International Journal of STEM Education for Sustainability, Vol.6, No.2, 2026, pp. 213-226
e-ISSN 2798-5091. DOI. 10.52889/ijses.v6i2.673

The Effect of Android-Based Educational Games on Students' Cognitive Learning Outcomes in the Electrical Engineering Fundamentals Subject

Submitted 29 May 2025, Revised 12 May 2026, Accepted 12 May 2026

Selpi Amanda Fadillah[1*], Siswo Wardoyo[2], Suhendar Suhendar[3]

[1,2,3]Department of Engineering Vocational Education, Postgraduate Program,
Universitas Sultan Ageng Tirtayasa, Serang, Indonesia
Corresponding Email : *2283210033@untirta.ac.id

Abstract

The purpose of this study was to ascertain how using educational games based on Android affected students' learning results in the Electrical Engineering Fundamentals course, particularly with regard to fundamental cable connection procedures. This study included a nonequivalent control group design, a quasi-experimental method, and a quantitative methodology. 62 10th graders enrolled in a Vocational High School in Banten, Indonesia's Electrical Power Installation Engineering (TITL) program served as the subjects; 30 of them were in the control group and 32 were in the experimental group. Tests (pretest and posttest) and questionnaires were utilized as data collection methods. The research tool was tested for validity and reliability, and the results showed that it was suitable for usage. The average pretest and posttest scores rose from 55.00 to 74.00 in the control class and from 47.19 to 77.50 in the experimental class, according to the data. With a significance threshold of 0.000 <0.05, the paired sample t-test revealed a calculated t-value of -14.827 for the control class and -18.735 for the experimental class, showing a substantial improvement in learning outcomes following the treatment. An average score of 0.89, classified as appropriate, was obtained through validation by media and material specialists. Therefore, it can be concluded that the use of Android-based educational games is effective and has a significant impact on improving student learning outcomes compared to conventional learning methods.

Keywords: Educational games, Android, Learning outcomes, Electricity, Quasi-experiment

INTRODUCTION

Improving student learning outcomes is one of the main indicators of a successful learning process, particularly in the context of vocational education, which focuses on mastering knowledge, skills, and work attitudes. In vocational high schools, the learning process requires not only understanding theoretical concepts but also developing application skills relevant to the needs of the workplace. However, in practice, teaching vocational subjects, particularly Fundamentals of Electrical Engineering, still faces various challenges that impact student learning outcomes (Endrayani et al., 2023; Liao et al., 2023; Tsai et al., 2022)

Based on initial observations at a Vocational High School in Banten, Indonesia it was found that most students experienced difficulty understanding technical and abstract material, such as basic cable connection procedures. This is reflected in the suboptimal learning outcomes, with some students failing to meet the Minimum Completion Criteria. This situation is caused by the use of learning media that is still dominated by conventional methods, such as lectures and one-way explanations, which are less able to provide interactive and contextual learning experiences. This support by research conducted by Sapitri & Suriani (2025), which state that conventional methods in learning are ineffective without the support

of interactive media, as interactive approaches are strictly required to visualize abstract concepts and improve student outcomes.

This problem indicates a gap between the needs of vocational learning, which demands practice and visualization, and the learning methods used in the classroom. In the context of 21st-century learning, students are required to have critical and creative thinking skills and adapt to technological developments (Gunartha et al., 2024 ; Chusna et al., 2024) . Therefore, innovative learning media are needed that not only deliver material but also increase student active engagement in the learning process (Faiza & Wardhani, 2024).

Along with the development of digital technology, the use of mobile learning-based learning media has become a relevant solution to improve the quality of learning (Kurnia et al., 2024). Android-based learning media allows students to learn flexibly , interactively, and independently, without being limited by space and time. One form of implementation of this media is educational games, which integrate game elements with learning materials to increase student motivation and engagement (Nawawi et al., 2026; Kurniawati et al., 2025).

Educational games have the advantage of presenting material visually and interactively, while providing direct feedback to users. This allows students to learn through direct experience (learning by doing), thus deepening conceptual understanding (Putri & Trisnawati, 2024). Previous research has shown that the use of educational games can significantly improve student motivation and learning outcomes by creating a fun and engaging learning environment (Rahmawati et al., 2025 ; Kurniawati et al., 2025).

In its development, the MIT App Inventor platform can be used as a medium for designing Android-based educational games easily and efficiently. This platform enables the development of interactive learning applications without requiring complex programming skills, making it more adaptable to the needs of teachers and students in vocational high schools (Edrianti et al., 2021).

This is still an area that needs to be explored especially on the impact of using educational games in electrical engineering lessons at vocational institutions due to the fact that many studies have proven their usefulness in improving learning outcomes. There is also a lack of empirical evidence on the effect of the use of Android based educational games on the learning outcome of students in the cable connection topic. Therefore, this research will play a very important role in assessing the effectiveness of the use of educational games as innovative learning technique to improve the learning outcomes of students. In this case, this study will assess the effects of the use of Android based educational games on the learning

outcomes of students taking Fundamentals of Electrical Engineering subject at a Vocational High School in Banten, Indonesia.

METHOD

As indicated in Table 1, this study employed a nonequivalent control group design and a quantitative approach with a quasi-experimental research methodology.

Table 1. Pretest and Posttest Research Design

Grup	Pretest	Treatment	Posttest
Experiment	0_1	X	0_2
Control	0_3	-	0_4

The experimental class' pretest score before treatment was 01. The treatment, symbolized by X, represented an educational game. After the treatment, the posttest score changed to 02. The control class' pretest and posttest scores were not treated with any treatment but instead used conventional learning.

Research Sample

This study used 10th-grade students at a Vocational High School in Banten, Indonesia, divided into two classes. The sampling technique used purposive sampling with an intact group sampling approach, as the researchers used pre-formed classes without randomizing individual students. Class selection was based on the characteristics and academic conditions of each class. Based on the midterm assessment data for the odd semester, the research sample consisted of 30 students from class X TITL-1 as the control class and 32 students from class X TITL-2 as the experimental class.

Research Instruments

a. Validity Test

Validity is the degree of accuracy of an instrument in measuring what it is supposed to measure, demonstrated through empirical evidence and a theoretical basis for interpreting the resulting scores (Azwar, 2021). Validity testing in this study was conducted on each statement item using the Statistical Package for Social Sciences (SPSS) version 25 software. The validity test involved 31 students as respondents in the instrument trial.

Based on the sample size, the estimated r value was compared with the table r at a 5% significance level ($\alpha = 0.05$) using Pearson product-moment correlation. The item is considered legitimate if the computed r value is greater than the table r value; if it is less than the table r value, it is considered invalid (Sugiyono, 2022).

Based on the validity test results for the 25-item questionnaire, 5 items were found to be invalid and 20 items were declared valid. Similarly, for the pretest and posttest instruments, of

the 25 items tested, 5 were invalid and 20 were declared valid. Therefore, only valid items were used in the research data collection.

b. Discriminatory Power Test

The discriminatory power of an item is the ability of an item to differentiate between students with high and low abilities. The discriminatory power index is an important indicator in determining item quality; the higher the discriminatory power value, the better the item is at measuring differences in student ability (Arikunto, 2021). In general, items with a discriminatory power index less than 0.20 are categorized as low quality and unsuitable for use in test instruments (Sugiyono, 2022).

The discriminatory power test in this study was conducted using the Statistical Package for Social Sciences (SPSS) version 25 software. Based on the analysis of 25 test items, five items had a discriminatory power index of less than 0.20: items 1, 2, 6, 21, and 25. These five items were categorized as weak, meaning they were unable to effectively differentiate between high- and low-ability students.

Therefore, based on this analysis, the researchers decided not to use items 1, 2, 6, 21, and 25 in the research instrument. Therefore, only items meeting the criteria for good discriminatory power were used in the data collection process, thereby maintaining the quality of the instrument and ensuring more accurate and reliable research results.

Reliability Test

Reliability testing is aimed at finding out the extent to which an instrument provides consistent and reliable data when used under the same conditions. A reliable instrument can be used in conducting research because it will produce results that are relatively consistent (Azwar, 2021). The reliability test in this study was conducted using the Cronbach's Alpha method through SPSS version 25 software.

Interpretation of the Cronbach's Alpha value by Sugiyono (2022) is presented below: Cronbach's alpha value less than 0.50 shows low reliability, between 0.50 and 0.70 - moderate reliability, greater than or equal to 0.70 shows acceptable reliability, greater than or equal to 0.80 – high dependability, and greater than 0.90 – excellent reliability of the instrument. The higher value of the Cronbach's Alpha test shows better internal consistency of the tool.

Based on the outcomes of the reliability test, the Cronbach's Alpha coefficient of the questionnaire is 0.787, which means that the instrument falls under the category of high (excellent) reliability. At the same time, the Cronbach's Alpha of the test instrument is 0.819, meaning that it belongs to the category of high (excellent) dependability. Due to their high consistency, both instruments can be considered reliable.

RESULTS AND DISCUSSION

This study, which focused on the Electrical Power Installation Technology (TITL) curriculum, was carried out in a vocational high school in Banten, Indonesia. 62 TITL program participants in the tenth grade were the study's subjects and respondents. One independent variable, educational games (X), and one dependent variable, student learning outcomes (Y), were included in the research data. A quasi-experimental design with two distinct classes—an experimental class and a control class—was used in this study's quantitative methodology. Class X TITL-1 served as the control class with 30 students, while Class X TITL-2, with 32 students, served as the experimental class. In the control class (which received no treatment), out of 30 respondents, there were 6 female students and 24 male students, while in the experimental class (which received treatment), out of 32 respondents, there were 6 female students and 26 male students.

a. Description of the Suitability of Media and Materials

The content and media feasibility validation test was used to measure the feasibility of the content and media in this study. The assessment by content and media experts was conducted by three individuals: two TITL teachers and one engineering lecturer. The calculations in the content and media feasibility test used the formula below (Ernawati & Sukardiyomo, 2017).

$$V = \frac{total\ score\ obtained}{maximum\ score} \times 100\%$$

The assessment of the suitability of the material and media can be considered valid if the calculation results align with the validity criteria values. The Table of validity criteria is presented in Table 2 (Maulana, 2022).

Table 2. Criteria for the Suitability of Material and Media

Value	Description
0.00 – 0.20	Unacceptable
0.20 – 0.40	Unsatisfactory
0.40 – 0.70	Fair
0.70 – 0.90	Acceptable
0.90 – 1.00	Very Acceptable

Based on the calculation of the average score from the subject matter experts, the result was 0.89. From this average score, it can be concluded that the suitability of the material in this study is deemed “Suitable” with a score of 0.89; similarly, the calculation of the average score from the media experts yielded a result of 0.89. Based on the average score obtained, the media used in this study is deemed “acceptable” with a score of 0.89.

b. Description of Pretest and Posttest Score Data

The pretest and posttest findings for the experimental and control classes are presented using descriptive statistics, including the number of respondents, the minimum and maximum scores, the mean, and the standard deviation. The descriptive data are shown in Table 3.

Table 3 Descriptive Statistics for Pretest and Posttest Scores

Class	Variabel	Respondent	Minimum Score	Maximum Score	Mean	Std. Deviation
Control	Pretest	30	35	80	55.5	12.78
Control	Posttest	30	55	95	74.00	10.45
Experiment	Pretest	32	30	70	47.19	11.62
Experiment	Posttest	32	50	95	77.50	9.15

Table 3 shows that the control class's pretest scores varied from a minimum of 35 to a high of 80, with an average of 55.00. The control group's posttest scores improved after receiving traditional teaching, averaging 74.00 and ranging from a low of 55 to a maximum of 95. The pretest results in the experimental class had an average of 47.19 and varied from a minimum of 30 to a maximum of 70. With a minimum score of 50, a maximum score of 95, and an average score of 77.50, the posttest results increased following instruction through an Android-based instructional game.

Therefore, it may be said that the experimental class's learning outcomes improved more than those of the control group. This suggests that using educational games based on Android improves students' learning results in the Fundamentals of Electrical Engineering course. Based on Figure 4, it can be seen that there are many score intervals (6 in total), with an interval width of 8. The control group’s posttest scores ranged from 74 to 81 for the highest scores and from 50 to 57 for the lowest scores. The control group’s average posttest score was 77.5.

Analysis of Learning Outcome Data

1. Normality Test

To ascertain if the learning result scores and the questionnaire data were normally distributed, a normality test was performed. The questionnaire analysis involved 32 respondents, whereas the learning outcome analysis involved 30 students in each class, comprising a control class and an experimental class. When the significance value was higher than 0.05, the data were deemed to be regularly distributed. IBM SPSS Statistics version 25 was used for the analysis. Table 4 displays the questionnaire's normality test findings, and Figure 1 shows the residuals' distribution.

Table 4. Normality Test of the Questionnaire

One-Sample Kolmogorov-Smirnov Test		
Unstandardized Residual		
N		32
Normal Parameters [a,b]	*Mean*	0.000
	Std.Deviation	10.077
Most Extreme Differences	*Absolute*	0.148
	Positive	0.116
	Negative	-0.148
Test Statistic		0.148
Asymp.Sig. (2-tailed)		0.73[c]

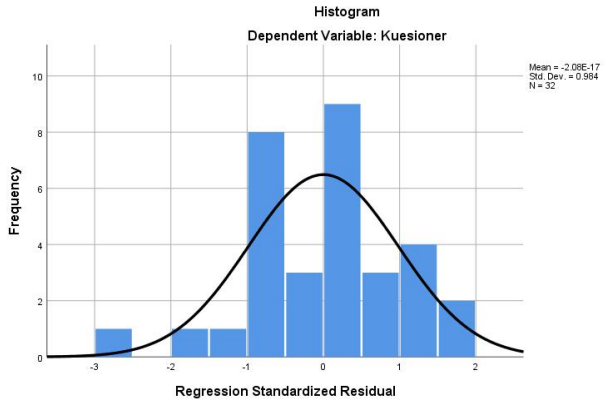

Figure 1. Histogram of the Normality Test for the Questionnare

It is clear from Table 4 and Figure 1, which display the questionnaire's normality test findings, that the data are normally distributed because the significance value of 0.73 is higher than 0.05. Additionally, the histogram supports the normality test result by demonstrating that the residuals are often scattered around the center of the normal curve. Table 5 displays the findings of the normality test for the pretest and posttest scores of the experimental and control groups. Figures 2, 3, 4, and 5 show the distributions of the scores.

Table 5. Normality Test Results

Class	**Variabel**	**Statictics**	**Respondent**	**Sign.**
Control	Pretest	0.950	30	0.167
	Posttest	0.953		0.204
Experiment	Pretest	0.939	30	0.100
	Posttest	0.948		0.129

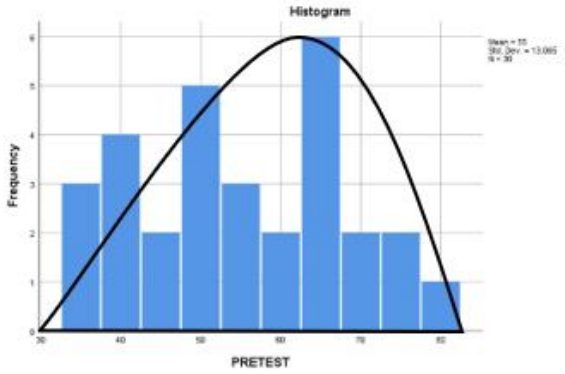

Figure 2. Histogram of the Pretest Normality Test for the Control Class

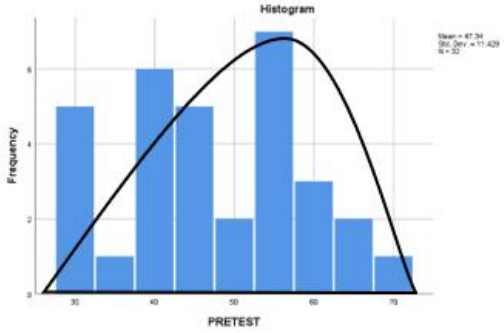

Figure 3. Normality Test for the Experimental Class Pretest

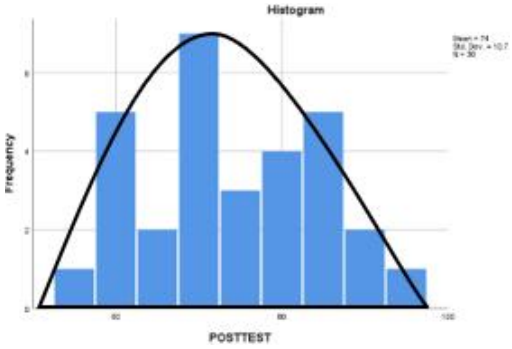

Figure 4. Histogram of the Posttest Normality Test for the Control Class

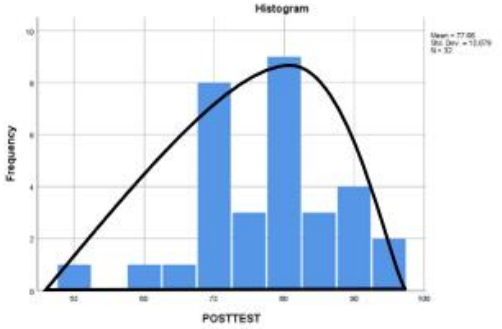

Figure 5. Histogram of the Posttest Normality Test for the Experimental Class

Table 5 shows that the pretest and posttest significance values for the control group were 0.167 and 0.204, respectively. In the meantime, the pretest and posttest significance

scores for the experimental class were 0.100 and 0.129, respectively. The pretest and posttest results in both classes were shown to be regularly distributed because all significant values were higher than 0.05. This conclusion is also supported by the histograms in Figures 2-5 which show that the score distributions generally follow the normal distribution curves. Therefore, the normality assumption was satisfied and the data were suitable for further analysis using parametric statistical tests.

2. Homogenity Test

The significant values (Sig.) for the Control Values and Experimental Values across all calculation methods—mean, median, trimmed mean, and adjusted df—were greater than 0.05, according to the findings of the homogeneity of variances test using Levene's Test. 0.161 was the highest recorded significance value, and 0.110 was the lowest. It is possible to assume that the variances between groups are homogeneous because all Sig. values were more than 0.05. As a result, parametric tests can be used for additional analysis as the assumption of homogeneity of variances is satisfied. Table 6 displays the homogeneity test findings.

Table 6. Homogeneity Test of Learning Outcomes for the Control Class and the Experimental Class

Test of Homogenity of Variance			
	Variabel	Levene Statistic	Significant
Control Value	Based on Mean	2.255	0.139
	Based on Median	2.014	0.161
	Based on Median and With adjusted df	2.014	0.161
	Based on trimmed mean	2.247	0.139
Experiment Value	Based on Mean	2.638	0.110
	Based on Median	2.257	0.138
	Based on Median and With adjusted df	2.257	0.139
	Based on trimmed mean	2.608	0.112

3. Paired-Sample t-Test

To determine if the means of two measures from the same group—that is, the experimental group and the control group—that received different treatments differ statistically significantly, the paired-sample t-test is utilized.In a paired-sample t-test, H0 is accepted and H1 is rejected if the significance value (two-tailed) is greater than 0.05; if the significance value (two-tailed) is less than 0.05, H0 is rejected and H1 is accepted. Table 7 displays the paired-sample t-test findings.

Table 7. Paired-Sample t-Test

Variabel	Mean	Std.Dev	Std.Error Mean	t	df	Sig. (2-tailed)
PretestControl-PosttestControl	-19.000	6.998	1.278	-14.827	29	0.000
PretestExperiment-PosttestExperiment	-30.313	9.153	1.618	-18.735	31	0.000

The test results for the control group produced a significant value (2-tailed) of 0.000 < 0.05 based on the paired samples t-test comparing the experimental group with the control group. Thus, it can be said that employing the traditional learning model results in different learning outcomes. There is a difference in the mean learning outcomes while utilizing educational games, according to the test findings for the experimental group, which showed a significant value (two-tailed) of 0.000 < 0.05.

This study was conducted over five sessions involving a control class and an experimental class. In the control class, the first session began with a pretest to assess the students' initial abilities. Subsequently, from the second to the fourth sessions, instruction was delivered using conventional methods. In the fifth session, students took a posttest to assess their learning outcomes following the intervention.

In the experimental class, the learning activities began with the administration of a questionnaire and a pretest. During the second through fourth sessions, the researcher implemented instruction using an Android-based educational game. During the fifth session, students took a posttest to measure improvements in learning outcomes following the use of this medium. The material taught in this study was types of cables and cable connections.

Use of educational games in learning makes the whole learning process interactive and more fun for the students. The students will be able to learn better and easily through the visuals and feedback provided by the game. The use of educational games can also motivate and engage the learners during the process of learning.

The participants for this study were tenth-grade students taking the program of Electrical Installation Technology (TITL) at a Vocational High School in Banten, Indonesia. Group TITL-1 served as the control group, while TITL-2 was the experimental group. The purpose of this research was to find out the difference between the learning outcomes of students using educational games as the learning medium and those using conventional learning.

Based on the validation results, the average score from the subject matter expert was 0.89 and from the media expert was 0.89, both falling within the "acceptable" category. This indicates that the educational game developed met the acceptability criteria and can be used in

the learning process. The analysis results show that the control class, which used conventional methods, experienced an improvement in learning outcomes, with the average pretest score rising from 55.00 to 74.00 on the posttest—an increase of 19.00 points. This finding demonstrates that conventional instruction was still able to improve students' understanding of the learning material. However, the improvement was lower than that observed in the experimental class, suggesting that conventional instruction may provide fewer opportunities for active interaction, repeated practice, and immediate feedback. Crawford (2026) emphasizes that effective technology-supported learning should provide learners with opportunities to actively construct knowledge through guided practice, meaningful interaction, feedback, reflection, and authentic learning tasks. Therefore, although conventional instruction can improve students' conceptual understanding, limited opportunities for active engagement may restrict the development of deeper understanding and higher-order thinking skills.

Unlike this, the experimental group that used educational games exhibited higher levels of improvement. The results indicate that the use of Android educational games may lead to greater opportunities to learn than the traditional teaching method. Indeed, educational games may offer not only instructional content but also its visual presentation, well-structured exercises, repetition and feedback, which makes it possible for the learners to become more active in terms of interacting with the instructional material (Damari, 2025; Puspita et al., 2024). It is also important to note that such characteristics may be especially useful for teaching electrical engineering since cable types and wiring procedures include procedural knowledge that cannot be easily communicated verbally (Purnomo et al., 2011; Ahmad et al., 2025).

It follows, therefore, that educational games are more effective than traditional methods in terms of improving the performance of students. This finding is consistent with previous studies that prove the effectiveness of educational games in terms of improving the learning results of students through increased motivation and interactions (Afifah & Subekti, 2024; Widiyantara et al., 2023).

CONCLUSION

The use of educational games developed on the Android platform is seen to positively influence the performance of learners in Fundamentals of Electrical Engineering, particularly on cable connection fundamentals, based on the findings and discussion of results from the research. A t-test with a p-value of $0.000 < 0.05$ shows that there is a significant difference in pretest and posttest scores of both the control and experimental classes. However, the

experimental group that was taught using educational games performed better compared to the control group that used conventional methods.

With an average score of 0.89, which is in the "feasible" range, the instructional game created also satisfied the feasibility requirements based on the validation results by subject matter experts and media experts. This shows that the medium is suitable for the learning process in terms of content, presentation, and interactivity. Therefore, it can be confirmed that, in comparison to traditional approaches, Android-based educational games are both appropriate for use and more successful in raising student learning results. Vocational high school students' learning results are positively impacted by the usage of this medium, which makes learning more dynamic and interesting and boosts student motivation and engagement. The findings of this study indirectly support the creation of innovative teaching strategies in vocational high schools, especially when it comes to the use of digital technology as a learning tool that can be adjusted to meet the demands of contemporary students.

REFERENCES

Afidah, N., & Subekti, F. E. (2024). Efektivitas penggunaan game edukasi digital terhadap hasil belajar matematika siswa. *Jurnal Basicedu, 8*(3), 1944–1952. https://doi.org/10.31004/basicedu.v8i3.7564

Ahmad, M. S., Sebu, R. U., & Tefa, M. (2025). Inovasi media pembelajaran interaktif berbasis rangkaian digital untuk meningkatkan pemahaman konsep fisika listrik. *Haumeni Journal of Education, 5*(2), 98–106. https://doi.org/10.35508/haumeni.v5i2.24089

Arikunto, S. (2021). *Dasar-dasar evaluasi pendidikan* (Edisi revisi). Bumi Aksara.

Azwar, S. (2021). *Reliabilitas dan validitas* (Edisi ke-5). Pustaka Pelajar.

Chusna, I. F., Aini, I. N., Putri, K. A., & Elisa, M. C. (2024). Literatur review: Urgensi keterampilan abad 21 pada peserta didik. *Jurnal Pembelajaran, Bimbingan, dan Pengelolaan Pendidikan, 4*(4). https://doi.org/10.17977/um065.v4.i4.2024.1

Crawford, R. (2026). Exploring technology supporting explicit teaching and learning of educator skills and knowledge: An IPA study. *Australian Journal of Teacher Education, 51*(1). https://doi.org/10.14221/1835-517X.6815

Damari, N. (2025). Peran game edukatif dalam mengoptimalkan pembelajaran IPA di sekolah dasar. *Intelektual: Jurnal Ilmiah Multidisiplin Mahasiswa dan Akademisi, 1*(1), 36–48.

Edriati, S., Husnita, L., Amri, E., Samudra, A. A., & Kamil, N. (2021). Penggunaan MIT App Inventor untuk merancang aplikasi pembelajaran berbasis Android. *E-DIMAS: Jurnal Pengabdian kepada Masyarakat, 12*(4), 652–657.

Endrayani, I., Efendi, A., & Yamtinah, S. (2023). The need for interactive media for electrical learning in vocational high schools: Fact from the classroom activities. *Advances in Social Science, Education and Humanities Research*, 2605–2612.

Ernawati, I., & Sukardiyomo, T. (2017). Uji kelayakan media pembelajaran interaktif pada mata pelajaran administrasi server. *ELINVO (Electronics, Informatics, and Vocational Education), 2*(2), 204–210.

Faiza, N. N., & Wardhani, I. S. (2024). Media pembelajaran abad 21: Membangun generasi digital yang adaptif. *Jurnal Media Akademik (JMA), 2*(12).

Gunartha, I. W., Widiasri, D. A., & Ekasriadi, I. A. A. (2024). Asesmen dan pembelajaran Bahasa Indonesia berbasis HOTS: Upaya peningkatan kemampuan berpikir kritis siswa di era digital abad ke-21. *SANDIBASA II (Seminar Nasional Pendidikan Bahasa dan Sastra Indonesia), 2*(1).

Kurnia, U. I., Lathifah, A., Rizki, F., Larasati, B. S., Puspitasari, S., & Fatiha, S. A. (2024). Penerapan media pembelajaran berbasis *mobile learning* di SMP Negeri 4 Abung Barat. *Jurnal Pengabdian Kepada Masyarakat Ungu (ABDI KE UNGU), 6*(1).

Kurniawati, R., Haifaturrahmah, H., & Sari, N. (2025). Pemanfaatan game edukasi sebagai media pembelajaran yang menarik bagi siswa sekolah dasar. *Didaktik: Jurnal Ilmiah PGSD FKIP Universitas Mandiri, 11*(4), 261–285.

Liao, C.-W., Tseng, Y.-J., Liao, Y.-H., Chen, B.-S., Ho, W.-S., Wang, I.-C., Lin, H.-I., & Chen, I.-M. (2023). A practical curriculum design and learning effectiveness evaluation of competence-oriented instruction strategy integration: A case study of Taiwan skills-based senior high school. *Behavioral Sciences, 13*, 43.

Maulana, A. (2022). Analisis validitas, reliabilitas, dan kelayakan instrumen penilaian rasa percaya diri siswa. *Jurnal Kualita Pendidikan, 3*(3), 133–139.

Nawawi, M. I., Nu'man, M., Maulana, M. F., & Syaifullah, M. D. (2026). Android-based learning media as an innovation in digital learning in the era of modern education. *Jurnal Pendidikan Bahasa Arab L-DHAD, 5*(1), 27–34.

Purnomo, T. H., Sugiyanto, & Akhlis, I. (2011). *Educational computer game* materi listrik dinamis sebagai media pembelajaran fisika untuk siswa SMA. *Jurnal Pendidikan Fisika Indonesia, 7*(2), 121–127.

Puspita, D., Antara, P. A., & Bayu, G. W. (2024). BATUMBUH: Game edukasi interaktif berbasis pendekatan kontekstual pada materi bagian tubuh tumbuhan. *Jurnal Media dan Teknologi Pendidikan, 4*(3), 327–337. https://doi.org/10.23887/jmt.v4i3.77315

Putri, L. A. I., & Trisnawati, N. (2024). Pengaruh media pembelajaran berbasis Educandy game terhadap motivasi dan hasil belajar siswa SMK. *Edukatif: Jurnal Ilmu Pendidikan, 6*(4), 3059–3070. https://doi.org/10.31004/edukatif.v6i4.7204

Rahmawati, N. A., Laila, A., & Dalalah, N. R. (2025). Efektivitas game edukatif sebagai media pembelajaran untuk meningkatkan literasi budaya dan numerasi siswa sekolah dasar. *Journal Scientific of Mandalika (JSM), 6*(12).

Sapitri, S., & Suriani, A. (2025). Efektivitas media pembelajaran interaktif dalam meningkatkan minat belajar siswa SD. *Pragmatik: Jurnal Rumpun Ilmu Bahasa dan Pendidikan, 3*(3), 282–292. https://doi.org/10.61132/pragmatik.v3i3.1829

Sugiyono. (2022). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Tsai, C.-C., Chung, C.-C., Cheng, Y.-M., & Lou, S.-J. (2022). Deep learning course development and evaluation of artificial intelligence in vocational senior high schools. *Frontiers in Psychology, 13*.

Widiyantara, I. G. R., Gading, I. K., & Bayu, G. W. (2023). Media game edukasi berbasis web untuk meningkatkan aktivitas dan hasil belajar siswa pada materi IPAS kelas IV sekolah dasar. *International Journal of Natural Science and Engineering, 7*(3), 182–195. https://doi.org/10.23887/ijnse.v7i3.75330