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ORIGINAL RESEARCH

Developing an interactive scratch-based learning media to enhance students' understanding of basic gravity concepts

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Abstract

This study aims to develop a 3D Scratch-based physics learning media to enhance student learning outcomes in basic gravity concepts. Traditional learning methods often limit student engagement and hinder the development of essential skills. By incorporating interactive simulations and animations, Scratch-based media can provide a more dynamic and engaging learning experience. The 4D development model was employed to design and develop the media, focusing on aspects such as visual clarity, accessibility, and language appropriateness. A panel of experts, comprising a physics education lecturer and three prospective physics teachers, validated the media. The results indicated that the developed media achieved a very high level of feasibility, with an average score exceeding 81%. This research suggests that the integration of Scratch-based learning media can significantly improve student learning outcomes in physics, particularly around basic gravity. The interactive nature of the media, coupled with its inclusion of exercises and discussion questions, fosters active learning and enhances comprehension.

Keywords: Basic Gravity · Physics Learning Media · Scratch

INTRODUCTION

Education is essential for individuals to develop the knowledge and skills necessary to adapt to societal changes and contribute to national progress (Sudarsana, 2016). The accelerated pace of educational development demands that students acquire robust process skills, especially in the realm of science, to equip them to confront global challenges (Jatmika et al., 2020). Most students lack proficient scientific process skills (Siswanto et al., 2017). This is because students are not actively involved in the learning process.

Traditional teaching methods often hinder the development of students' scientific process skills by limiting their active involvement in the learning process. Teachers may not encourage students to ask questions, design experiments, or explore concepts independently. As a result, students become passive learners, relying solely on teacher-led explanations. This approach can stifle creativity, critical thinking, and problem-solving skills, which are essential for scientific inquiry (Yuniati, 2017). Additionally, many teachers struggle to effectively impart fundamental scientific process skills to their students (Wahyuni et al., 2018). Consequently, students may fail to develop these essential skills, leading to suboptimal learning outcomes.

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Scientific knowledge, including physics, is essential for developing students' understanding of the world. However, abstract concepts such as gravity can be challenging for students to grasp. According to Edgar Dale's Cone of Experience, learning is most effective when it involves multiple senses (Jackson, 2016). Traditional teaching methods, which often rely heavily on verbal explanations, can limit students' understanding. To address this, educators can utilize learning media to provide more concrete and engaging representations of abstract concepts. By incorporating visual aids and interactive elements, learning media can help students develop a deeper understanding of gravity and other complex topics (Sanjaya, 2016).

Effective learning media can significantly enhance students' understanding of complex concepts and improve overall learning outcomes. Research suggests that visual learning plays a crucial role in information retention. By engaging multiple senses, including sight and hearing, learning media can create more immersive and memorable learning experiences. However, traditional learning methods often rely heavily on text-based materials and lectures, which may not fully capitalize on the potential of visual and auditory learning (Hatika, 2016). To address this limitation, the development of innovative learning media, such as 3D application-based tools, has gained significant attention. 3D application-based learning media offers a promising approach to enhance student engagement and learning. By providing interactive and visually stimulating experiences, these tools can make learning more enjoyable and effective.

The 3D application-based learning media can significantly enhance student engagement by providing interactive and visually appealing learning experiences. Such media is often user-friendly and accessible, making it easy for students to explore and learn at their own pace (Astriani, 2018). Despite their numerous advantages, certain 3D applications present significant challenges such as VR and AR. These include substantial financial investments in VR-related equipment, necessitating the acquisition of professional hardware and software for the development of effective educational stations utilizing VR technology. Furthermore, the creation of a comprehensive virtual environment demands considerable effort, requiring the meticulous design and implementation of numerous test scenarios and intricate details (Paszkiewicz et al., 2021). Augmented Reality (AR) is subject to certain limitations, including the demand for advanced technological skills, considerable hardware resource consumption, and the constraint of inflexible platforms (Gómez-Rios et al., 2023). It is therefore imperative to explore alternative 3D application media that exhibit both economic viability and ease of implementation within the educational context.

One popular example of a 3D application-based learning tool is Scratch. It is the most widely adopted programming language in educational settings due to its versatility, catering to learners from early childhood to advanced levels of study (Pérez-Jorge, 2022). Scratch provides an accessible platform for individuals with limited programming knowledge to engage with computational concepts (Herawati et al., 2024). Therefore, we choose 3D application scratch as an alternative to web simulation-based learning.

Scratch is a visual, block-based programming platform designed to be both educational and engaging. It offers a comprehensive library of pre-built programs that can be adapted and extended (Ouahbi et al., 2022). This innovative programming language empowers students to create interactive stories, animations, games, and other digital projects (Laily & Mulyani,

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2022). By engaging in these creative activities, students develop essential skills such as computational thinking, problem-solving, and collaboration. Additionally, Scratch can familiarize students with new media technologies and promote active learning. Through hands-on experiences, students can acquire knowledge and skills more effectively than through traditional, passive learning methods.

Students can develop a deeper understanding of the subject matter by utilizing interactive and engaging learning media. Scratch offers a user-friendly platform that facilitates the acquisition of programming fundamentals, including algorithms and core concepts, for students within the school-aged demographic. This fosters an enhanced interest in programming while simultaneously cultivating creativity and problem-solving abilities (Sulaymonova & Bo'riyev, 2024). This approach fosters effective communication between teachers and students, enhancing the overall learning experience (Nabila et al., 2021). Furthermore, the use of multimedia can stimulate students' cognitive and emotional engagement, leading to improved learning outcomes (Nurfadhilah et al., 2021). Consequently, the utilization of scratch as a 3D application proves to be highly advantageous for students within the educational context.

The concept of "gamification" has gained significant attention in recent years as a promising approach to enhance student engagement and motivation. By incorporating game-like elements into the learning process, educators can create more interactive and stimulating experiences. 3D application-based learning media, such as Scratch, offer a powerful platform for gamifying education. By allowing students to create interactive simulations, animations, and games, Scratch can foster creativity, problem-solving skills, and a deeper understanding of complex concepts. This study aims to investigate the feasibility of using a 3D Scratch-based physics learning media to enhance student learning outcomes in basic gravity concepts. By leveraging the interactive and engaging nature of Scratch, this research seeks to explore the potential of gamified learning to improve student achievement and motivation.

METHOD

This research employs a Research and Development (R&D) methodology to develop a learning media focused on basic gravity concepts. This approach allows for a deeper understanding of the learning media's effectiveness by analyzing both its process and outcomes. The 4D development model (Define, Design, Develop, and Disseminate) was used to guide the research process. The initial phase, Define, involved a thorough literature review to identify existing challenges in science education, particularly in the area of scientific process skills and the teaching of gravity concepts such as definition of gravity, discoverer of the concept of gravity, universal law of gravity, gravitational force, gravitational potential energy, and the application of gravity. Based on this analysis, the research problem was formulated: to develop a 3D Scratch-based learning media to enhance student understanding of basic gravity concepts. The Design phase focused on creating the learning media. This involved developing assessment instruments, designing learning materials, and creating visual representations using tools such as Microsoft Word and Canva. The media was designed to be interactive and engaging, incorporating game-like elements to motivate students. The final phase, Development, involved validating the learning media through expert reviews and pilot testing as shown in Table 1.

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Table 1. Validating assessment

Aspect	Indicator
Fill	Completeness of learning media identity
	Appropriateness of the proportion of learning media layout
	Appropriateness of the color proportion of learning media
	Appropriateness of the selection of learning media background
	Suitability of the choice of letters of the Learning media
	Suitability of the choice of letters of the Learning media
Construction	Ease of access
	Creativity and innovation
	Media development opportunities for the development of science and technology
	Conformity with physics concepts
Language	The structure of the language is easy to understand
	Effective and unambiguous sentences
	Communicative language
	Spelling used according to EYD
	The terms used have the appropriate meaning.

The product validation was conducted by a panel of four reviewers comprising one physics education lecturer and three prospective physics teachers. Theye evaluated the media's content, construction, and language. This feedback was used to refine the media and ensure its suitability for classroom use. This study employs a validation sheet to assess the quality of the developed learning tools. The validation process involves a panel of experts who provide ratings and feedback on various aspects of the media. This study employed the Successive Interval Method (MSI) to analyze interval data. To facilitate qualitative analysis, the interval data, measured on a 4-point Likert scale, was converted into qualitative categories using a modified version of Mardapi's conversion formula (Mardapi, 2017). The inclusion criteria for the study were based on the feasibility test results provided by the respondents. Table 2 presents the assessment scores for the feasibility of the learning media.

Table 2. Criteria of validation

Quantitative Score Interval	Criteria
$X \geq M_i + 2.5SB_i$	Very decent
$M_i \leq X < M_i + 2.5SB_i$	Decent
$M_i - 2.5SB_i \leq X < M_i$	Less Decent
$X < M_i - 2.5SB_i$	Not Worth it

Information : $X = Average\ score\ of\ each\ aspect$; $M_i = ideal\ average\ = \frac{1}{2}(ideal\ max\ score\ + ideal\ min\ score)$ $SB_i = Ideal\ Standard\ Score\ = \frac{1}{6}(ideal\ max\ score - ideal\ min\ score)$

The calculation process yielded the assessment criteria for the assessment instrument, as presented in Table 3.

Table 3. Eligibility Score

Quantitative Score Interval	Criteria
$X \geq 81\%$	Very decent
$63\% \leq X < 81\%$	Decent
$44\% \leq X < 63\%$	Less Decent
$X < 44\%$	Not Worth it

The dissemination phase involves the publication of research findings in reputable, Sinta-accredited journals. By sharing the results of this study, the researcher aims to contribute to the

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advancement of knowledge in the field of physics education, specifically in the development of innovative learning media.

RESULT AND DISCUSSION

This study employs a Research and Development (R&D) methodology to develop and evaluate a 3D Scratch-based physics learning media focused on basic gravity concepts. The goal is to assess the feasibility of this media in enhancing student learning outcomes. The research process is guided by the 4D development model, comprising four stages: Define, Design, Develop, and Disseminate. The initial phase of the research involved a comprehensive literature review. This review identified several challenges in science education, including the low development of scientific process skills among students. These skills, such as observation, hypothesis formulation, experimentation, data analysis, and critical thinking, are essential for effective scientific inquiry. Additionally, the study found that traditional teaching methods often lack the necessary engagement to motivate students and stimulate their interest in learning.

Figure 1. (a-c) Scratch for Basic gravity concept

The integration of block-based programming environments, such as Scratch, into education has become increasingly prevalent (Batni et al., 2024). The development of 3D Scratch-based physics learning media aligns with previous research (Pratiwi et al., 2023), which highlighted the practicality of such media as a valuable tool for enhancing student learning. Students can effectively learn and apply core programming logic principles through the utilization of the Scratch environment (Cárdenas-Cobo et al., 2021). Design-based activities integrated with coding tools using Scratch, can effectively facilitate the development of problem-solving skills

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among students (Erol & Çırak, 2022). Improving student learning outcomes is a fundamental goal in education, as it contributes to the development of well-rounded and knowledgeable individuals. The initial phase of the design process involved the identification of the necessary tools and materials for creating the learning media. The outcomes of this stage included the development of learning drafts, sketches, and assessment instruments. The following image illustrates the design of the 3D Scratch-based physics learning media.

The 3D Scratch-based physics learning media, designed to teach basic gravity concepts, leverages visual elements that can be accessed individually or collaboratively. This interactive approach encourages students to engage with the material, fostering interaction with peers and teachers. As noted by (Astriani, 2018), the use of such media enhances communication and interaction between students and teachers, thereby improving the overall learning experience. Additionally, the media simplifies complex gravity concepts, making them more accessible to students.

The subsequent stage of the research involved the development and evaluation of the 3D Scratch-based physics learning media. A feasibility test was conducted with four experts to assess the media's content, design, and functionality. The Successive Interval Method (MSI) was employed to analyse the experts' ratings. To be categorized as highly feasible, the media had to achieve an average score of 81% or higher in each aspect. The Figure 2 presents the results of the feasibility test.

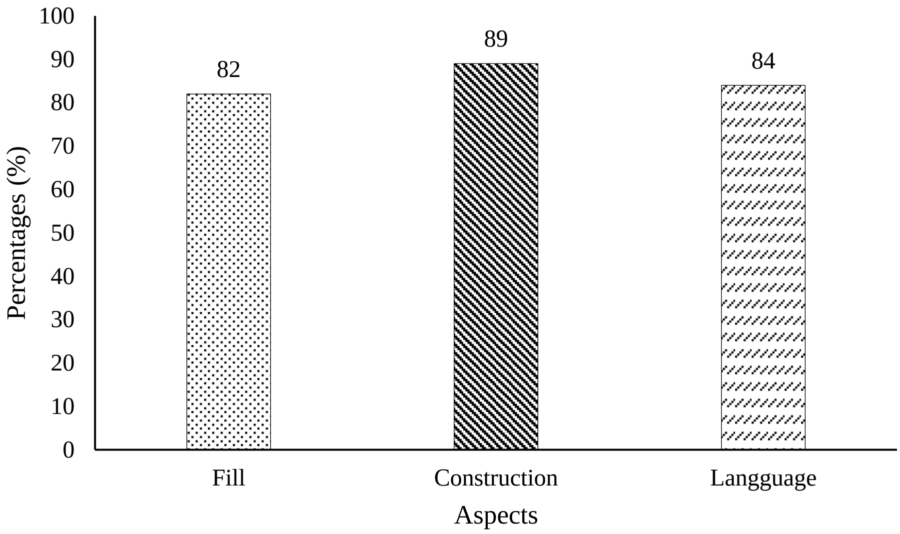

Figure 2. Expert Score for Review Product

Overall, the evaluation results indicate that the 3D Scratch-based physics learning media is highly feasible for teaching gravity concepts. The media received an average score of over 81% across all three evaluation criteria, demonstrating its potential to enhance student learning. While the content aspect received the lowest score, it still fell within the "very feasible" category. Validators provided suggestions for improvement, such as expanding on certain topics and initially hiding some variables. The use of effective learning media can significantly impact student learning by stimulating interest, motivation, and engagement. As noted by (Sri,

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2008), learning media can evoke new desires, interests, and psychological influences on students, ultimately leading to improved learning outcomes.

The final stage of the research involves the dissemination of the findings through publication in a peer-reviewed journal or international conference. This dissemination aims to share the latest research findings and contribute to the advancement of physics education by providing insights into the development and effectiveness of 3D Scratch-based learning media. Based on the evaluation provided by experts, the 3D Scratch-based learning media was deemed highly feasible, albeit with a few suggested revisions. To further validate the effectiveness of the media, additional research is necessary to conduct comprehensive testing with students. Additionally, exploring the potential application of the media in teaching other scientific concepts is a promising avenue for future research.

From 2012 to 2020, the Scratch program has seen progressive advancement within the educational science discipline (Dúo-Terrón, 2023). It is suggested that younger individuals utilize Scratch to cultivate critical thinking skills and devise solutions for global challenges such as climate change, conflict, and pandemics. This platform empowers them to evaluate multiple solutions and select the most appropriate course of action (Alp & Bulunuz, 2023). The Scratch application proved effective as an online platform for facilitating science education and promoting the application of scientific principles to real-world contexts (Satria & Sopandi, 2022). Scratch activities were effective in fostering computational and creative thinking skills among students and can enhance students' higher-order cognitive abilities (Cırıt & Aydemir, 2023). It is recommended that Scratch be integrated into mathematics and science education (Iyamuremye et al., 2022; Koray & Bilgin, 2023).

Recent research in this field has demonstrated the positive impact of using Scratch on students' academic performance, making it a suitable tool for subject-matter education (Choi & Hong, 2015). Because Scratch provides a platform for the design and implementation of interactive media (Jatiningsih & Dewi, 2022). Scratch programming components that students can interact with and activities that promote the development thinking skill (Fagerlund et al., 2021). Scratch can serve as an effective pedagogical tool in higher education, particularly for students with no prior programming background, due to its engaging nature and ease of use (Campbell & Atagana, 2022).

Scratch also gives positive impact for educator. Teachers surveyed expressed positive views on the use of Scratch: (1) Pedagogical Value: Teachers perceive Scratch as an effective tool for introducing programming concepts within the Moroccan educational context. (2) Collaborative Learning: A preference for group-based Scratch instruction was indicated by the teachers. (3) Interdisciplinary Applications: Teachers expressed interest in utilizing Scratch to create content for other subjects, demonstrating its potential for cross-curricular integration. (4) Teacher Confidence: Teachers reported feeling comfortable with teaching Scratch, suggesting a positive perception of its accessibility and ease of use. (5) Student Engagement: Teachers recommended Scratch as a suitable tool for introducing programming fundamentals to students, implying its potential to engage learners. (6) Peer Recommendation: Teachers noted that their colleagues also endorsed the use of Scratch in the classroom, highlighting its growing acceptance among the teaching community. Additionally, a notable finding emerged regarding the potential impact of Scratch on broader learning outcomes. Participants indicated that learning Scratch may positively influence the acquisition of knowledge and skills in other

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subjects (Binaoui et al., 2022). Scratch users frequently create projects with code that exhibits "code smells," such as duplicated code blocks and excessively long scripts, which can hinder their ability to comprehend and troubleshoot their projects (P. Rose et al., 2020).

CONCLUSION

Based on the findings of this research, the 3D Scratch-based physics learning media for basic gravity concepts is deemed highly feasible, with minor revisions recommended. This conclusion is supported by the validator's assessments, which indicate an average score of over 81% across all aspects. To further evaluate the effectiveness of this media, it is recommended to conduct a comprehensive study involving a larger sample of students.

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REFERENCES

Alp, G., & Bulunuz, N. (2023). Effect of Web-Based Collaborative Learning Method with Scratch on Critical Thinking Skills of 5th Grade Students. *Participatory Educational Research, 10*(2). https://doi.org/10.17275/per.23.30.10.2

Astriani, S. A. (2018). *Prinsip dan Kriteria Pemilihan Media Pembelajaran*. Universitas Nurul Jadid.

Batni, B., Junaini, S. N., Sidi, J., Mustafa, W. A., & Awang Ismail, Z. I. (2024). Current Research Trends of Scratch Block based Programming for K-12: A Systematic Review. *Journal of Advanced Research in Applied Sciences and Engineering Technology, 51*(2), 138–152. https://doi.org/10.37934/araset.51.2.138152

Binaoui, A., Moubtassime, M., & Belfakir, L. (2022). The Effectiveness and Impact of Teaching Coding through Scratch on Moroccan Pupils' Competencies. *International Journal of Modern Education and Computer Science, 14*(5). https://doi.org/10.5815/ijmecs.2022.05.05

Campbell, O. O., & Atagana, H. I. (2022). Impact of a Scratch programming intervention on student engagement in a Nigerian polytechnic first-year class: verdict from the observers. *Heliyon, 8*(3). https://doi.org/10.1016/j.heliyon.2022.e09191

Cárdenas-Cobo, J., Puris, A., Novoa-Hernández, P., Parra-Jiménez, Á., Moreno-León, J., & Benavides, D. (2021). Using scratch to improve learning programming in college students: A positive experience from a non-weird country. *Electronics (Switzerland), 10*(10). https://doi.org/10.3390/electronics10101180

Choi, Y., & Hong, S.-H. (2015). Effects of STEAM Lessons Using Scratch Programming Regarding Small Organisms in Elementary Science-Gifted Education. *Journal of Korean Elementary Science Education, 34*(2). https://doi.org/10.15267/keses.2015.34.2.194

Cırıt, D. K., & Aydemir, S. (2023). Online scratch activities during the COVID-19 pandemic: Computational and creative thinking. *International Journal of Evaluation and Research in Education, 12*(4). https://doi.org/10.11591/ijere.v12i4.24938

Dúo-Terrón, P. (2023). Analysis of Scratch Software in Scientific Production for 20 Years: Programming in Education to Develop Computational Thinking and STEAM Disciplines. *Education Sciences, 13*(4). https://doi.org/10.3390/educsci13040404

Erol, O., & Çırak, N. S. (2022). The effect of a programming tool scratch on the problem-solving skills of middle school students. *Education and Information Technologies, 27*(3), 4065–4086. https://doi.org/10.1007/s10639-021-10776-w

Fagerlund, J., Häkkinen, P., Vesisenaho, M., & Viiri, J. (2021). Computational thinking in programming with Scratch in primary schools: A systematic review. *Computer Applications in Engineering Education, 29*(1). https://doi.org/10.1002/cae.22255

Gómez-Rios, M. D., Paredes-Velasco, M., Hernández-Beleño, R. D., & Fuentes-Pinargote, J. A. (2023). Analysis of emotions in the use of augmented reality technologies in education: A systematic review. *Computer Applications in Engineering Education, 31*(1). https://doi.org/10.1002/cae.22593

Hatika, R. G. (2016). Peningkatan hasil belajar fisika dengan menerapkan model pembelajaran advance organizer berbantu animasi komputer. *Jurnal Pendidikan Fisika Indonesia, 12*(2), 13–117. https://doi.org/10.15294/jpfi.v12i2.5210

Herawati, N. I., Kuswanto, H., Wahyuni, M., & Aristaria, A. (2024). Scratch-Assisted Computational Thinking in Physics: A Literature Review. *JIPF (Jurnal Ilmu Pendidikan Fisika), 9*(1). https://doi.org/10.26737/jipf.v9i1.4696

Iyamuremye, A., Nsabayezu, E., & Habimana, J. C. (2022). Secondary school teacher's conception and reflection of computer programming with Scratch. *Discover Education, 1*(1). https://doi.org/10.1007/s44217-022-00006-x

Jackson, J. (2016). Myths of Active Learning: Edgar Dale and the Cone of Experience. *HAPS Educator, 20*(2), 51–53. https://doi.org/10.21692/haps.2016.007

Jatiningsih, N. A. L. B., & Dewi, N. R. (2022). Development of e-Comic Science Interactive Learning with Scratch (eCILS) Based on Problem Based Learning to Train Critical Thinking Skills for Junior High School Students. *Unnes Science Education Journal, 11*(2). https://doi.org/10.15294/usej.v11i2.56448

Jatmika, S., Lestari, S., Rahmatullah, R., Pujianto, P., & Dwandaru, W. S. B. (2020). Integrasi Project Based Learning dalam Science Technology Engineering and Mathematics untuk Meningkatkan Keterampilan Proses Sains dalam Pembelajaran Fisika. *Jurnal Pendidikan Fisika Dan Keilmuan (JPFK), 6*(2), 107. https://doi.org/10.25273/jpfk.v6i2.8688

Koray, A., & Bilgin, E. (2023). The Effect of Block Coding (Scratch) Activities Integrated into the 5E Learning Model in Science Teaching on Students' Computational Thinking Skills and Programming Self-Efficacy. *Science Insights Education Frontiers, 18*(1). https://doi.org/10.15354/sief.23.or410

Laily, S. J., & Mulyani. (2022). Pengembangan Media Quizland Berbasis Scratch Games Pada Pembelajaran Tematik Subtema Aku dan Cita-Citaku Kelas IV Sekolah Dasar. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar, 10*(6).

Mardapi, D. (2017). *Pengukuran penilaian dan evaluasi pendidikan*. Yogyakarta: Nuha Medika

Nabila, S., Adha, I., & Febriandi, R. (2021). Pengembangan Media Pembelajaran Pop Up Book Berbasis Kearifan Lokal pada Pembelajaran Tematik di Sekolah Dasar. *Jurnal Basicedu, 5*(5), 3928–3939. https://doi.org/10.31004/basicedu.v5i5.1475

Nurfadhilah, S., Hidayati, N., Effendi, H., Sabila, R., Umroh, S., & Tangerang, U. M. (2021). Pengembangan media audio visual pembelajaran matematika di era pandemi covid-19 di SDN Pangakalan 4. *Jurnal Pendidikan dan Ilmu Sosial, 3*(1).

Ouahbi, I., Darhmaoui, H., & Kaddari, F. (2022). Visual Block-based Programming for ICT Training of Prospective Teachers in Morocco. *International Journal of Modern Education and Computer Science, 14*(1). https://doi.org/10.5815/ijmecs.2022.01.05

Paszkiewicz, A., Salach, M., Dymora, P., Bolanowski, M., Budzik, G., & Kubiak, P. (2021). Methodology of implementing virtual reality in education for industry 4.0. *Sustainability (Switzerland), 13*(9). https://doi.org/10.3390/su13095049

Pérez-Jorge, D. (2022). Gamification with Scratch or App Inventor in Higher Education: A Systematic Review. *Future Internet, 14*(12). https://doi.org/10.3390/fi14120374

Pratiwi, I. A., Afisa, Z. R., & Fajrie, N. (2023). Analisis Kebutuhan Media Komik Edukasi Berbasis Kearifan Lokal Kota Pati untuk Meningkatkan Hasil Belajar Kognitif Siswa Kelas V. *Jurnal Basicedu, 7*(3), 1592–1600. https://doi.org/10.31004/basicedu.v7i3.5573

https://doi.org/10.17509/wapfi.v10i1.77260

Rose, S., Habgood, M. P. J., & Jay, T. (2020). Designing a Programming Game to Improve Children's Procedural Abstraction Skills in Scratch. *Journal of Educational Computing Research, 58*(7). https://doi.org/10.1177/0735633120932871

Sanjaya, W. (2016). *Media komunikasi pembelajaran.* PrenadaMedia.

Satria, E., & Sopandi, W. (2022). Creating Science Online Learning Media Using Scratch App Block Programming. *KnE Social Sciences*. https://doi.org/10.18502/kss.v7i6.10639

Siswanto, S., Yusiran, Y., & Fajarudin, M. F. (2017). Keterampilan proses sains dan kemandirian belajar siswa: profil dan setting pembelajaran untuk melatihkannya. *Gravity: Jurnal Ilmiah Penelitian Dan Pembelajaran Fisika, 2*(2), 190–202.

Sri, A. (2008). *Media pembelajaran*. Surakarta: UNS.

Sudarsana, I. K. (2016). Peningkatan mutu pendidikan luar sekolah dalam upayapembangunan sumber daya manusiA. *Jurnal Penjaminan Mutu, 1*(1), 1. https://doi.org/10.25078/jpm.v1i1.34

Sulaymonova, D. B., & Bo'riyev, F. F. (2024). Advantage of Scratch In Improving Students' Programming Competence. *Models And Methods For Increasing The Efficiency Of Innovative Research, 3*(35), 253–255.

Wahyuni, S., Kosim, K., & Gunawan, G. (2018). Pengembangan Perangkat Pembelajaran Fisika Berbasis Inkuiri Terbimbing Berbantuan Eksperimen Untuk Meningkatkan Penguasaan Konsep Siswa. *Jurnal Pendidikan Fisika Dan Teknologi, 4*(2). https://doi.org/10.29303/jpft.v4i2.891

Yuniati, D. (2017). *Analisis Keterampilan Proses Sains Siswa Terhadap Model Project Based Learning Pada Materi Koloid* [Thesis]. UINJakarta.

https://doi.org/10.17509/wapfi.v10i1.77260