic problems with the theoretical and pedagogical underpinnings for the application of mobile learning in education that are currently insufficient and off target, in addition to the actual implementation concerns that arise in learning practices. Numerous writers examine and analyze this from a socio-constructivist perspective, and they conclude that mobile devices' communication capabilities can foster teamwork and serve as the cornerstone of mobile learning. Instead of using the resources or media, students might engage in active learning with one another and themselves. Therefore, for technology-based learning to be effective, all facets of education government, educators, students, and society at large must adapt (Agustina et al., 2021). Some research suggests that mobile devices can have a positive impact on learning in general, but it is not always clear how educators use mobile technology or how they design learning to enhance student creativity (NI Syar & Al Ibtida, 2022).

In the 21st century, there are several skills that students must have, known as the 4Cs (Critical Thinking, Communication, Collaboration, Creativity and Innovation). It is important to develop students' higher-order thinking competencies, such as creative thinking and critical thinking skills (Jufriadi et al., 2022). Technology-based education can be a creative (Li et al., 2024). In addition to assisting teachers and students in understanding the subject matter being studied, technology learning helps pupils develop their higher-order thinking, communication, and problem-solving abilities. Students with higher order thinking skills are able to think at a higher level (Ikhsan, M., & Kuswanto, 2025). Pupils with this aptitude will assess, analyze, and come up with novel solutions to issues.

Based on this, appropriate pedagogical methods and theories are needed to assist teachers in designing learning using technology to enhance students' creativity and critical thinking (Alsaleh, 2020). This method has strategies to integrate technology learning into the classroom to achieve learning objectives with technology aids. In addition, the strategy should embed problem-based learning skills to enhance students' creativity and critical thinking (Ekaputri & Simanjorang, 2022).

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This research aims to present an overview of the use of Information and Communication Technology (ICT) in the science learning process, with a particular focus on enhancing students' creativity. The use of ICT has grown rapidly to make learning methods more flexible and in line with students' needs and interests. According to (Falloon, 2024) , ICT is seen as a facilitator that facilitates the flow of information so that it is easily obtained. In addition, (Dini et al., 2024) explained that ICT also has an important role in education to create creativity, interest, and motivation to learn.

The use of ICT in science education is not only limited to its basic applications but also involves a variety of electronic teaching materials such as Power Point Presentations (PPT), photos, electronic books, electronic modules, animated videos, and others. With the ability of the internet network and the development of increasingly advanced technology, ICT allows students to learn together without time or location restrictions.

In addition, the use of ICT can also assist teachers in optimizing the use of better learning media, especially for materials that require more complex processes. Science itself is a branch of science that focuses on the study of nature and the processes that exist in it. Through technology, lessons can be made more interactive and real, even allowing students to be introduced to new places, the past, and geography in the classroom.

Based on this analysis, we can see that the use of ICT in science education is not just about using technology but must also be accompanied by appropriate learning strategies so that student learning objectives can be achieved. Strategies such as project-based learning and problem-based learning have been proven effective in enhancing students' creativity and critical thinking.

Therefore, this study will conduct a systematic review of empirical articles related to scientific education to find out what electronic teaching materials are used in the teaching and learning process, and how their use can improve 21st century skills, especially student creativity.

This review was produced using systematic content analysis of empirical science education research articles. The review above, which was produced through a methodical content analysis of empirical research articles on science education, aims to address the following queries: 1) What electronic teaching materials are used in learning?l 2) What 21st century skills can be improved when utilizing ICT in science learning, especially using these electronic teaching materials?.

METHOD

This research is a systematic literature review. The method used in this study is Systematic Literature Review (SLR) using the Preferred Reporting Items for Systematic Reviews and Metaanalyses model or called PRISMA. This method researchers do by identifying, reviewing, evaluating and interpreting all available research. With this method, the researcher reviews and identifies journals systematically in each process following predetermined steps. By encouraging evidence-based activities, conducting more objective evaluations of previous efforts, and identifying new research directions, the SLR approach advances our understanding of research topics (Sun et al., 2023). To ensure systematic SLR, this study followed the PRISMA guidelines.

Electronic scientific databases such as Sinta, Scopus, and ScienceDirect (Elsevier) were searched to find pertinent studies. These databases were chosen due to their interdisciplinary scope, usability, and theme relevance. The electronic scientific database literature search was conducted using the PRISMA framework.

Table 1. Publishers of Analysis Articles

Publishers
https://www.sciencedirect.com/
https://www.scopus.com
https://www.sinta.kemendikbud.go.id

Electronic scientific databases such as Sinta, Scopus, and ScienceDirect (Elsevier) were searched to find pertinent studies. These databases were chosen because of their theme-relevant content, accessibility, and multidisciplinary coverage. The PRISMA framework was utilized to conduct a literature search within an electronic scientific database.

This research discusses the use of Information and Communication Technology (ICT) in science learning to enhance students'

creativity. By utilizing the Systematic Literature Review (SLR) method and following PRISMA guidelines, the authors analyzed scientific articles from databases such as Sinta, Scopus, and ScienceDirect.

This research is oriented towards articles that have been indexed in databases that are more specific and relevant to the context of science education, such as Sinta, Scopus, and ScienceDirect, which provide access to a wider and more diverse literature in the field of education. Secondly, the selection of these databases was based on strict inclusion and exclusion criteria to ensure that only high-quality empirical research was included in the analysis.

This study used secondary data for its data collection. The documentation method from existing data is applied to secondary data. instead of data obtained from direct observation. The procedure is divided into four stages: (1) As illustrated in Figure 1, the steps are identification, (2) screening, (3) eligibility, and (4) inclusion. The initial step entailed performing a methodical search of electronic databases, as illustrated in Figure 1. Studies that satisfied the following inclusion requirements were chosen: (a) The study is an empirical investigation into learning that makes use of ICT to enhance 21st century skills through teaching and learning. (b) Junior secondary school education is the study's educational level. (c) The study was released between 2015 and 2023. (d) English is used in the research paper. A visual representation of the PRISMA criteria is provided below.

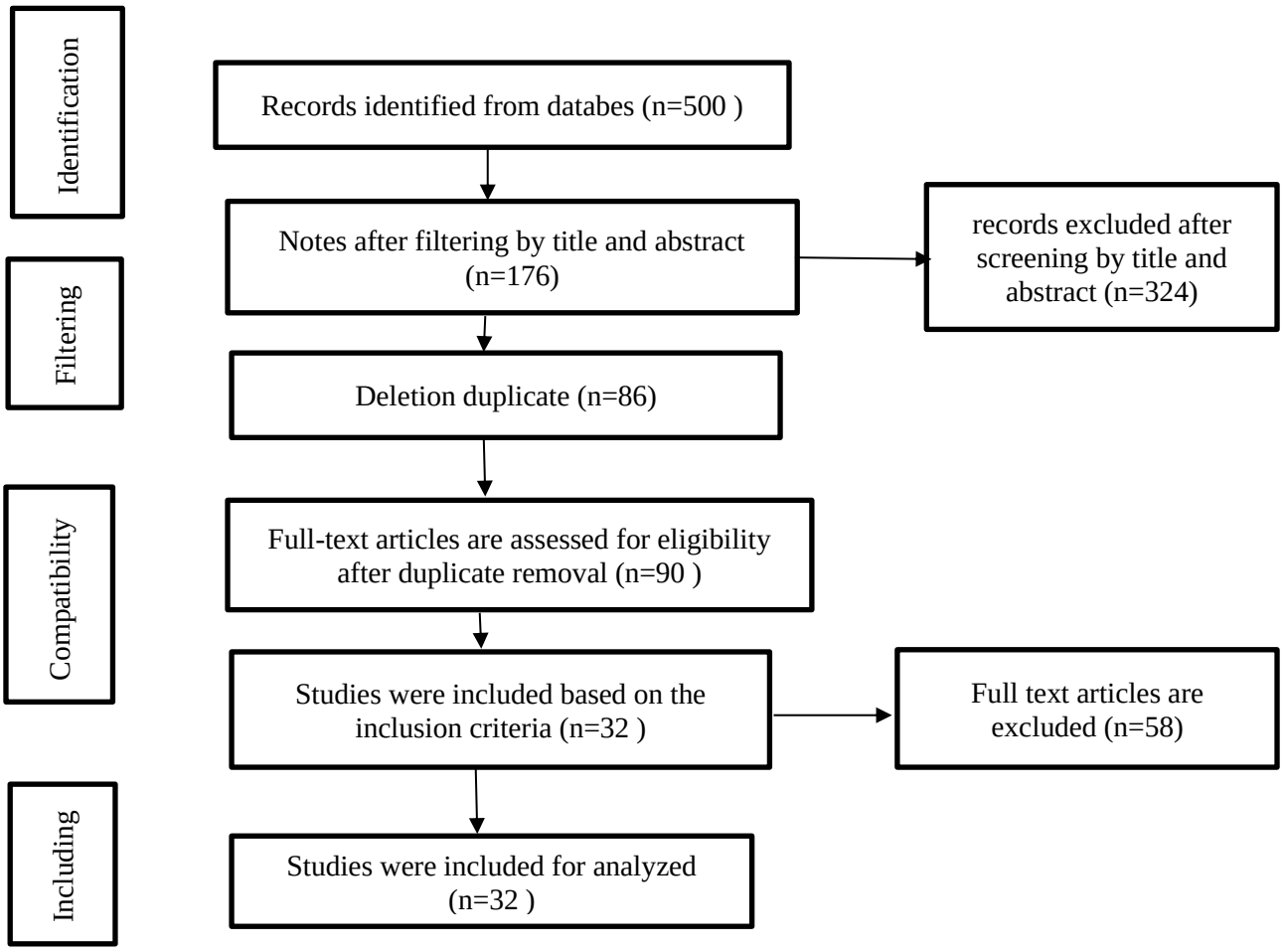

Figure 1. Flowchart PRISMA

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This search process yielded 500 results. Next, the second stage involved screening the titles and abstracts of the selected studies. In total, this screening procedure yielded 176 relevant papers, 86 of which were found to be duplicates when checking the screening results by reading the abstracts of each article. The third stage involved assessing the eligibility of 90 selected full-text articles. During this procedure, each paper was carefully read, and only papers that met the inclusion requirements were selected for inclusion with the exclusion criteria being: (a) Non-empirical studies do not present empirical data, (b) Different educational contexts such as arts education, sports, (c) Traditional teaching methods research that only discusses traditional teaching methods without ICT integration or innovation, (d) Low data quality, Articles that have significant problems in methodology, such as small sample size, obvious bias, or inadequate data analysis, will be removed to maintain the quality of the analysis. 32 scientific articles that satisfied the selection criteria were taken into consideration for the final extraction after this process. At the last phase, the caliber of the scientific publications (n=32) was assessed based on research questions.

The studies referenced in this article were sourced from a selection conducted through the Systematic Literature Review (SLR) method. In this process, the authors followed structured steps to identify, review and evaluate scientific articles relevant to the topic of using Information and Communication Technology (ICT) in science learning. All references used in this article are from studies that have gone through a rigorous selection process, ensuring that the data presented are consistent and relevant to the research objectives. This is important for maintaining the authenticity and integrity of the information presented, as well as providing a strong basis for the findings.

RESULTS AND DISCUSSIONS

Teaching materials that should be used in learning are flexible and easy to understand. Electronic teaching materials are of course teaching materials that require a smartphone or computer as a place for these teaching materials (Dini et al., 2024). The results of the study reported that in learning, e-books or e-modules are the most frequently used electronic teaching materials according to Table 2.

Table 2. Electronic Teaching Material Analysis Results

Electronic Teaching Materials	F	P
E-book atau E-modul	9	28.12%
Website	4	12.5%
Phet	1	3.12%
Geogebra	1	3.12%
Storytelling	3	9.37%
Game mobile	3	9.37%
Virtual Reality (VR)	1	3.12%
Power Point (PPT)	1	3.12%
Edmodo	2	6.25%
Argumented Reality (AR)	3	9.37%
Animation	1	3.12%
Application	3	9.37 %

The results of the analysis of ICT utilization in learning the highest electronic teaching materials, namely E-modules 28.12% E-modules based on ethnoscience guided inquiry (Kirana 2023), Problem Based Learning (PBL) based E-modules (Imaningtyas et al., 2017) Flip PDF Professional-based digital book (Febrianti, 2021) interactive E-book (Agustina et al., 2021), basic physics practicum guide E-module (Defianti, 2022), E-module of general chemistry platform for first year students (Schettini et al., 2020), E-module based on Project Based Learning (PjBL) Integration with CCR Implementation in Science Education (Ulfa et al., 2023), E-Book based on Socio Scientific Issues (SSI) (Asi et al., 2021).

E-modules are ICT utilization of electronic teaching materials that are widely used in learning in schools because in addition to saving the use of paper e-modules are more efficient and practically easy to make and use by students and teachers, E-modules are also teaching materials that can help students measure and control their learning abilities and intensity. The use of modules is not limited by place and time, because it depends on the ability of students to use the module. Thus, the developed e-modules can be used anytime and anywhere using smartphones that most students already have in this technological era (Ilmi et al., 2021). There are 87% of studies that aim to measure the improvement of student learning that report that they successfully achieve the set goals. In a review of previous research, of all subjects, natural science is the

subject that uses electronic teaching materials used (Li et al., 2024).

The use of ICT in learning has a positive impact, namely improving creativity skills, critical thinking, communication, collaboration, science literacy, concept understanding and understanding processes. Based on the analysis of creativity skills is the highest aspect of the use of electronic teaching materials according to Table 3.

Table 3. Results of Analysis of Improvement Aspects

Aspects of Improvement	F	P
Creativity	9	28.12%
Critical Thinking	7	21.87%
Process Skills	3	9.37%
Science Literacy	3	9.37%
Colaboration	1	3.12%
Comunication	1	3.12%

The results of the analysis increase the highest creativity, namely 28.12% E-learning in the form of a website increases creativity and concept assignment (Septajati & Widowati, 2024), E-modules based on guided inquiry increase students' creative thinking (Kirana, 2023), ICT-based learning assisted by geogebra software increases creativity and understanding of student concepts (Wardaya et al., 2019), Blog and Facebook-based learning on student creativity (Rianawaty, 2020) Storytelling discovering scientific increases student creativity (Chen et al., 2023), Mobile games increase student creativity (Atwood-Blaine et al., 2019), Mobile learning increases student creativity (Chang et al., 2017), Mobile games increase student creativity (Stolaki, 2018). There are several articles that only make electronic teaching materials but do not measure student improvement only student responses.

Terras & Ramsay, (2019) suggested that electronic teaching materials in learning can expand teacher pedagogy and develop students' 21st century skills. In this analysis, several learning models are used in electornic teaching materials, namely, blanded learning, inquiry, Project Based Learnign (PjBL), Problem Based Learning (PBL). There are some using the Socio Scientific Issues (SSI), Ethnoscience approach. There are several studies that do not use models and approaches in electronic teaching materials.

Using electronic teaching materials in learning can help students gradually develop their statistical thinking in daily life. Students have the concept of self-learning with their characters so that interaction occurs continuously (Burden & Kearney, 2016). Currently, mobile devices enter the classroom because mobile learning has a more significant effect than learning that does not use mobile devices, of course it is utilized, especially in learning in the form of teaching materials used (Afikah et al., 2022).

Learning models to improve 21st century skills, Project Based Learning (PjBL) is one of the science learning models that are widely used in electronic teaching materials (Shao et al., 2021).

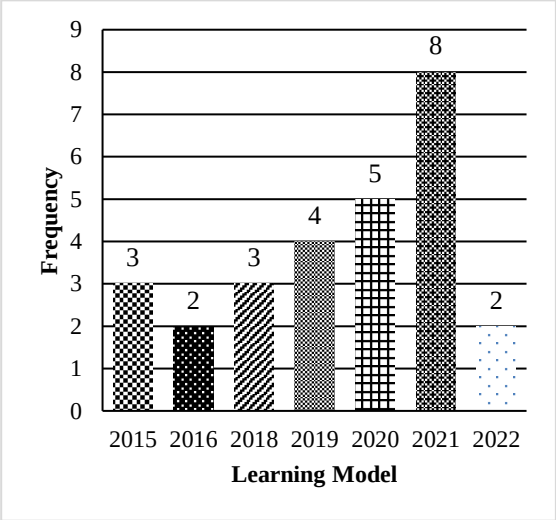

Figure 2. Diagram of Learning Model

Project-based learning, often known as PjBL, is the science learning methodology that is used in electronic teaching materials (Shao et al., 2021). Through project-based learning, students examine and resolve challenging issues (Anazifa & Djukri 2017). Students are better able to research, investigate, and ask questions when they use inquiry-based learning. According to (Shao et al., 2021) problem-based learning is the science learning approach used in electronic teaching materials. A learning technique known as "problem-based learning" centers on a particular occurrence or issue in order to help students improve their problem-solving and self-control abilities. The next blandded learning science learning model applied in electronic teaching materials is blended learning. It combines face-to-

face learning with technology-mediated learning (Idris & Husni, 2019).

The highest percentage of learning models used to improve 21st century skills, namely creativity skills, is Project Based Learning (PjBL). There are some articles that do not use learning models but use approaches in their electronic teaching materials. This research shows that the application of Project Based Learning (PjBL) learning model has a positive impact in improving students' learning creativity. In a study conducted in class VB of SD Negeri 34/I Teratai in the 2017/2018 academic year, the results showed a significant increase in student creativity, with indicators showing an increase in the number of students in the excellent category. For example, in the first cycle, the percentage of student creativity increased from 59.4% to 66.25%, and in the second cycle it increased again to 81.8%.

The PjBL model provides opportunities for students to think critically and develop creativity through real projects, where they have to plan, execute, and evaluate the project results independently. However, it is important to note that although this model encourages independence, teachers are still needed to guide students in completing project tasks. This study utilizes quantitative and qualitative analysis techniques to describe the improvement of students' creativity in more depth. The results show that PjBL not only enhances creativity but also helps students in developing new skills and solving problems based on real experiences. Therefore, the application of innovative learning models such as PjBL is highly recommended to improve the quality of learning in elementary schools.

The analyzed articles range from 2015 to 2023. As shown in Figure 3, the highest number of articles was published in 2021, with 8 articles, followed by 5 articles in 2020, 5 articles in 2023, 4 articles in 2019, 3 articles in 2018, 3 articles in 2015, 2 articles in 2022, and 2 articles in 2016. The high number of articles in 2021, as depicted in Figure 3, was mainly due to the COVID-19 pandemic, during which teaching was conducted online. This led to an increased use of technology in education, particularly in the form of electronic teaching materials. This shift has had a lasting positive impact, as electronic teaching materials continue to play a crucial role in enhancing students' 21st-century skills.

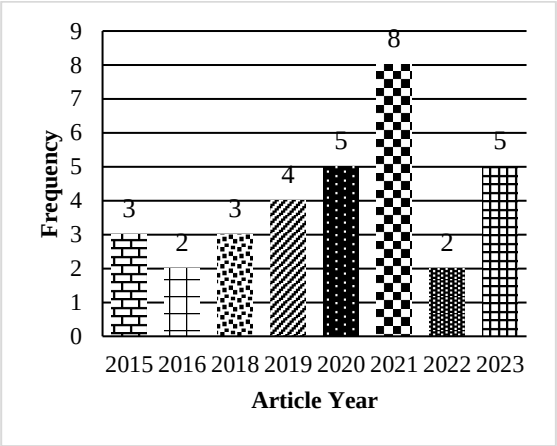

Figure 3. Year of Article

This study has several limitations to its findings: Firstly, this study examined the use of ICT in what electronic teaching materials are most frequently used in science learning. Secondly, and most importantly, various factors other than electronic teaching materials, 21st century skills enhancement and learning models.

CONCLUSION

This study offers an up-to-date overview of electronic teaching materials tools for science learning, which can strengthen the foundation of scientific research and be helpful to future researchers. When it comes to achieving learning objectives, electronic books, websites, games, narrative, powerpoint, augmented reality (AR), virtual reality (VR), animation, Edmodo, and gaming are the ideal electronic teaching resources. This research is also expected to be an example for future researchers in developing electronic teaching materials with learning models to improve students' creativity for better 21st century skills and how to implement electronic teaching materials in different educational contexts. Project Based Learning (PjBL), Blended Learning, Problem Based Learning (PBL), Inquiry, and Discover are some of the innovative learning models used in science education to enhance 21st century skills. Ethnoscience and Socio Scientific Issues (SSI) are two methods. Furthermore, the availability of electronic teaching resources has created an environment in which a variety of learning objectives, including autonomous learning,

learning at any time and from any location, learning based on interests, and learning to identify the traits of individual students, can be met.

References

Afikah, Adilah, Sri Rejeki, Dwi Astuti, Suyanta Suyanta, Jumadi Jumadi, & Eli Rohaeti. (2022). Mobile Learning in Science Education to Improve Higher-Order Thinking Skills (HOTS) and Communication Skills: A Systematic Review. IJACSA) International Journal of Advanced Computer Science and Applications 13(7). doi:10.14569/IJACSA.2022.0130782.

*Agustina, A, YS Rahayu, & Y Yuliani. (2021). The Effectiveness of SW (Student Worksheets) Based on STEM (Science, Technology, Engineering, Mathematics) to Train Students' Creative Thinking Skills. EJ (Science Education Journal) 5: 1. doi:10.21070/sej.v5i1.1346.

Alsaleh. (2020). Teaching Critical Thinking Skills: Literature Review. Turkish Online Journal of Educational Technology-TOJET 19(1): 21–39.

*Akhlis, I., & Dewi, N. R. (2019). Pengembangan perangkat pembelajaran science berorientasi cultural deviance solution berbasis inkuiri menggunakan ICT untuk mengembangkan karakter peserta didik. Jurnal Pendidikan IPA Indonesia, 3(1). https://doi.org/10.15294/jpii.v3i1.2905.

Anazifa, R. D., & Djukri. (2017). Project- Based Learning and Problem-Based Learning: Are They Effective to Improve Student's Thinking Skills? Jurnal Pendidikan IPA Indonesia 6(2): 346–55. doi:10.15294/JPII.V6I2.11100.

Ariani. (2020). Analysis of Students' Critical Thinking Skills in Physics Problems. Kasuari*:* Physics Education Journal (KPEJ) 3(1): 1–17. https://doi.org/10.37891/kpej.v3i1.119.

*Asi, Maolina, Amin Retnoningsih, & Andin Irsadi. (2021). Effectiveness of Interactive E-Book Global Warming and Climate Change Integrated Socio Scientific Issues Peat Ecosystem. Jurnal Penelitian Pendidikan IPA 7(SpecialIssue): 240–44. doi:10.29303/jppipa.v7ispecialissue.1039.

*Atwood-Blaine, Dana, Audrey C. Rule, & Jordan Walker. (2019). Creative Self-Efficacy of Children Aged 9-14 in a Science Center Using a Situated Mobile Game. Thinking Skills and Creativity 33: 100580. doi:10.1016/J.TSC.2019.100580.

Bayram-Jacobs, Durdane, Ineke Henze, Maria Evagorou, Yael Shwartz, Elin Leirvoll Aschim, Silvia Alcaraz-Dominguez, Mario Barajas, & Etty Dagan. (2019). Science Teachers' Pedagogical Content Knowledge Development during Enactment of Socioscientific Curriculum Materials. Journal of Research in Science *Teaching* 56(9): 1207–33. doi:10.1002/tea.21550.

Burden, Kevin, & Matthew Kearney. (2016). Conceptualising Authentic Mobile Learning. Lecture Notes in Educational Technology (9789811000256): 27–42. doi:10.1007/978-981-10-0027-0_2.

*Chang, YS, YH Chien, & KC Yu. (2017). Students' Innovative Environmental Perceptions and Creative Performances in Cloud-Based m-Learning. Computers in human behavior 63: 988–94. https://doi.org/10.1016/j.chb.2016.06.032.

*Chen, Ying Tze, Min Ju Liu, & Ying Yao Cheng. (2023). Discovering Scientific Creativity with Digital Storytelling. Journal of Creativity 33(1): 100041. doi:10.1016/J.YJOC.2022.100041.

*Defianti & Aprina. (2022). Development of E-Module Guideline on Basic Physics Practicum for Science Process Skills in a Pandemic Period. Article in Journal of Natural Science and Integration. doi:10.24014/jnsi.v5i1.15595.

*Demircioglu, T., Karakus, M., & Ucar, S. (2023). Developing students' critical thinking skills and argumentation abilities hrough augmented reality–based argumentation activities in science classes. Science & Education, 32(4), 1165-1195.

Dini, NAI, M Ikhsan, O Pamungkas, & H Kuswanto. (2024). ICT-Based Teaching Materials on Science Learning to Improve 21st-Century Skills: A Systematic Review. IJORER: International Journal of Recent Educational Research 5(5): https://doi.org/10.46245/ijorer.v5i5.679.

Ekaputri, Hardianti, & Mangaratua M Simanjorang. (2022). The Effect Of Problem-Based Learning Model on Students' Mathematical Literacy. Internasional Jurnal. 1(12): https://doi.org/10.55324/iss.v1i12.289.

*Ekici, M., & Erdem, M. (2020). Developing science process skills through mobile scientific inquiry. Thinking Skills and Creativity, 36, 100658. https://doi.org/10.1016/j.tsc.2020.100658.

Encabo-Fernández, Eduardo, Domingo Albarracín-Vivo, & Isabel Jerez-Martínez. (2023). Evaluative Research on the Critical Thinking of Primary School Students. International Journal of Educational Research Open 4: 100249. doi:10.1016/J.IJEDRO.2023.100249.

Falloon. (2024). Investigating Pedagogical, Technological and School Factors Underpinning Effective 'Critical Thinking Curricula' in K-6 Education. Thinking Skills and Creativity 51: 101447. doi:10.1016/J.TSC.2023.101447.

*Febrianti & Fitri Ayu. (2021). Pengembangan Digital Book Berbasis Flip PDF Professional Untuk Meningkatkan Kemampuan Literasi Sains Siswa. Jurnal Ilmiah Pendidikan Dasar 4(2): 102–15. doi:10.33603/.v4i2.5354.

*Gürsoy, G. (2021). Digital Storytelling: Developing 21st Century Skills in Science Education. European Journal of Educational Research, 10(1), 97-113.

*Hamka, D., & Effendi, N. (2019). Pengembangan media pembelajaran blended learning berbasis edmodo pada mata kuliah fisika dasar di program studi pendidikan IPA. Journal of Natural Science and Integration, 2(1), 19-33. http://dx.doi.org/10.24014/jnsi.v2i1.7111.

*Haspen, C. D. T., Syafriani, S., & Ramli, R. (2021). Validitas e-modul fisika SMA berbasis inkuiri terbimbing terintegrasi etnosains untuk meningkatkan kemampuan berpikir kreatif peserta didik. Jurnal Eksakta Pendidikan (Jep), 5(1), 95-101. https://doi.org/10.24036/jep/vol5-iss1/548.

Idris & Husni. (2019). Pembelajaran Model Blended Learning. Jurnal Ilmiah 5(1).

Ikhsan, M., & Kuswanto, H. (2025). What are the Misconceptions that occur to Students in Science Learning in Indonesia? A Systematic Literature Review. IJIS Edu: Indonesian Journal of Integrated Science Education, 7(1). http://dx.doi.org/10.29300/ijisedu.v7i1.4840.

Ilmi, R., I. M. Arnawa, Yerizon, & N. N. Bakar. (2021). Development of an Android-Based for Math E-Module by Using Adobe Flash Professional CS6 for Grade X Students of Senior High School. Journal of Physics: Conference Series 1742(1): 012026. doi:10.1088/1742-6596/1742/1/012026.

*Imaningtyas, CD, P Karyanto, & N Nurmiyati. (2017). Penerapan E-Module Berbasis Problem Based Learning Untuk Meningkatkan Literasi Sains Dan Mengurangi Miskonsepsi Pada Materi Ekologi Siswa Kelas x Mia 6 Sman. Bioedukasi: Jurnal Pendidikan Biologi, 9(1), *4-10*. 9(1): 4–10. https://doi.org/10.20961/bioedukasi-uns.v9i1.2004.

Jufriadi, Akhmad, Choirul Huda, Sudi Dul Aji, Hestiningtyas Yuli Pratiwi, & Hena Dian Ayu. (2022). Analisis Keterampilan Abad 21 Melalui Implementasi Kurikulum Merdeka Belajar Kampus Merdeka. Jurnal Pendidikan Dan Kebudayaan 7(1): 39–53. doi:10.24832/jpnk.v7i1.2482.

Kirana, C. (2023). Pengembangan E-Modul Berbasis Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Berpikir Kreatif Siswa Kelas VIII di SMP Negeri 1 Berbek Kabupaten Nganjuk. Universitas Negeri Sebelas Maret.

*Li, Yibo, Dongli Yang, & Siyuan Liu. (2024). The Impact of Environmental Education at Chinese Universities on College Students' Environmental Attitudes. PLoS ONE 19(2). doi:10.1371/journal.pone.0299231.

*Muzana, S. R., Lubis, S. P. W., & Wirda, W. (2021). Penggunaan simulasi phet terhadap efektifitas belajar IPA. Jurnal Dedikasi Pendidikan, 5(1), 227-236. https://doi.org/10.30601/dedikasi.v5i1.1587.

NI Syar, & Al Ibtida. (2022). The Analysis of Creativity and Misconceptions of Elementary School Student Teachers in Science Learning through the Mind Map in Virtual Classrooms. Jurnal Pendidikan Guru MIsyekhnurjati.ac.id 9: 34–54.

*Novriandami, A., Jannah, M., Arrahma, A., Randa, G., & Nasir, M. (2023). Development of microsoft power point interactive media based on visual basic for application as middle school science learning media. Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education), 11(3), 528-544. https://doi.org/10.24815/jpsi.v11i3.29927.

*Nuryantini, A. Y., & Yudhiantara, R. A. (2019). The Use of Mobile Application as a Media in Physics Learning. Jurnal Penelitian dan Pembelajaran IPA, 5(1), 72- 83. https://dx.doi.org/10.30870/jppi.v5i1.3732.

*Pujiastuti, H., & Haryadi, R. (2020). The use of augmented reality blended learning for improving understanding of food security. Jurnal Pendidikan IPA Indonesia, 9(1), 59-69.

*Rianawaty I. (2020). Pengaruh Model Pembelajaran Kreatif Produktif Terintegrasi Dengan Blog dan Facebook Terhadap Prestasi dan Motivasi Belajar Ipa Siswa Kelas VIII SMP. Jurnal Inovasi Teknologi Pendidikan 1(2): 190–98. doi:10.21831/TP.V1I2.2529.

*Sanjaya, L. A., Putri, E. A., Wibowo, F. C., & Robby, D. K. (2021). Digital Storytelling of Physics (DiSPhy): Belajar Fisika melalui Cerita. Journal of Natural Science and Integration, 4(2), 195-203.

*Schettini, Chiara, Daniela Amendola, Ido Borsini, & Rossana Galassi. (2020). A Blended Learning Approach for General Chemistry Modules Using a Moodle Platform for First Year Academic Students. Journal of e-Learning and Knowledge Society 16(2): 61–72. doi:10.20368/1971-8829/1135197.

Septajati, Agum Yuda, & Asri Widowati. (2024). Development of Science Electronic Modules with an Ethnoscience Integrated STEM Approach in Traditional Herbal Medicine Making. Journal of Educational Science and Technology (EST) 10(2): 161–70. https://doi.org/10.26858/est.v10i2.60750.

Shao, Mingming, Xiaohong Liu, Mingming Shao, & Xiaohong Liu. (2021). Impact of the Flipped Classroom on Students' Learning Performance via Meta-Analysis. Journal of Social Sciences 9(9): 82–109. doi:10.4236/JSS.2021.99007.

*Sinaga, P., & Setiawan, W. (2022). The impact of electronic interactive teaching materials (EITMs) in e-learning on junior high school students' critical thinking skills. Thinking Skills and Creativity, 46, 101066. https://doi.org/10.1016/j.tsc.2022.101066.

*Stolaki, A. (2018). The Creativity Challenge Game: An Educational Intervention for Creativity Enhancement with the Integration of Information and Communication Technologies (ICTs). Computers & Education 123: 195–211. doi:10.1016/j.compedu.2018.05.009.

Sun, Liping, Marjaana Kangas, Heli Ruokamo, & Signe Siklander. (2023). A Systematic Literature Review of Teacher Scaffolding in Game-Based Learning in Primary Education. Educational Research Review 40: 100546. doi:10.1016/J.EDUREV.2023.100546.

*Suzuki, S. N., Akimoto, Y., Suzuki, K., Okada, A., Hirata, K., Kato, T., & Yoshikawa, F. (2020). Development of A-txt system compatible introductory teaching materials for Electric Power Engineering using gaming simulation. Procedia Computer Science, 176, 1557-1566. https://doi.org/10.1016/j.procs.2020.09.167.

Terras, Melody M., & Judith Ramsay. (2019). The Five Central Psychological Challenges Facing Effective Mobile Learning. British Journal of Educational Technology 43(5): 820–32. doi:10.1111/J.1467-8535.2012.01362.X.

*Ulfa, Efrika Marsya, Sri Wahyuni, & Zainur Rasyid Ridlo. (2023). Development of E-Module-Based PjBL to Develop Computational Thinking Skills Integrategration with CCR Implementation in Science Education. JPPS (Jurnal Penelitian Pendidikan Sains) 12(2): 176–91. doi:10.26740/JPPS.V12N2.P176-191.

*Wahyuni, S., Erman, E., Sudikan, S., & Jatmiko, B. (2020). Edmodo-based interactive teaching materials as an alternative media for science learning to improve critical thinking

skills of junior high school students. Learn Teach Lib. 1(2) https://doi.org/10.3991/ijim.v14i09.13041.

*Wardaya, Puji, Nila Kurniasih, & Isnaeni Maryam. (2019). Peningkatan Kreativitas dan Pemaham Konsep Siswa Melalui Model Pembelajaran Berbasis ICT Berbantuan Software Geogebra pada Materi Segiempat. Ekuivalen-Pendidikan Matematika 11(1).

*Yilmaz, O. (2021). Augmented Reality in Science Education: An Application in Higher Education. Shanlax International Journal of Education, 9(3), 136-148. https://doi.org/10.34293/education.v9i3.3907.

*Yuda, I. G. N. H., Suma, K., Candiasa, I. M., & Kom, M. I. (2017). Pengembangan e-learning fisika dalam bentuk website berorientasi sains teknologi masyarakat untuk meningkatkan penguasaan konsep dan kreativitas siswa kelas XI IPA. Jurnal Pendidikan dan Pembelajaran IPA Indonesia, 4(2).

*Yusup, D., Situmorang, R. P., & Tapilouw, M. C. (2022). The Development of Animated Media Based on Project-Based Learning to Cultivate Problem Solving Skills in Fungi Topic. 7(1).

Zhang, J., H. Chen, X. Wang, X. Huang, & D. Xie. (2024). Application of Flipped Classroom Teaching Method Based on ADDIE Concept in Clinical Teaching for Neurology Residents. *BMC Medical Education* 24(1). doi:10.1186/s12909-024-05343-z.

*Zulherman, Z., Amirulloh, G., Purnomo, A., Aji, G. B., & Supriansyah, S. (2021). Development of android-based millealab virtual reality media in natural science learning. Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education), 9(1), 1-10. https://doi.org/10.24815/jpsi.v9i1.18218.