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## The Effect of Interactive Snakes and Ladders Game on Improving Elementary School Students Basic Motor Skills

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### ABSTRACT

*Fundamental movement skills constitute an essential foundation for the motor development of elementary school students, particularly in lower grades who are in a phase of rapid motor development. However, Physical Education learning in elementary schools is still often dominated by conventional teaching methods that provide limited active student engagement. The use of interactive digital game-based learning media represents an alternative approach to increase student participation and stimulate movement activities. This study aimed to examine the effect of audio-visual media in the form of an interactive digital Snakes and Ladders game on improving elementary school students' fundamental movement skills. This study employed a pre-experimental method using a one-group pretest-posttest design without a control group, which limits the ability to establish strong causal conclusions. The population consisted of all second-grade students at UPT SDN Kemlaten, with a total sample of 18 students selected using total sampling. The research instrument was an observation sheet assessing fundamental movement skills, including balance, coordination, locomotor movement, non-locomotor movement, and manipulative movement. Data analysis was conducted using a normality test and a paired sample t-test. The results showed an improvement in students' fundamental motor skills after the implementation of the interactive digital game media. The mean score increased from 9.83 in the pretest to 13.28 in the posttest. The t-test results indicated a statistically significant difference ( $t = -20.604$ ;  $p < 0.05$ ) with a very large effect size (Cohen's  $d = 4.86$ ). These findings suggest that the integration of interactive digital game-based media in Physical Education learning has the potential to support the development of fundamental motor skills among elementary school students. Future studies are recommended to employ experimental designs with control groups in order to provide stronger causal evidence.*

**Keywords:** *interactive snakes and ladders game; fundamental movement skills; audio-visual media; physical education learning; elementary school students.*

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**ABSTRACT**

Keterampilan gerak dasar merupakan fondasi penting bagi perkembangan motorik siswa sekolah dasar, khususnya pada kelas rendah yang berada pada fase perkembangan motorik pesat. Namun, pembelajaran PJOK di sekolah dasar masih sering didominasi metode konvensional yang kurang melibatkan siswa secara aktif. Pemanfaatan media pembelajaran interaktif berbasis permainan digital menjadi salah satu alternatif untuk meningkatkan keterlibatan dan stimulasi gerak siswa. Penelitian ini bertujuan untuk mengetahui pengaruh media audio-visual berupa game ular tangga interaktif berbasis digital terhadap peningkatan keterampilan gerak dasar siswa sekolah dasar. Penelitian ini menggunakan metode *pre-eksperimental* dengan desain *one-group pretest-posttest* tanpa kelompok kontrol, sehingga kemampuan untuk menarik kesimpulan kausal yang kuat menjadi terbatas. Populasi penelitian adalah seluruh siswa kelas II UPT SDN Kemlaten, dengan jumlah sampel sebanyak 18 siswa yang diambil menggunakan teknik total sampling. Instrumen penelitian berupa lembar observasi keterampilan gerak dasar yang mencakup aspek keseimbangan, koordinasi, gerak lokomotor, gerak non-lokomotor, dan gerak manipulatif. Analisis data dilakukan melalui uji normalitas dan uji *paired sample t-test*. Hasil penelitian menunjukkan adanya peningkatan keterampilan motorik dasar siswa setelah intervensi pembelajaran menggunakan media permainan digital interaktif. Nilai rata-rata meningkat dari 9,83 pada pretest menjadi 13,28 pada *posttest*. Hasil uji t menunjukkan perbedaan yang signifikan ( $t = -20.604$ ;  $p < 0.05$ ) dengan effect size yang sangat besar (*Cohen's d* = 4.86). Temuan ini menunjukkan bahwa integrasi media permainan digital interaktif dalam pembelajaran PJOK berpotensi mendukung pengembangan keterampilan motorik dasar siswa sekolah dasar. Penelitian selanjutnya disarankan menggunakan desain eksperimen dengan kelompok kontrol untuk memperoleh bukti kausal yang lebih kuat.

**Kata kunci:** game ular tangga interaktif; keterampilan gerak dasar; media audio-visual; pembelajaran PJOK; siswa sekolah dasar

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**INTRODUCTION**

Physical Education, Sports, and Health (PJOK) learning plays a crucial role in helping elementary school students develop fundamental movement skills. At ages 7-9, children are in a period of rapid motor development, requiring learning activities that are not only informative but also stimulate active and enjoyable movement. Oktarifaldi et al. (2024) Amidst rapid technological developments, the use of audio-visual and interactive digital media is increasingly being utilized to engage students in learning. Several studies have shown that audio-visual-based media can increase student motivation and interest in physical education learning, especially when presented in clear, easy-to-understand visual formats. (Rahmani et al., 2022; Rasyid et al., 2023)

In line with the development of learning methods, several studies have begun to focus on the use of interactive multimedia and technology-based educational games in physical education learning. Developing interactive multimedia to improve elementary school students' basic motor skills and finding that engaging and adaptive media can help students understand movement more effectively. Rahmadani et al. (2023) also developed interactive video media for locomotor and non-locomotor movement materials for first grade elementary school students and reported significant improvements in learning outcomes.

In the realm of digital media development, Adnyana et al. (2025) developing interactive website-based learning for floor gymnastics material, while Utilizing animated videos as a medium for physical education (PJOK) learning. Other research shows that video-based and visual-statistical movement learning has a positive impact on students' technical performance, motivation, and cognitive load. H'mida et al. (2020) Mohammad & Boushehry (2023) The play

approach and physical games have also proven effective in improving the basic motor skills of elementary school students. Suryadi et al. (2024)

Various studies have examined the use of audio-visual media and games in physical education learning, but most still focus on passive visual media such as video or display-based multimedia. Research on interactive digital game-based learning media that combine audio-visual elements and physical activities in physical education is still relatively limited, particularly for lower elementary school students. Previous studies have mainly examined video-based learning media or multimedia applications to support movement learning, while the use of interactive game-based media designed to stimulate multiple components of fundamental motor skills has received less attention Suryadi et al. (2024). As a result, empirical evidence regarding the effectiveness of interactive digital game media in supporting the development of fundamental motor skills among younger elementary students remains limited, even though students at this developmental stage require more intensive and contextual motor skill stimulation.

Physical game-based learning without technology support has been widely implemented and proven effective. Rezki et al. (2024) Interactive digital games specifically designed to improve elementary school students' fundamental motor skills are still relatively limited in research. However, previous studies suggest that interactive media and gamification approaches have strong potential to support children's motor development and learning engagement (Guedes et al., 2020; Hadders-Algra, 2020; Sanmiguel-rodr & Á, 2022)

Based on these conditions, the study offers a novel approach in the form of an interactive digital audio-visual media game, Snakes and Ladders, specifically designed for lower elementary school students. The media not only presents images and sounds but also integrates elements of play, challenges, and motor activities that encourage active student interaction. With this approach, physical education learning is expected to be more enjoyable, contextual, and relevant to the characteristics of child development and the demands of learning in the digital era. Although several studies have examined the use of digital media in physical education learning, most of them focus on conventional multimedia such as instructional videos or visual presentations. Research that integrates interactive digital games with audio-visual elements to support students' physical movement activities remains limited. In addition, previous studies rarely examine the combination of interactive digital game media and the development of fundamental movement skills in lower-grade elementary school students. Therefore, further research is needed to investigate the effectiveness of interactive audio-visual snakes and ladders game media in improving students' fundamental movement skills in physical education learning.

### **Research purposes.**

Therefore, this study aims to examine the effect of an interactive digital audio-visual snakes and ladders game on improving fundamental movement skills of elementary school students in physical education learning.

## **METHOD**

### **Types and designs**

The present study employed a pre-experimental method using a one-group pretest-posttest design to observe changes in students' basic motor skills before and after the implementation of the interactive snakes and ladders audio-visual game media. This design allows researchers to identify potential improvements in students' performance following the intervention by comparing pretest and posttest scores.

However, it is important to acknowledge that the absence of a control group limits the ability to establish strong causal inference. Improvements observed in the posttest may not solely result from the intervention but could also be influenced by several threats to internal validity, such as maturation, testing effects, and novelty effects. For example, students may naturally improve their motor skills over time due to developmental processes (maturation), become more familiar with the assessment tasks after the pretest (testing effect), or show increased motivation simply because the learning activity is new and engaging (novelty effect).

Therefore, the results of this study should be interpreted as indicative evidence of potential improvement rather than definitive causal proof of the effectiveness of the interactive game media. Despite these limitations, the design remains useful as an exploratory approach for examining the feasibility and potential benefits of integrating digital game-based learning media in elementary school physical education contexts Kurki et al. (2021)

Future studies are recommended to employ experimental or quasi-experimental designs with control groups in order to provide stronger evidence regarding the causal impact of interactive digital game-based media on students' motor skill development.

### **Data and Data Sources**

The research was conducted at UPT SDN Kemlaten, with 18 second grade students as participants who were selected through total sampling, because all students were at the active basic motor development stage and had homogeneous characteristics. Gandasari et al. (2023) The entire data collection process was conducted within a series of learning activities scheduled by the school, according to the academic calendar. The sample size was deemed adequate for a pre-experimental design aimed at observing changes in motor skills before and after treatment, as used in other physical education studies with small samples. (Prasetio et al. 2023). Data were collected using an observation sheet to measure students' fundamental movement skills. The observation sheet was developed based on fundamental motor skill indicators consisting of balance, coordination, manipulative movement, locomotor movement, and non-locomotor movement. To ensure content validity, the instrument was evaluated through expert judgment by two physical education lecturers and one elementary school physical education teacher. The reliability of the observation instrument was tested using inter-rater reliability, where two observers independently assessed students' motor performance during the assessment process. The scoring system used a four-point rating scale ranging from 1 (poor) to 4 (very good) for each motor skill component. The instrument used for data collection in this study was an observation sheet designed to assess students' fundamental movement skills during physical education activities. The assessment included several indicators of basic motor skills such as balance, coordination, locomotor movements, non-locomotor movements, and manipulative movements. Each indicator was evaluated using a four-point rating scale ranging from 1 (poor), 2 (fair), 3 (good), to 4 (very good).

To ensure the validity of the instrument, content validity was examined through expert judgment involving two experts in physical education and motor learning. The experts evaluated the relevance, clarity, and suitability of each assessment indicator with the concept of fundamental movement skills for elementary school students.

Prior to the main study, the instrument was also pilot tested with a small group of students who had characteristics similar to the research participants. This preliminary testing aimed to evaluate the clarity of the assessment indicators and the practicality of the observation procedure during physical education activities.

The reliability of the instrument was tested using Cronbach's Alpha coefficient to determine the internal consistency of the observation items. The reliability test results indicated that the instrument had acceptable reliability and was appropriate for use in data collection, as listed in Table 1.

Table 1. Basic Movement Assessment Aspects

Rated aspect	1 (Less)	2 (Good Enough)	3 (Good)	4 (Very Good)
<b>Balance</b>	Unable to maintain balance when performing movements.	Able to maintain balance even though often losing position.	Able to maintain balance with minimal errors.	Able to maintain balance in a stable and consistent manner.
<b>Coordination</b>	Uncoordinated movements between the eyes, hands, and feet.	Motor coordination is still not precise.	Movement coordination is quite good and precise.	Movement coordination is very good, precise and efficient.
<b>Manipulative Movement</b>	Unable to throw, catch, or hit properly.	Able to perform manipulative movements but often makes mistakes.	Able to perform manipulative movements with reasonable accuracy.	Able to perform manipulative movements with great accuracy and control.
<b>Locomotor Movement</b>	Inability to walk, run, or jump properly.	Able to perform locomotor movements but not very smoothly.	Able to perform locomotor movements well.	Able to perform locomotor movements very well and smoothly.
<b>Non- Locomotor Movement</b>	Unable to bend, twist, or swing properly.	Able to perform non-locomotor movements but not accurately.	Able to perform non-locomotor movements well.	Able to perform non-locomotor movements very well and in a controlled manner.

### **Data collection technique**

The research procedure was carried out through several systematic stages to obtain accurate data on the effectiveness of the interactive audio-visual game "Snakes and Ladders." In the initial stage, the researcher prepared the learning tools and digital media to be used. This step was crucial to ensure that the developed media aligned with the characteristics of elementary school students and supported the learning objectives. which emphasizes that physical education media in the digital era needs to be designed by considering pedagogical and technological aspects. The observation sheet as the main instrument was developed based on fundamental motor skill indicators commonly used in research on children's motor development, including locomotor, non-locomotor, and manipulative movements (Oktarifaldi et al., 2024; Suryadi et al., 2024)

After the instruments and materials were prepared, the study continued with a pretest, where students were asked to perform various basic movement activities. The pretest aimed to obtain an initial overview of students' motor skills, and assessment was conducted through direct observation using a prepared observation sheet to ensure the data accurately reflected students' actual performance. Gandasari et al. (2023).

The intervention using interactive audio-visual snakes and ladders game media was conducted over six meetings for three weeks, with two sessions per week. Each session lasted approximately 35 minutes, following the standard duration of physical education learning in elementary schools.

During each session, students participated in physical activities integrated with the interactive snakes and ladders game designed to stimulate locomotor and manipulative movements. After the intervention period was completed, a post-test was administered to measure the improvement in students' motor skills.

### **Data analysis**

Data analysis was conducted quantitatively based on a one-group pretest-posttest research design. The data were obtained from observations of students' fundamental motor skills before and after the implementation of the interactive audio-visual snakes and ladders game media.

The initial stage of the analysis involved descriptive statistics to provide an overview of the distribution and improvement of students' motor skill scores (Oktarifaldi et al., 2024)

Before conducting further statistical testing, a normality test using the Shapiro-Wilk method was performed to ensure that the data met the assumptions required for parametric analysis. The use of normality testing is commonly recommended in pretest-posttest studies examining motor performance (Kurki et al., 2021)

After the data were confirmed to be normally distributed, a paired sample t-test was conducted to determine whether there were significant differences between pretest and

posttest scores. This statistical technique is widely used to evaluate changes in performance within the same group following an intervention (Gandasari et al., 2023)

In addition to statistical significance testing, the magnitude of the intervention effect was also calculated using Cohen's *d* effect size to determine the practical significance of the improvement in students' motor skills. The interpretation of the effect size followed the general criteria where 0.2 indicates a small effect, 0.5 a medium effect, and 0.8 or higher a large effect. The inclusion of effect size analysis provides additional information about the strength of the intervention beyond the *p*-value (Rahmani et al., 2022)

## RESULTS AND DISCUSSION

The results showed that the mean score increased from 9.83 in the pretest to 13.28 in the posttest, indicating an improvement in students' fundamental motor skills after participating in the learning activities using the interactive digital game media. To obtain a more detailed understanding of the improvement, the analysis was also conducted for each motor skill component, including balance, coordination, manipulative movement, locomotor movement, and non-locomotor movement.

Overall, the results indicate that students experienced improvements across most motor skill components after the implementation of the interactive digital game-based learning media.

Descriptive statistical analysis was conducted to provide an overview of students' fundamental motor skills before and after the intervention. The results of the descriptive analysis are presented in Table 2.

Table 2. Statistical description of pretest and posttest results

Source					Standard.			
Data	N	Min	Max	Mean	Median	Deviation	Reach	Amount
Pretest	18	8	10	9.83	10	1.29	4	177
Posttest	18	12	16	13.22	13	1.70	6	238

Based on the table above, it can be seen that the descriptive statistics of students' basic motor skills in the research group show that in the pretest, the maximum score was 10 and the minimum score was 8, with an average of 9.83, a median of 10, a standard deviation of 1.29, a range of 4, and a total score of 177. These results indicate that students' basic motor skills before receiving treatment were still in the moderate category with relatively homogeneous data variations. In the posttest, the maximum score was 16 and the minimum score was 12, with an average of 13.22, a median of 13, a standard deviation of 1.70, a range of 6, and a total score of 238. The increase in maximum, minimum, and average scores in the posttest showed positive changes in students' basic motor skills after being given treatment in the form of physical education learning using digital-based interactive audio-visual snake and ladder game media.

To obtain deeper insight into the pattern of improvement, the results were also analyzed at the component level. Table 3 presents the comparison between pretest and posttest scores for each fundamental motor skill component.

Table 3. Analysis of Improvement in Each Motor Skill Component

Motor Skill Component	Mean Pretest	Mean Posttest	Improvement
Balance	1.61	2.50	+0.89
Coordination	1.89	2.39	+0.50
Manipulative Movement	1.94	2.44	+0.50
Locomotor Movement	2.00	2.72	+0.72
Non-Locomotor Movement	2.22	3.11	+0.89

The component-level analysis shows that all fundamental motor skill components improved after the implementation of the interactive audio-visual snakes and ladders game media. The largest improvements were observed in balance and non-locomotor movements, both showing an increase of 0.89 points from pretest to posttest.

Locomotor skills also showed a substantial increase with a mean improvement of 0.72, indicating that activities involving movement across the game board effectively stimulated students' running, jumping, and general locomotor coordination.

Meanwhile, coordination and manipulative movements demonstrated moderate improvements of 0.50 points each. Although the increase was smaller compared to other components, these skills still showed positive development after the intervention.

These results indicate that the use of interactive game-based media can stimulate multiple aspects of students' motor development, although the magnitude of improvement varies across different motor skill components.

The data normality test in the study was conducted by testing the pretest and posttest data using the Shapiro-Wilk method with the help of SPSS VERSION 29. The test criteria state that the data is normally distributed if the significance value (Sig.) is greater than 0.05. The results of the data normality test can be seen in the following table.

Table 4. Normality Test Results

Design	Sig	Sig Level	Information
Pretest	.123	>0.05	Normal
Posttest	0.284	>0.05	Normal

Based on the results of the normality test, the significance value of the pretest and

posttest data was found to be greater than 0.05, so it can be concluded that the data is normally distributed. The data meets the assumptions for parametric statistical analysis, and then, a Paired Sample t-Test was conducted to determine the differences in students' basic motor skills before and after being given treatment in the form of an interactive digital snakes and ladders audio-visual game. The significance criteria in this study were determined based on a significance level of  $\alpha = 0.05$ . Data are considered significant if the significance value (Sig.) of the statistical test is less than 0.05 (Sig. < 0.05), which means there is a clear difference or effect. Conversely, if the significance value is greater than 0.05 (Sig. > 0.05), the difference is considered insignificant.

Table 5. Paired t-Test Results

Variable	N	Mean	SD
Pretest	18	9.83	1.15
Posttest	18	13.22	1.56

  

Test	t	df	p	Effect Size (d)	95% CI
Pretest-Posttest	-20.60	17	<0.001	4.86	3.04-3.74

Table 5 presents the results of the paired sample *t*-test comparing students' motor skill scores before and after the implementation of the interactive audio-visual snakes and ladders game media. The mean score increased from 9.83 (SD = 1.15) in the pretest to 13.22 (SD = 1.56) in the posttest. The results indicate a statistically significant difference between the pretest and posttest scores,  $t(17) = -20.60$ ,  $p < 0.001$ .

The 95% confidence interval ranged from 3.04 to 3.74, indicating a consistent improvement among students. In addition, the effect size (Cohen's  $d = 4.86$ ) indicates an extremely large effect, suggesting that the use of the interactive game-based learning media had a substantial impact on students' motor skill development.

The findings of this study indicate that the implementation of interactive audio-visual snakes and ladders game media contributed to improvements in students' fundamental motor skills. The results showed that the mean posttest scores were higher than the pretest scores across all assessed components, including balance, coordination, manipulative movement, locomotor movement, and non-locomotor movement. These results suggest that integrating interactive and game-based learning media into physical education activities can provide meaningful stimulation for the development of students' motor abilities.

One possible explanation for the observed improvement is the increased student engagement and motivation generated by game-based learning activities. Interactive games create a learning environment that combines elements of challenge, enjoyment, and competition, which encourages students to participate more actively in movement-based tasks. Previous research has shown that game-based learning approaches can significantly enhance student motivation and participation in physical education, which in turn contributes to improvements in motor skill development (Rahmadani et al., 2023; Adnyana et al., 2025)

In addition, the use of audio-visual media provides clear demonstrations and instructions that help students better understand the correct execution of movements. Visual modeling and auditory cues allow students to observe, imitate, and practice movements repeatedly, which are important processes in motor learning. According to motor learning theory, repeated practice combined with visual feedback can accelerate the development of fundamental motor skills in children. Therefore, the integration of visual guidance within the interactive game media likely supported students in performing movements more accurately and confidently.

The component-level analysis further revealed that improvements across motor skill components were not entirely proportional. The largest improvements were observed in balance and non-locomotor movements, while coordination and manipulative skills showed more moderate increases. One possible explanation is that the structure of the snakes and ladders game requires students to frequently perform body control and posture adjustments while moving between game spaces, which naturally stimulates balance and non-locomotor movements. In contrast, manipulative skills such as throwing and catching involve more complex coordination between visual perception and hand movement, which typically requires longer and more specialized practice to develop optimally (Kurki et al., 2021)

Another important factor contributing to the improvement may be the playful learning environment created by the game-based approach. Young learners tend to respond more positively to learning activities that resemble play rather than formal instruction. When students perceive activities as enjoyable and non-threatening, they are more willing to experiment with movements and repeat them multiple times, which supports motor skill acquisition. This aligns with previous studies suggesting that playful and interactive learning environments can enhance both physical activity participation and motor development in elementary school students (Rezki et al., 2024; Suryadi et al., 2024). Previous research on exergames and digital physical activity interventions has also shown positive effects on children's motor skills and psychological engagement during learning activities (Rosi et al., n.d.)

Despite the positive findings, this study has several limitations. The use of a one-group pretest-posttest design without a control group limits the ability to establish strong causal relationships between the intervention and the observed improvements. Other factors such as natural maturation, repeated exposure to the assessment tasks, or novelty effects may also have contributed to the improvements. Therefore, future research is recommended to employ experimental or quasi-experimental designs with control groups to provide stronger evidence regarding the effectiveness of interactive digital game-based media in physical education settings.

Overall, the results of this study suggest that interactive audio-visual game-based learning media have promising potential to support the development of fundamental motor skills among elementary school students. By combining physical activity, visual instruction, and game elements, this approach can create an engaging and supportive learning environment that promotes both motor skill development and student participation in physical education.

## CONCLUSION

The results of this study showed an improvement in students' motor skill scores after the implementation of the interactive audio-visual snakes and ladders game media. These findings suggest that the use of interactive game-based learning media may support the development of students' fundamental motor skills in elementary school physical education.

However, since this study used a pre-experimental design without a control group, the results should be interpreted with caution. Future studies are recommended to use experimental or quasi-experimental designs to provide stronger evidence regarding the effectiveness of interactive game-based learning media.

This study contributes theoretically to the development of physical education learning by providing empirical evidence on the effectiveness of interactive digital game-based media in supporting the development of fundamental movement skills among elementary school students. Practically, the findings of this study provide an alternative learning strategy for physical education teachers to integrate interactive digital games into classroom activities in order to enhance students' engagement and motor skill development.

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