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The Effectiveness of Using the Play-Based Learning Strategy in Enhancing the Concept of Mechanical Energy for Fifth-Grade Students

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Abstract
The study aimed to investigate the effectiveness of using the play-based learning strategy in enhancing the concept of mechanical energy among fifth-grade students. To achieve the study's objectives, a purposive sample of students was selected, and the targeted scientific content (mechanical energy, potential energy, kinetic energy, and related applications) was redesigned to align with the play-based learning strategy. Realistic and alternative tools – formative and summative – were also designed to collect data. After that, the data was collected and analyzed descriptively. The results indicated that the students' scores ranged between 46 and 54 out of a total score of 54. While the overall average performance of the study sample was 51.3 out of 54, six students achieved the full score of 54/54. The results also indicated that the students who scored high were the most engaged, participative, and interactive during the games, activities, and teaching events. In light of these results, the study recommends the importance of activating learning through play in teaching physics and other subjects, and training teachers to design lessons using creative and innovative games that stimulate and enhance students while considering their diversity.

Keywords: Play-Based Learning, Mechanical Energy Concepts, Fifth Grade, Science Education

Introduction

Educational literature emphasizes the importance of integrating play into the educational process and its effectiveness in developing scientific concepts among students. Al-Sahar (2017) [4] indicates that organized play contributes to the development of creative thinking skills and conceptual understanding and enhances student participation within the classroom. Masa'adeh (2021) [12] adds that play is an effective means of transferring the scientific concept from just a theoretical term to a tangible experience that the student lives and understands through movement and participation. The study by Özdemir (2019) [13] demonstrated that students who learned thru play-based activities showed higher enthusiasm and motivation, and their conceptual understanding was greater compared to their peers who learned thru traditional methods.

This research focuses on applying the play-based learning strategy in teaching the concepts of mechanical energy, which includes potential energy associated with an object's height and kinetic energy associated with an object's speed. Since these concepts require the use of sensory experiences, experiments, and interactive activities for a deep understanding, the use of play provides a realistic and experimental framework that makes learning more solid. This is also supported by Al-Ghamdi (2019) [2] and Bawaneh & Alnamshan (2023) [8], who indicated that a classroom environment that allows for movement and play enhances conceptual thinking and practical application among elementary school students. This research was conducted in one of the Jordanian Badia schools affiliated with the Mafraq Governorate – East Jordan – which is an educational environment that provides suitable spaces for implementing various physical and educational activities. A sample of fifth-grade students, aged 10-11 years, was selected, a group characterized by physical activity, a love for exploration, and a readiness for group participation. This age group also represents a critical stage in the student's transition from simple sensory learning to abstract thinking, making it ideal for applying active learning strategies such as learning through play. This research aims to study the effectiveness of the play-based learning strategy in improving students' understanding of mechanical energy concepts, through analyzing the results of field application, comparing them with relevant literature, and providing recommendations that science teachers in primary grades can benefit from to enhance their teaching practices and achieve deeper and more effective learning.

Literature Review

When reviewing educational literature related to the study question "What is the effectiveness of using the play-based learning strategy in enhancing the concept of mechanical energy for fifth-grade students?" It became clear to me that this field is rich in studies that emphasize the importance of integrating active methods with abstract scientific concepts, especially at the elementary education stage. This educational literature has helped develop a deep understanding of how to employ play-based learning as an effective pedagogical approach that enhances the quantity of the learning process through excitement and motivation. It has also strengthened the ability to build comprehensive study units that align with the characteristics and needs of learners, while considering educational values and ethical considerations. By revisiting the literature, Al-Sahar's (2017) [4] study demonstrated the importance of the play-based learning strategy in developing scientific concepts among elementary school students. The researcher explained that this strategy allows learners to actively participate in educational situations and helps them build concepts through sensory experience and collaborative practice. This aligns perfectly with the context of the current research, where this strategy was applied in the lesson on mechanical energy (which includes the concepts of potential energy and kinetic energy) within an engaging school environment, utilizing simple tools and kinetic activities to represent the concepts in tangible ways. As for the cognitive content level, educational literature has helped enhance the understanding of the nature of concepts related to mechanical energy, as studies have shown that these concepts are characterized by abstraction and relative difficulty, which necessitates the use of teaching strategies that integrate theory and practice. Therefore, it was important to design activities that helped students distinguish between potential energy (related to the height of the body) and kinetic energy (related to the movement of the body). The educational plans included interactive games, such as the game "From Top to Bottom: Is There Energy?" And the "Energy Race" game, to bring these concepts closer in a fun and practical way. From the perspective of pedagogical content knowledge, educational literature has provided sufficient support to understand the relationship between scientific material and its teaching methods. For example, Masa'adeh (2021) [12] study clarified that a successful teacher is one who can transform an abstract scientific concept into a realistic educational activity suitable for the student's age, which was applied by linking classroom games with the physical behavior related to force and energy. Other studies, such as Özdemir (2019) [13], have also helped in understanding how play affects students' motivation toward learning, which was observed during the implementation and data collection when noticing positive interaction and active engagement in activities, reflecting on their understanding of the targeted concepts.

In terms of assessment and data collection in this study, alternative and authentic assessment strategies were used. Educational literature has emphasized the importance of using alternative assessment tools that measure learners' true understanding, not just their ability to memorize. Therefore, this study resorted to using observation cards and group performance assessment, in addition to carefully designed worksheets to measure the student's ability to apply the concept in similar life situations. These tools enabled the researcher to collect precise qualitative data, enhancing the reliability of the survey results Bawaneh., Moumene, & Aldalalah (2020) [9]. The study by Al-Sumairat (2023) [5] indicated that using alternative assessment tools within active strategies such as learning through play enhances learning outcomes and increases diagnostic accuracy. On the other hand, the study employed the inquiry-based approach in planning, implementation, and even in reading and discussing the results. Considering that, educational literature helped in recognizing the importance of choosing a clear and specific investigative question that stems from the reality of educational practice (Al-Hattami and Bawaneh, 2025) [3]. The proposed question has been refined to focus on the effectiveness of a specific strategy (learning through play), within a specific scientific context (mechanical energy), and for a specific age group (fifth-grade students). The understanding of literature also supported linking the question to a systematic action plan, which included designing curricula related to the targeted content, using multiple tools for data collection, and considering the real school context characterized by environmental and educational features suitable for implementing such activities.

The literature also indicated the importance of linking educational content to the student's reality and local environment (Mahmoud and Bawaneh, 2025) [11]. The researcher noticed that students respond more to activities that represent situations from their daily lives, such as linking kinetic energy to the movement of bicycles, or potential energy to playing on the playground hills. This practical application enhanced the value of the concept in the learner's view, making the learning more stable and longer lasting. Literature has supported these practices and considered them among the most important characteristics of active and successful education. Additionally, through a review of educational literature, the researcher concluded that some studies did not sufficiently clarify the impact of cultural or environmental diversity on the outcomes of strategy implementation. This study attempted to address this by applying activities in a school located in an area with medium population density and modest classroom environment, making the practical application of the play-based learning strategy more challenging. This reflects the importance of adapting theories and strategies to local contexts and modifying them to suit the school's resources and the classroom reality.

In light of the above, I see that educational literature has played a pivotal role in shaping my understanding of the nature of inquiry, identifying its strengths, such as its suitability for the target audience, its integration with the curriculum, and its ability to generate qualitative data that enhances teaching effectiveness (Bawaneh, 2026) [6]. It also helped expand the vision toward the importance of inquiry as a tool for improving classroom practices, by utilizing evidence to modify planning and assessment strategies, linking learning outcomes to reality, and starting from field observations to develop professional performance. So, we can say that educational literature was not just a source of knowledge supporting the research content, but rather a practical guide that helped in shaping the theoretical framework, building the action plan, designing assessment tools, and interpreting results in an integrated manner that supports professional understanding and develops teaching practices. This review of the literature also helped to

enhance the awareness that the educational process must be constantly renewed, based on continuous inquiry, ongoing reflection, and learning from reality.

The inquiry-based approach in teaching

This inquiry focuses on studying the effectiveness of the learning-through-play strategy in enhancing fifth-grade students' understanding of the concept of mechanical energy, with its two components: potential energy and kinetic energy. I chose this topic because I believe that play is not just a means of entertainment, but an effective educational tool, especially in the foundational stages, where play serves as a central hub for students' interaction with educational concepts. I based this approach on several studies that examined the impact of play on achievement and understanding, including Al-Sahar's (2017) [4] study, which demonstrated the positive effect of learning thru play in developing scientific concepts and creative thinking skills, as well as Masa'adeh 's (2021) [12] study, which showed a tangible impact of the play strategy in improving students' attitudes toward science. During the preparation phase, the research question was carefully selected: "What is the effectiveness of using the play-based learning strategy in enhancing the concept of mechanical energy for fifth-grade students?" This question was refined to ensure its clarity, direct relevance to the content of the Jordanian science textbook, and its applicability in the real school context. To enrich the theoretical aspect, reference was made to educational literature related to play-based learning and science education, focusing on various studies such as Al-Sumairat's study (2023) [5] and Özdemir's study (2019) [13], which linked the use of play to increased student motivation for learning.

The action plan was developed by designing the curricula to rely entirely on the play-based learning strategy. The first plan addressed the basic concepts of kinetic energy and potential energy in an engaging introductory manner, incorporating tangible tools such as balls and inclined planes to represent potential and kinetic energy. As for the second plan, it was dedicated to applying the concept of mechanical energy and distinguishing between kinetic and potential energy through group educational games designed to stimulate collective interaction and enhance the understanding of concepts through competition and cooperation among students. The plans included all the necessary elements for implementation: lesson plans, illustrative images, worksheet templates, and educational activities. This planning was aligned with the principles of the play-based learning strategy, where play was employed as a learning tool rather than just a means of entertainment. The activities were designed to serve specific educational objectives and are directly linked to the lesson's learning outcomes. Educational tools have been employed within a flexible environment that allows for movement and interaction, contributing to increasing student motivation and reinforcing concepts through active learning. As indicated by Al-Sumairat's study (2023) [5], involving students in physical and competitive activities positively reflects their understanding of science. In addition to implementation, planning also focused on appropriate assessment tools for this strategy, such as criteria for evaluating tasks during the lesson, criteria for the play-based learning strategy, and the overall lesson outcomes, which helped in collecting qualitative and quantitative data to answer the research question. This is confirmed by educational studies that view learning thru play as a comprehensive approach that can combine both education and assessment simultaneously (Özdemir, 2019) [13].

Ethical considerations for research

Ethical considerations are an integral part of any educational research involving direct interaction with students, especially when activities are conducted within the classroom. In the context of my research on the effectiveness of using the play-based learning strategy to enhance the concept of mechanical energy among fifth-grade students, I was keen from the outset to adhere to a set of ethical guidelines that ensure respect for participants' rights and maintain a safe and effective learning environment. Some studies have indicated that ethical commitment is one of the critical factors in the success of any educational experiment based on active practices (Musa, 2021; Bawaneh. *Et al*., 2025 [7]).

The first steps involved ensuring approval from the education administration and the school after communicating with them and informing them of the research objectives and plan, while confirming that the proposed activities complement the curriculum and do not conflict with the official schedule or educational content, nor cause physical or psychological harm to the students. This aligns with what Al-Sumairat (2023) [5] mentioned about the importance of prior coordination between the researcher and teachers to avoid any conflicts in the academic schedules and ensure smooth implementation. Coordination was also carried out with the teachers of other subjects for the study sample class to ensure the success of the experiment without negatively affecting the regular lesson schedule. One of the important aspects that were considered in this context is the protection of the privacy of the participating students. All the data collected, whether related to performance, interaction, or responses during play, was kept completely confidential. Real names or any identifying data were not used; instead, alternative codes were employed when recording and analyzing the results. This procedure was necessary to maintain the students' identities and ensure that the information was not misused for any purpose outside the scope of the research, which was emphasized by Abdullah's (2020) [1] study that confirmed the necessity of preserving the confidentiality of participants in classroom research.

As for the use of the results, there was a commitment not to exploit them in any context outside the objectives of scientific research. The data was also not used for individual student evaluation purposes or for comparing classes or schools. The data were analyzed objectively, focusing on general trends that serve the study's purpose, without referencing individual details that could be misinterpreted. This reflects a commitment to scientific neutrality and respect for the principles of transparency and integrity in presenting the results (Özdemir, 2019) [13]. I also ensured that student participation in activities is voluntary and non-mandatory, and this was explained in a simplified manner appropriate for their ages. It was emphasized that their unwillingness to participate would not have any negative impact, whether on academic evaluation or on the relationship with the teachers. This clarification helped create an environment of trust and psychological safety, which is emphasized by modern educational literature in

active play practices that respect the student's right to refuse participation without pressure (Bruner, 1960) [10]. Another aspect of great importance is the cultural and psychological appropriateness of the activities for the students. The content of the activities has been designed to avoid any sensitive or controversial topics, taking into account the cultural background and social values of the school environment. The goal was to provide an enjoyable and safe educational experience that supports scientific curiosity and does not impose psychological pressure on learners, as recommended by Vygotsky in his theory of social learning and the importance of context in shaping cognitive experience (Vygotsky, 1978) [14]. Through all these measures, it can be said that ethical considerations were an essential part of the planning and implementation and were not merely formal requirements. The commitment to these aspects helped build a mutual trust relationship with students and teachers and contributed to the success of the experiment both educationally and research-wise. It also enhanced the credibility and reliability of the research, ensuring that the obtained results came within a fair and humane context that respects the learner's entity and strengthens their role in a healthy educational environment.

Results

This section of the research includes the presentation and analysis of the results obtained thru the application of the play-based learning strategy in teaching the topic of mechanical energy to fifth-grade students. The aim of this presentation is not only to provide numerical data but also to examine the actual practices that took place within the classroom environment, analyze how this strategy affected student learning, and connect it to educational literature to reach conclusions that enhance the educational understanding of practical applications. Initially, academic performance data for students were collected through various assessment tools, including observation of individual and group performance, evaluation of classroom tasks, analysis of the achievement of predetermined educational outcomes, and monitoring student engagement with classroom activities based on the play-based learning strategy. Three main criteria were adopted to evaluate the results: (I) the criteria specific to the play-based learning strategy (15 points), (II) the general outcomes of the mechanical energy lesson (18 points), and (III) the criteria for evaluating tasks during the lesson (21 points). The total possible score was 54 points for each student. These criteria were applied to a sample of 16 students, as shown in Table 1, and the results ranged between 46 and 54 points, with the majority falling within the high range (48 and above) as indicated in the table. Six students scored full marks (54), while the overall average performance was 51.3 out of 54, indicating a high effectiveness of the strategy used.

Table 1: Students' results in all assessment tools as well as the total sum

Student	The criteria for the play-based learning strategy (Out of 15)	General Learning outcomes of the mechanical energy lessons (Out of 18)	The criteria for evaluating tasks and activities during the lessons (Out of 21)	Total (Out of 54)
A	15	18	21	54
B	12	16	18	46
C	13	16	19	48
D	15	18	21	54
E	13	18	20	51
F	13	16	19	48
J	13	16	19	48
K	15	18	21	54
L	15	18	21	54
M	14	17	18	49
N	15	18	21	54
O	13	15	19	47
P	13	18	21	52
Q	15	18	21	54
R	15	18	20	53
S	15	17	20	52

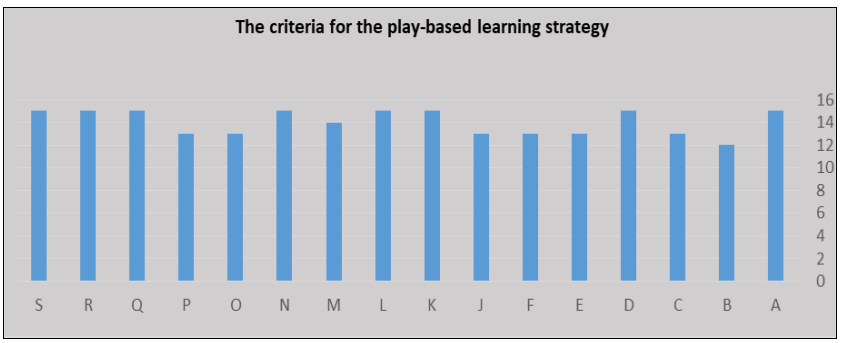

Fig 1: Students' results in interacting with play-based learning strategy

When analyzing the data, we noticed that the interaction with the play activities (Fig 1) was high, as the activities were designed to include physical and mental games that simulate the concepts of kinetic and potential energy, such as the game (from top to bottom... Is there energy?), in which students use simple tools to demonstrate the effect of the body's height or speed on the amount of energy. It has been found that students who scored high on this criterion had the confidence to express their opinions, participated in discussions and presentations, were receptive to interacting with their peers, and were more engaged and helpful within the group when needed and in emergency situations. They completed the tasks assigned to them fully and correctly.

As for the educational outcomes criterion (Fig 2), the data showed that most students were able to achieve the targeted outcomes, such as (the student identifying the factors that kinetic energy depends on, the student understanding the concept of mechanical energy, the student explaining the factors that potential energy depends on). Interestingly, the students who achieved full marks in this criterion are the same ones who actively participated in the post-play stages, such as interpretation and linking the results to the scientific context.

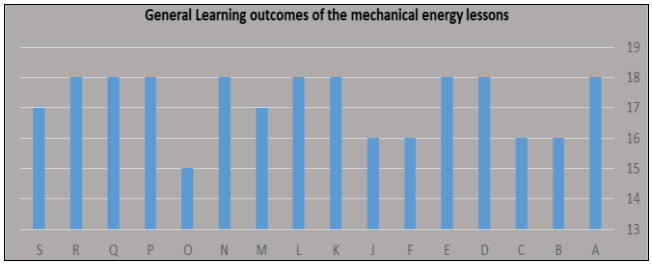

Fig 2: Students' results related to learning outcomes associated with mechanical energy

As for the third criterion, task evaluation during the lesson (Fig 3), most students received scores ranging between 18 and 21, reflecting that the tasks accompanying the activity were suitable for the students' abilities. These tasks were characterized by a focus on deep understanding through open-ended questions, assigning students to answer cards, students performing activities, recording results during the activities, and answering worksheets. The students who were less effective in this criterion were those who showed hesitation in written or oral expression, despite their good participation in play.

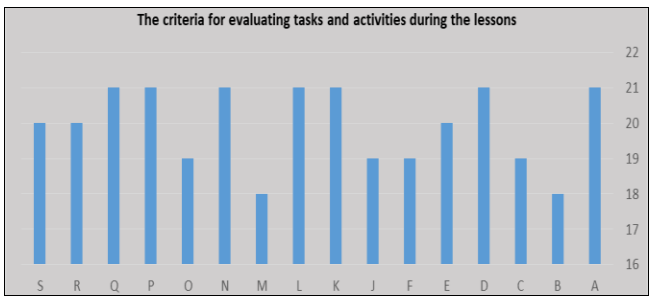

Fig 3: Student performance on tasks and activities during the lessons

Discussion and recommendations

When linking these results to educational literature, we find that they align with Vygotsky's theory, which views play as an educational medium that enhances higher mental functions through an interactive learning environment that allows for stimulation and experimentation (Vygotsky, 1978) [14]. Bruner (1960) [10] confirms that learning through play develops exploratory thinking and intrinsic motivation in the learner. Al-Ghamdi's study (2019) [2] found that using play in science teaching increased achievement levels by 23% compared to traditional methods. Abdullah's study confirmed that play enhances students' ability to connect concepts and apply them in new situations, thereby expanding their understanding and improving the efficiency of constructivist learning (Abdullah, 2020) [1]. These results indicate that play is not just a means of entertainment in the classroom, but rather an effective strategic approach to building deep scientific learning, especially in subjects that require conceptual and experiential understanding. The experiment of teaching mechanical energy using the play-based learning strategy demonstrated that students who deeply engaged with classroom games showed a broader understanding and better performance in related tasks. Accordingly, a set of conclusions can be drawn:

- The play-based learning strategy has proven effective in enhancing the understanding of physical concepts, such as mechanical energy. The play-based learning strategy has proven effective in enhancing the understanding of physical concepts, such as mechanical energy.
- It has shown good ability to engage students in the educational process through interactive activities that focus on understanding rather than memorization. Showed a good ability to integrate students into the educational process through interactive activities that focus on understanding rather than memorization.
- It boosted students' self-confidence and expression of ideas, especially in early age stages. It enhanced self-confidence and the expression of ideas among students, especially at the early age stages.

Therefore, it is recommended to intensify the use of this strategy in teaching science, with the necessity of diversifying play activities to suit different learning styles and ensuring effective participation from all students.

Upon reflecting on this study, which employed the experimental inquiry method thru the use of the learning-by-playing strategy to enhance the learning of fifth-grade students on the topic of mechanical energy, we find that the educational inquiry process is not merely a tool for evaluating the effectiveness of the lesson and teaching methods, but rather a rich experience that enhances teachers' professional awareness and drives them to deeply review their educational practices. This is what many studies indicate, confirming that field-based educational research allows teachers to reconsider their plans and perceptions through real data and critical analysis of the context (Musa, 2021; Al-Sahar, 2017 [4]). The inquiry-based approach provides teachers with space for critical thinking in the planning and implementation steps, guiding their practices more consciously, focused, and effectively, by relying on

data rather than just intuition. Bruner (1960) [10] indicates that a successful teacher treats education as an experience open to reflection and continuous development. One of the educational aspects related to this study is that active learning—especially thru play—enhances the learner's ability to express, understand, and connect concepts to their experience. As the results of Özdemir's (2019) [13] study showed, play not only stimulates understanding but also creates a positive emotional environment that encourages students to explore and increases their enthusiasm for learning. I noticed that students who engaged deeply in play were more capable of providing accurate scientific explanations and showed confidence in discussing concepts such as potential energy and kinetic energy. As for the learning outcomes, the data collected through observation and worksheets confirmed that the students did not merely absorb the information but also used it in practical activities and representations. Literature has supported this type of learning as authentic constructivist learning, where the student participates in building their knowledge through experimentation and thinking (Abdullah, 2020) [1]. Vygotsky (1978) [14] also pointed out that learning based on social interaction and stimulating activities raises the level of thinking and enhances the student's analytical abilities. With a critical reading of the results and proceedings of this study, many questions arose for me, some educational and some methodological. I wondered, for example, how to adapt the play strategy to suit more complex abstract concepts, or how to involve teachers and parents in this type of learning. I also thot about the possibility of developing qualitative assessment tools that demonstrate critical thinking and collaboration skills, not just academic achievement, which was indicated by Masa'adeh study (2021) [12] when it discussed the impact of play on scientific thinking skills and attitudes toward the subject.

From here, the study concludes the importance of learning through play in enhancing students' understanding of physical concepts such as mechanical energy and its transformations between potential energy and kinetic energy, and the conservation of energy. This strategy also plays an important role in integrating students and increasing their motivation toward learning. Accordingly, the study recommends the importance of activating this strategy according to the inquiry-based approach in various subjects, especially physics, as well as training teachers to design diverse games and possibly integrating them with digital applications to accommodate the diversity of learners to enhance students' learning, motivation, and attitudes toward science and other subjects.

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