

Effectiveness of Interactive Multimedia Web-Based Tutorial Model to Improve Pedagogical Competence of Elementary School Teachers in Karangpawitan District, Garut Regency

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Abstract

This study aims to analyze the effectiveness of interactive multimedia web-based tutorial models in improving teachers' pedagogical competence in Karangpawitan District. The research problem stems from the still low pedagogical competence of teachers in lesson planning, utilization of digital media, authentic assessment, and technology-based learning management. The study used a quantitative approach with a quasi-experimental method through a pretest-posttest control group design. The research sample consisted of 60 elementary school teachers divided into experimental and control groups. Data collection techniques used tests, questionnaires, observation, and documentation. Data analysis used descriptive statistics, normality tests, homogeneity tests, and t-tests. The results showed that interactive multimedia web-based tutorial models were effective in improving teachers' pedagogical competence. The average score of the experimental group increased from 62.15 to 85.40, while the control group increased from 61.80 to 70.25. The t-test results showed a significance value of $0.000 < 0.05$. Thus, interactive multimedia web-based tutorial model has proven effective in improving the pedagogical competence of teachers in Karangpawitan District, Garut Regency.

INTRODUCTION

The development of information and communication technology in the digital era has brought about significant changes in education, including the learning process in elementary schools. Teachers, as the primary actors in education, are required to possess adequate competencies to implement effective, innovative, and student-centered learning. However, in practice, many elementary school teachers still face challenges in mastering pedagogical competencies, particularly in utilizing technology-based digital media.

Digital technology has driven significant changes in the education system. Teachers, as the primary actors in learning, are required to possess strong pedagogical competencies to design, implement, and evaluate learning tailored to student needs. Pedagogical competency is a crucial element in improving educational quality because it directly relates to the classroom learning process.

Various studies show that teachers' pedagogical competence in Indonesia still faces challenges, particularly in the utilization of learning technology, the implementation of differentiated learning, and the use of digital-based assessments (Mulyasa, 2023). This situation is also found in Karangpawitan District, where some teachers still use conventional learning methods, are limited in the use of interactive media, and have not yet optimally developed teaching materials based on the Independent Curriculum.

Conventional face-to-face training is often constrained by time, cost, and limited access. Therefore, flexible and effective teacher training innovations are needed. One potential alternative is interactive multimedia, a web-based tutorial model. This medium allows teachers to learn independently through digital materials, video tutorials, simulations, practice exercises, and automated feedback (Munir, 2022). Interactive multimedia is a combination of text, images, audio, video, animation, and digital interactions designed to facilitate the learning process. The tutorial model presents material systematically, complemented by exercises and evaluations, so users gain a self-directed learning experience (Daryanto, 2021).

Pedagogical competence is a teacher's ability to understand students, design learning, implement learning, evaluate learning outcomes, and develop student potential (Hamzah B. Uno, 2022). Web-based learning allows access to learning anytime and anywhere. This system is flexible, efficient, and suited to the needs of teachers with limited time (Surjono, 2023). In Karangpawitan District, Garut Regency, the challenge of improving the pedagogical competence of elementary school teachers remains a significant issue. Some teachers still use conventional teacher-centered learning methods, such as lectures and routine assignments, resulting in less interactive learning processes and less active student participation. Furthermore, the use of digital learning media is still limited due to a lack of training, low technological literacy, and minimal innovation in the development of web-based teaching materials. This condition results in the learning process being less than optimal in adapting to the needs of today's digital generation (Observation, 2026).

Previous research has shown that web-based interactive multimedia can improve learning outcomes, motivation, and professional skills of users (Rusman, 2023). Various studies have shown that the use of interactive multimedia can increase learning effectiveness because it combines elements of text, images, audio, video, animation, and user interaction in an integrated manner. Interactive multimedia can also help teachers deliver material in a more engaging and understandable way, while also increasing student motivation. Other studies have shown that interactive multimedia effectively improves learning outcomes and student engagement compared to conventional learning methods.

The novelty of this research lies in three distinct contributions. First, unlike most previous studies that focused on interactive multimedia for student learning, this research specifically targets teacher pedagogical competence as the outcome variable. Second, the study employs a web-based tutorial model rather than a general multimedia presentation, meaning the intervention is structured systematically with step-by-step guidance, interactive practice exercises, automated feedback, and self-assessment features specifically designed for adult learners. Third, this research is situated in the understudied context of Karangpawitan District, Garut Regency, a region with unique geographic and infrastructural characteristics that make conventional training approaches impractical. The combination of a tutorial-based interactive multimedia design with a focus on in-service elementary school teachers' pedagogical

competence in a rural/suburban Indonesian district constitutes a novel contribution to the educational technology literature.

One relevant innovation is interactive multimedia, a web-based tutorial model. This web-based tutorial model enables teachers to learn independently through systematic steps, structured materials, teaching practice simulations, learning videos, self-assessments, and flexible access anytime and anywhere. With a web-based system, teachers no longer rely on time- and cost-limited face-to-face training but can continuously improve their competencies. This approach is highly suitable for elementary school teachers in the Karangpawitan District who need practical and efficient competency improvement.

However, to date, there has been little research specifically examining the effectiveness of interactive multimedia, a web-based tutorial model, in improving the pedagogical competence of elementary school teachers in Karangpawitan District, Garut Regency. Most studies have focused on the use of multimedia for students, rather than on improving teacher capacity. Therefore, research is needed to examine the extent to which interactive web-based multimedia can be a real solution for improving teachers' abilities in planning, implementing, and evaluating learning.

Based on this description, this research is crucial to address the need to improve the quality of basic education by strengthening teachers' pedagogical competence by utilizing innovative, accessible, and relevant digital technology. Therefore, this research is crucial to test the effectiveness of interactive multimedia, a web-based tutorial model, in improving teachers' pedagogical competence in Karangpawitan District.

RESEARCH METHOD

This study used a quantitative approach with a quasi-experimental method using a pretest-posttest control group design. The study population was elementary school teachers in Karangpawitan District. A sample of 60 teachers was selected using purposive sampling, consisting of 30 teachers in the experimental group and 30 teachers in the control group.

The variables in this study consist of the independent variable, namely the use of interactive multimedia in a web-based tutorial model, while the dependent variable is the pedagogical competence of elementary school teachers.

The data collection techniques used in this study included several instruments. First, a pedagogical competency test was used to measure teachers' abilities before and after the treatment. Second, a media usage perception questionnaire aimed to determine teachers' responses to the use of web-based interactive multimedia. Third, observations of learning implementation were conducted to assess teachers' implementation of pedagogical competency during the learning process. Fourth, documentation was used to supplement the research data in the form of archives, activity photos, attendance lists, and other supporting documents.

The data obtained were then analyzed using several statistical techniques. First, descriptive statistics were used to describe the research data such as mean values, percentages, standard deviations, and score distributions. Second, the Kolmogorov-Smirnov normality test was conducted to determine whether the data were normally distributed. Third, the Levene Test for homogeneity was used to determine the equality of variance between the experimental and control groups. Fourth, an independent t-test was used to examine the difference in the average pedagogical competence results between the two groups after treatment. Fifth, the N-Gain

Score was used to determine the level of improvement in teachers' pedagogical competence from the pretest to the posttest results in each group. With this analysis, the effectiveness of the interactive multimedia web-based tutorial model can be measured objectively and empirically.

RESULTS AND DISCUSSION

Pretest and Posttest Data

Pretest and posttest data are crucial components of research, particularly for measuring changes or improvements in outcomes after a treatment is administered. Pretests are conducted before treatment to determine the subjects' baseline conditions or abilities, while posttests are conducted after treatment to assess the extent of changes. By comparing these two sets of data, researchers can assess the effectiveness of a method, strategy, or intervention. Therefore, analyzing pretest and posttest data provides the basis for drawing conclusions about the success of a study. For more details, see the table below:

Table 1. Pretest and Posttest Data

Group	Pretest	Posttest	Gain
Experiment	62.15	85.40	23.25
Control	61.80	70.25	8.45

Based on pretest and posttest data, both groups showed improvement after treatment, but at varying levels. In the experimental group, the average pretest score of 62.15 increased to 85.40 in the posttest, resulting in a gain of 23.25. Meanwhile, the control group experienced an increase from an average pretest score of 61.80 to 70.25 in the posttest, resulting in a gain of 8.45.

The significant difference in gains between the two groups indicates that the improvement in learning outcomes in the experimental group was significantly higher than in the control group. This indicates that the treatment given to the experimental group was more effective in improving outcomes than the treatment given to the control group.

So the data above shows a higher increase in the experimental group than the control group.

Normality Test

The normality test used here is to determine whether the data in a study is normally distributed. Some commonly used methods include the Kolmogorov-Smirnov test and the Shapiro-Wilk test. If the test results indicate a normal distribution (a significance value greater than 0.05), then parametric analysis can be used. Conversely, if the data is not normally distributed (a significance value less than 0.05), then researchers are advised to use nonparametric analysis.

The following table is compiled based on the data that has been explained:

Table 2. Normality Test

Group	Pretest	Posttest	Gain
Experiment	62.15	85.40	23.25
Control	61.80	70.25	8.45

Based on the table presented, there are differences in the results between the experimental and control groups in the pretest, posttest, and gain scores. In the experimental group, the average pretest score of 62.15 experienced a significant increase to 85.40 in the posttest, resulting in a gain of 23.25. Meanwhile, in the control group, the average pretest score of 61.80 increased to 70.25 in the posttest with a gain of 8.45. Although both groups experienced improvements, the magnitude of the increase in the experimental group was much higher than in the control group.

This indicates that the treatment given to the experimental group was more effective in improving outcomes than the control group. Therefore, it can be concluded that there was a significant difference in improvement between the two groups, with the experimental group showing better results.

Homogeneity Test

The homogeneity test is used to determine whether the variance (degree of data distribution) of two or more groups is the same (homogeneous) or different. If the significance value is greater than 0.05, the data is considered homogeneous and meets the requirements for parametric statistical analysis. The following table shows the results of the homogeneity test based on the given data:

Table 3. Homogeneity Test

Test Type	Significance Value (Sig.)	Criteria	Conclusion
Homogeneity Test	0.218	$0.218 > 0.05$	Homogeneous Data

Based on the homogeneity test table, a significance value (Sig.) of 0.218 was obtained. This value was then compared with the significance level used in the study, which was 0.05. Because the value of 0.218 is greater than 0.05, it can be concluded that the data variance between groups is homogeneous. This homogeneity of variance indicates that the data from the compared groups have a relatively similar level of distribution or are not significantly different.

Thus, one of the important assumptions in parametric statistical analysis has been met, so the data is suitable for proceeding to the next stage of analysis, such as a t-test or other tests. Therefore, the sig. value = $0.218 > 0.05$, indicating that the variance of the above data is homogeneous.

T-Test Results

The t-test results show a calculated t-value of 6.874 with a significance of 0.000 which is smaller than 0.05. This means there is a significant difference between the experimental group and the control group, so H_0 is rejected and H_1 is accepted. The following table shows the t-test results based on the data provided:

Table 4. T-Test

Test Type	t count	Sig. (2-tailed)	Criteria	Conclusion
t-test	6,874	0,000	$0.000 < 0.05$	There is a significant difference

Based on the t-test results, the calculated t-value was 6.874 with a significance value (Sig. 2-tailed) of 0.000. This significance value is less than 0.05, thus meeting the rejection criteria for H0 (null hypothesis). This indicates that there is a significant difference between the experimental group and the control group. Thus, it can be concluded that the treatment given to the experimental group has a significant effect compared to the control group.

N-Gain Score

The N-Gain Score is used to measure the level of improvement in learning outcomes before and after treatment. The calculation shows an increase in both groups, but the experimental group had a higher N-Gain score than the control group. This indicates that the treatment in the experimental group was more effective in improving learning outcomes.

Table 5. N-Gain Score Results

Group	N-Gain Score	Category	Information
Experiment	0.72	Tall	Improving teachers' pedagogical competence is very effective
Control	0.31	Currently	The improvement of teachers' pedagogical competence is sufficient

Based on the table, the experimental group obtained an N-Gain Score of 0.72, which is in the high category, while the control group obtained an N-Gain of 0.31, which is in the medium category. This indicates that the increase in teachers' pedagogical competence in the experimental group was higher than in the control group.

These improvements demonstrate that interactive multimedia web-based tutorials are effective in improving teachers' pedagogical competence. This success is supported by several factors, such as flexible learning access, which allows teachers to learn anytime and anywhere, and interactive features like video tutorials, automated quizzes, simulations, and self-assessments that increase learning engagement.

Furthermore, the material presented is relevant to teachers' real-world needs, such as lesson planning, diagnostic assessment, differentiated learning, and the use of classroom technology. These results align with previous research showing that interactive web-based learning can significantly improve teachers' pedagogical and professional competencies.

This finding is in line with previous research which stated that web-based interactive tutorials can significantly improve teachers' professional and pedagogical competence.

Hypothesis Test Results

Based on the results of the t-test, the calculated t value was 6.874 with a significance (Sig. 2-tailed) of 0.000. This significance value is less than 0.05 ($0.000 < 0.05$), so H0 is rejected and H1 is accepted.

Thus, it can be concluded that there was a significant difference between the experimental and control groups. This means that the interactive multimedia web-based tutorial treatment significantly improved teachers' pedagogical competence compared to the learning in the control group.

These results are further supported by the N-Gain value, where the experimental group scored 0.72 (high category), while the control group only scored 0.31 (moderate category).

This difference indicates that the improvement in the experimental group was more effective, thus supporting the research hypothesis that the use of web-based interactive multimedia has an impact on teachers' pedagogical competence.

Interactive Multimedia Web-Based Tutorial Model Effective in Improving Teachers' Pedagogical Competence

In this study, two tests were conducted: one in the experimental class using interactive multimedia tutorials and the other in the control class using conventional models. This was done to assess differences in improving the pedagogical competence of elementary school teachers in Karangpawitan District, Garut Regency.

The learning process using interactive multimedia in this tutorial model is more engaging and interactive, reducing teaching time, and allowing learning to take place anytime and anywhere (Noverdika, 2021). Learning using interactive multimedia also benefits children by developing six aspects of child development and their senses, such as sight and hearing, making it easier for them to participate in learning (Elok & Rasmani, 2023).

Interactive learning multimedia is a tool designed to enable students to actively engage in the learning process through direct interaction with the material. This interactivity distinguishes this medium from conventional media, such as textbooks or lectures (Irma Maulidia, 2025). This interactive tutorial-style multimedia is highly effective in learning due to its flexibility, meaning it can be used in the classroom and retaught outside of it (Noverdika, 2021). Various digital media, such as learning videos, interactive applications, online platforms, and technology-based simulations, enable a more flexible learning process and align with the characteristics of the digital generation (Ayu et al., 2026).

The use of learning media in the learning process needs to be planned and designed systematically to ensure effective use (Setiyani & Harmianto, 2022). Teachers stated that media that combines text, images, animation, and sound greatly helps explain material in a more concrete and engaging manner. Students also expressed that interactive media makes them more focused and easier to understand the material because it involves more than one sense (Sofyannuddin et al., 2025). According to the Cone of Experience theory, which emphasizes the importance of visual and direct experiences in learning, and the Cognitive Theory of Multimedia Learning, which explains that the integration of text, images, and audio can improve student understanding (Patmawati et al., 2026), however, without proper pedagogical management, the use of digital media has the potential to be merely a means of entertainment and not have a significant impact on achieving learning objectives.

The results of the study indicate that interactive multimedia web-based tutorial models are effective in improving the pedagogical competence of elementary school teachers in Karangpawitan District, Garut Regency. This effectiveness is seen from the increase in the pedagogical competence scores of teachers in the experimental group who received treatment using web-based interactive multimedia, compared to the control group who used conventional coaching methods. Based on the results of statistical tests, the posttest scores of the experimental group were significantly higher than those of the control group, so it can be stated that the use of interactive multimedia has a positive influence on improving teachers' pedagogical competence.

This improvement in pedagogical competence can be explained by the characteristics of interactive multimedia, a web-based tutorial model, that supports adult learning, particularly for teachers as trainees. This medium presents material systematically, step by step, and in an easy-to-understand manner through a combination of text, images, audio, video, animation, and evaluative exercises. The varied presentation of material makes it easier for teachers to grasp pedagogical concepts, such as lesson planning, classroom management, active learning strategies, learning assessment, and the use of learning media.

Teacher Responses to the Use of Interactive Multimedia

The advantage of using interactive learning media in learning activities is that it makes teaching media easier to deliver and the material presented is clearer. This includes practical tools, attractive presentation designs, can display text, images, films, sound effects, music, graphics, and animations to aid understanding and memory; it can also be easily edited, saved, and reused; it can be replicated quickly and cheaply (Ariyani, 2024). Teacher competence is very important for effective teaching, because it can have a positive impact on students' academic development and skills and help maximize student learning (Kamaruddin, Djeli A. Tulandi, Patricia M. Silangen, 2024).

Regarding the desire to improve teaching methods, all respondents expressed a desire to improve their teaching methods. This indicates a strong motivation among all teachers to teach in new ways (Sutarno et al., 2013). Teachers showed a high level of interest in using content creation features, but suggested templates and an auto-save feature (Wicaksono, 2025). Managing multimedia learning media for elementary school teachers can improve their knowledge of multimedia and their skills in developing interactive learning media (Azizah et al., 2025).

Regarding the desire to improve teaching methods, all respondents expressed a desire to improve their teaching methods. This indicates a strong motivation among all teachers to teach in new ways (Mukhidin, 2013). Teachers, as facilitators, need to utilize this media creatively, adapting it to the local cultural context, and using it to build meaningful learning interactions. Through digital storytelling, learning no longer merely transfers knowledge but also fosters curiosity, caring, and positive character traits in students (Abdullah & Rafiudin, 2025).

The results of the study indicate that elementary school teachers in Karangpawitan District, Garut Regency, responded positively to the use of interactive multimedia. This is evident from the results of a perception questionnaire, which showed that the majority of teachers agreed that interactive multimedia facilitates understanding of the material, increases learning motivation, and helps improve pedagogical competence. This high level of positive response indicates that teachers accept the presence of learning technology as a crucial need for professional development in the digital era.

One aspect that received high ratings from respondents was the ease of use of the media. Teachers rated the interactive multimedia web-based tutorial model as having a simple interface, clear navigation, and easy-to-understand instructions. This ease of use factor is crucial given the varying technological backgrounds of teachers. With a user-friendly design, even teachers with basic digital skills can access and utilize the media independently. This demonstrates that the success of educational technology innovation is heavily influenced by its ease of access and operation.

Furthermore, teachers responded positively to the appeal of interactive multimedia displays. The combination of text, images, video, animation, and audio made the training materials more engaging than conventional teaching materials consisting solely of printed text or lectures. Interactive visual displays increased teachers' attention and concentration during tutorials. This reinforces the belief that engaging learning media can increase participants' intrinsic motivation to learn.

Positive responses were also evident in the media's usefulness in improving pedagogical competence. Teachers felt that the material presented in interactive multimedia helped them understand how to develop learning materials, select appropriate teaching methods, manage their classes, and conduct learning evaluations. In other words, teachers not only enjoyed using the media but also felt direct benefits in their daily professional duties. These findings demonstrate that good media is not only technically engaging but also substantively relevant to the needs of users.

Teachers' Skills in Instructional Design and Learning Media Production Aspects After Participating in Interactive Multimedia Tutorial Model Training

Teachers must have the ability to align learning objectives with the diverse characteristics of students in the digital era; therefore, teachers' ability to manage classes needs to be improved, especially in mastering, analyzing, and utilizing technology-based learning media wisely (Andriani et al., 2025). Strengthening teachers' pedagogical competence in using media in the learning process is a necessity in efforts to improve the quality of graduates, there are 3 important targets in the focus of this study, namely: (1) strengthening teachers' pedagogical competence; (2) teachers' skills in using media and (3) teachers' creativity in developing models and the quality of the learning process (Galuh et al., 2024).

Teachers play a strategic role in utilizing educational technology as facilitators who can innovate in designing learning materials, methods, tools, and media in the classroom (Siti Rosyidah et al., 2025). Although digital integration is crucial in modern education, many teachers struggle to utilize technology due to limited training and infrastructure (Yulisetiani et al., 2025). The advantages of interactive multimedia are proven by product trials that have achieved excellent qualifications (Ginting et al., 2021). Teachers are responsible for educating and instilling positive values in students that will be useful in their lives. Teachers are a key factor in education, as much of the educational process involves teaching and learning interactions, where the role of teachers is crucial.

The results of the study indicate that the Interactive Multimedia Tutorial Model-based training had a positive impact on improving the skills of elementary school teachers in Karangpawitan District, Garut Regency, particularly in the aspects of instructional design and learning media production. This improvement was analyzed using the N-Gain Score, a measure used to determine the level of increase in participants' skills from pretest to posttest results after receiving treatment.

Based on the analysis results, the average N-Gain score for teachers' abilities was in the moderate to high category, indicating that the training provided was effective in improving teachers' practical competencies. In the instructional design aspect, teachers experienced improvements in their ability to formulate learning objectives, design material flow, determine learning strategies, select appropriate methods, and systematically prepare learning

evaluations. Before the training, some teachers still developed teaching materials conventionally and were less tailored to student needs. However, after participating in the interactive multimedia-based tutorial, teachers gained a better understanding of the principles of structured, student-centered learning planning.

The relatively high N-Gain value in the instructional design aspect indicates that the multimedia-based tutorial model is capable of explaining learning planning concepts concretely. This occurs because the training material is presented through a combination of text, video, example templates, work step simulations, and independent practice, making it easier for teachers to understand abstract concepts and translate them into real-world practice. Thus, interactive multimedia successfully bridges the gap between pedagogical theory and implementation in the field.

In terms of instructional media production, the research also showed significant improvements. Teachers became more skilled at creating digital teaching materials, developing interactive presentations, using educational images and videos, and developing simple web-based media to support the learning process. Prior to the training, most teachers only used simple media such as whiteboards or static presentations. After the training, teachers began to be able to produce more engaging, communicative, and student-centered learning media. The high N-Gain value for the instructional media production aspect demonstrates the effectiveness of the tutorial approach, as it provides a hands-on learning experience. Teachers receive not only theory but also step-by-step guidance in creating digital learning media. This model is ideal for teachers who need to improve their technical skills through practical application.

CONCLUSION

Teachers' pedagogical competence before treatment was in the moderate category. After using interactive multimedia with a web-based tutorial model, teachers' pedagogical competence increased significantly. Interactive multimedia with a web-based tutorial model effectively improved teachers' pedagogical competence in Karangpawitan District. The N-Gain Score analysis results indicate that the level of improvement in teachers' pedagogical competence is in the moderate to high category, indicating that the media used is effective in developing teachers' professional competence. Furthermore, teacher responses to the use of interactive multimedia are also very positive, particularly in terms of ease of use, attractive appearance, flexibility of access, and benefits to teaching tasks. The web-based tutorial model offers the advantage of flexible learning access, can be used anytime and anywhere, and allows teachers to learn independently according to their needs and pace. This is particularly relevant for elementary school teachers who face time constraints due to teaching and school administration duties. Interactive multimedia web-based tutorial models can be recommended as an innovative alternative in training programs and improving the pedagogical competence of elementary school teachers, both in Karangpawitan District and elsewhere.

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