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Integration of Local Wisdom of Pencak Silat in Learning Newton's Laws based on ICT-Technology to determine Student Learning Motivation

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ABSTRACT

Objective: *This research aims to develop a 2D technological visualization that integrates the application of Newton's Third Law into pencak silat movements, providing a contextual bridge between physics concepts and traditional martial arts. The objective is to enhance students' motivation and conceptual understanding by presenting the action–reaction principle through culturally relevant motion analysis.* ***Method:*** *The study employed a qualitative descriptive method with data collected from literature analysis and expert interviews involving pencak silat practitioners and physics educators. The visualization design was then refined to display key pencak silat techniques such as stances, strikes, and blocks – while mapping the corresponding forces of action and reaction.* ***Results:*** *2D visualization is effective in clarifying how Newton's Third Law operates within martial movements, making abstract concepts more tangible. Teachers and students reported that the visualization improved comprehension, engagement, and learning motivation. Moreover, the concise two-dimensional format allowed force interactions to be represented clearly without overwhelming detail, supporting efficient classroom integration.* ***Novelty:*** ***T****his research lies in merging local cultural heritage with interactive technological media, transforming pencak silat not only as a form of art and self-defense but also as an innovative educational tool for learning physics. This approach highlights how digital visualization can preserve tradition while modernizing science education, thus offering a meaningful model for contextual and technology-enhanced learning*

INTRODUCTION

In the field of education, learning and teaching are inseparable components. Learning concerns what students should do as recipients of instruction, while teaching is the teacher's role in delivering education. These two elements interact between students and between students and teachers in the classroom (Arrafi et al., 2023; Lestari & Mansyur, 2021). The learning process is more than just memorizing and practicing drills, emphasizing changes in behavior, thinking, and personality in students. Success in the learning process is achieved if students master the material according to the curriculum, especially in the field of physics (Apriantono et al., 2020; Marisa et al., 2022). Physics is the study of physical phenomena, including scientific cyclical processes, interconnections, and explanations of natural events that are measured through observation and research (Fachrezzy et al., 2024). As a scientific discipline, physics includes scientific products, processes, and attitudes, which cultivate outstanding and well-rounded students in physics learning. Student development is closely related to teacher support, including motivating students from the start of learning to ensure they are involved in learning. When teachers start by providing motivation, they can help students understand the purpose of learning and its relevance to life. This not only helps

create a positive learning environment but also builds students' enthusiasm for understanding the lesson material (Taam et al., 2024).

Many countries include physics in their education policies to equip human resources with knowledge that is useful for technological development, discovery, and other sciences. As part of a scientific discipline, physics plays a role in advancing science in life. People often interpret their experiences based on beliefs in their environment, which is known as indigenous science. Indigenous knowledge reflects local wisdom as an understanding of nature and culture in society (Sunarti et al., 2024). Educators guide their students in acquiring knowledge, which requires adapting the learning process to the environment. When the potential of the environment is maximized, learning becomes more meaningful (Prabowo, 2022). Contextual learning connects students' direct experiences with their lessons, creating a more engaging educational experience (Koto et al., 2025). Although students know their culture, their actual experiences may differ, providing opportunities for ethnoscience-based learning approaches. This method incorporates cultural elements throughout the learning process, making education more reflective of students' own cultural context and fostering an appreciation of culture and heritage (Alimuddin et al., 2022; Habibbulloh et al., 2023; Kwangmuang et al., 2021).

Ethnoscience integrates local wisdom and culture into the curriculum, giving students a concrete perspective and helping them develop critical thinking and skills. By combining local environmental knowledge with cultural aspects, students experience learning that is directly related to the surrounding environment (Sunarti et al., 2024). The diversity of Indonesian culture and traditions spread across various regions not only gives a sense of pride but also supports education in their respective regions (Liana et al., 2023). Adapting learning to local culture and traditions can create a meaningful context in education, where ethnoscience plays an important role in integrating local culture and traditions with the educational process, making learning more relevant and impactful (Ryou et al., 2025). Local wisdom emerges through a long internalization process and is passed down from generation to generation due to interactions between humans and their environment (Luchembe & Shumba, 2022). This evolution of values produces a crystallized value system in the form of customary law, beliefs, and local culture. To keep pace with technological advances, science must develop, and for this reason, it is necessary to explore the scientific potential that exists in society's culture. Madiun, for example, offers many tourist destinations and cultural attractions, such as the art of Pencak Silat. Integrating these cultural elements into basic education in Madiun can help preserve cultural heritage for future generations and foster a reading culture (Farhana et al., 2024).

The application of ethnophysics in supporting motivation to learn the physics concept of Newton's laws has. The average score for each indicator is calculated to determine the highest score. Of the 27 students in the experimental class, five students had moderate motivation, while the majority had high or very high motivation. This shows that student learning motivation in the experimental class is generally high, with an average score

percentage of 90% (Alsalhi et al., 2024). Then, according to the Minister of Education and Culture Regulation Number 21 of 2016, high school students and their equivalents are required to master self-defense activities such as pencak silat, karate, taekwondo, or other traditional martial arts. Pencak silat is part of Indonesian art and culture that must be preserved, including through learning (Ha et al., 2022; Maknun, 2020). Motivation is an important factor in effective learning because it helps inspire, maintain, and control student interest. Students show very low learning motivation towards learning pencak silat (Bouchée et al., 2024). Students tend to reject pencak silat lessons because they are less modern and have dominant elements of violence. In addition, sports teachers feel less confident in teaching pencak silat due to a lack of practice and innovation in learning methods, which may lead to less enjoyable, effective, and efficient learning. This can cause a less conducive learning atmosphere and reduce student motivation (Hadi et al., 2022).

Students often face challenges and a lack of motivation in understanding physics concepts, especially those related to Newton's laws of motion. This can make it difficult for students to understand the abstract material and apply it in real-world situations (Lintangesukmanjaya et al., 2024). To overcome this problem, integrating local wisdom such as pencak silat into physics education can provide a more interesting and enjoyable learning experience. By using pencak silat movements and principles as a medium for teaching physics concepts, students can see the practical application of Newton's laws in their cultural context, thereby increasing their understanding and motivation to learn. Thus, researchers investigated the effectiveness of local pencak silat wisdom in the study of the philosophy of physics, aiming to increase students' learning motivation and explore its potential application in learning.

The purpose of this research is to develop a technological visualization that can utilize Newton's Third Law in pencak silat movements, thereby enabling a more concrete understanding of the relationship between physics and martial arts concepts. This research aims to develop a 2D technological visualization that integrates the application of Newton's Third Law into pencak silat movements, providing a contextual bridge between physics concepts and traditional martial arts. The objective is to enhance students' motivation and conceptual understanding by presenting the action–reaction principle through culturally relevant motion analysis. Through this visualization, pencak silat students and practitioners are expected to be able to see how the principles of action and reaction operate in each attack and defense technique. Thus, this research not only strengthens the understanding of the concepts of physics in a contextualized manner but also provides a learning innovation that connects theory with real-world practice in traditional sports.

RESEARCH METHOD

This research was conducted using a descriptive method with a qualitative approach. Research that describes a phenomenon, event, or ongoing event is called descriptive

research. The research location is the UNESA UKM Center, Ketintang, Surabaya City. The sampling technique uses a purposive sampling method. The samples chosen in this study were five community members, including coaches, athletes, traditional Pencak Silat arts activists, and UNESA physics and sports teachers. The reason for selecting the sample is that the sample is an individual who has in-depth knowledge about the research object (Park et al., 2024).

Figure 1. Research flow

Data was obtained through two techniques, namely interviews and literature study. Interviews are a way to obtain information directly from sources through face-to-face contact. Researchers build a good atmosphere by getting to know and staying in touch with the informants, so that the informants agree to provide real information in detail and quality. The research instrument is in the form of structured interview questions that follow interview guidelines. Interviews were conducted directly with both samples on Thursday, May 16, 2024, at the research location.

Meanwhile, library research is carried out through various library sources to obtain research data. Data from library sources is only used as library collection documents. The research study material includes history and physics concepts related to Newton's laws in Pencak Silat.

The visualization designs in this study were derived through analysis of relevant literature and interviews with experts, resulting in designs based on both theoretical studies and practical experience. This approach ensures that the visualizations developed are not only scientifically grounded but also aligned with the needs and realities of the field, particularly in the application of Newton's Third Law to pencak silat movements. Qualitative data analysis involves activities to obtain meaning from each variable that can be used to answer the researcher's problem formulation. Initially, the researcher examined data collected from field notes and recorded interviews. In the next step, all the collected data is examined.

Researchers categorize and adjust the data needed to address the research problem. The final stage includes data analysis using descriptive and narrative review methods, namely describing everything related to the research object based on philosophical objectives. The conclusion drawn from this analysis technique is to examine and process data, categorize it, and analyze it in a systematic, structured, and orderly manner. In qualitative data analysis, the first step involves activities to obtain meaning from each variable that can be used to answer the researcher's problem. Researchers examined the data collected, including field notes and recorded interviews. Next, all collected data is examined and categorized by researchers to address the research question. The final stage

involves data analysis using descriptive and narrative methods, by describing everything related to the research object in accordance with the objectives of philosophical reflection. The conclusion of this analysis technique is to examine and process data in a systematic, structured, and orderly manner (Rahman et al., 2019; Ruwiyah et al., 2021).

The instrument in this research is a questionnaire for measuring student interest and motivation variables using a Likert Scale. The answer choices and scores used are "Strongly Agree with a value of 4, Agree with a value of 3, Disagree with a value of 2, Strongly Disagree with a value of 1" for positive statement items of motivation to learn. Meanwhile, negative statement items regarding learning motivation were given the opposite score (Hasyim et al., 2024).

RESULTS AND DISCUSSION

Results

Pencak Silat, a traditional martial art native to the Indonesian Archipelago, has various meanings that have evolved. Etymologically, it consists of Pencak, which means basic, organized martial movements, and Silat, which means refined martial movements rooted in spirituality. Thomas A. Green describes regional use, noting Pencak dominates in central and eastern Java, while silat is more common in Sumatra, the Malay Peninsula, and Kalimantan. However, this definition has evolved, with Pencak emphasizing aspects of artistry and grace, and Silat highlighting the essence of martial arts. The history of this art, rooted in traditional Indonesian life, such as swimming, reflects human instincts in response to survival and environmental challenges. Today's Pencak Silat originates from the natural fighting of ancestors, inspired by the movements of local fauna. Insights by Draeger and archaeological evidence prove its existence since Hindu-Buddhist times, as evidenced by weapon artifacts and temple reliefs (Maesaroh & Sutikno, 2025; Muharom & Zaini, 2021).

The spread of Pencak Silat occurred through oral tradition, where each region had respected pencak silat figures. Apart from that, the story of the heroism of the freedom fighters who used Pencak Silat in their struggle also made a significant contribution to the excellence of society. The earliest organizational body that oversees Pencak Silat in Indonesia is the Indonesian Pencak Silat Association (IPSI), which was founded in 1948. In addition, the International Pencak Silat Association (Persilat), which unites Indonesia, Malaysia, Brunei Darussalam, and Singapore, underlines its international recognition. Beyond national borders, Pencak Silat organizations are emerging globally, even in Europe and America. Its integration into national sporting events, such as the National Sports Week (PON) since 1975, reflects its institutionalized presence. UNESCO's recognition of Pencak Silat as an Intangible Cultural Heritage of Humanity on December 13, 2019, underscores its global significance and cultural heritage. Based on interviews with several athletes in the field of pencak silat and physics teachers in Sidoarjo. The following is an analysis of pencak silat as local wisdom integrated with physics concepts.

An interview was conducted with a pencak silat athlete in the arts field named Putri Rusmila, a Physics student at Unesa class of 2022 who once won pencak silat in the art of competition by winning first place at the 2021 Youth Class D Championship, third place at PorKab in Probolinggo Regency, and winning second place in women's doubles in 2020. She started her hobby in pencak silat in the 2nd grade of junior high school in 2018. The motivation for participating in pencak silat is to train in skills and self-defense in everyday life. Apart from that, pencak silat is also able to increase self-confidence, develop mental resilience, foster tenacity, and develop self-awareness of the surrounding environment. On the other hand, it is because the cultural traditions in the area need to be preserved (Olugbade et al., 2024; Setyadi et al., 2025).

One of the basics of Pencak Silat is stance. According to him, the local wisdom of pencak silat is in the single art part 1, which is a series of movements used to attack and defend, and the Toya style. The existing physics concept is modeled as 1 A collisions of martial arts attacks, which combines angular movements, resulting in a model with wider application, not just attacking movements. Move 1 in Pencak Silat is usually a basic move that teaches body position, balance, and basic movements.

Figure 1. Prefix movement of step 1

Move 1 in Pencak Silat is related to Newton's First Law or Law of Inertia, where a martial artist maintains his body both when still and moving. The initial position in the picture shows,

$$\sum F = 0 \quad \ldots (1)$$

$$\sum F - N = 0 \quad \ldots (2)$$

$$\sum F = N = m.g \quad \ldots (3)$$

The footrest position aims to maintain the balance of the fighter's body without any movement or external force. In this case, it is related to ensuring that the fighter's body remains in balance and is ready to continue the next movement. Newton's Third Law is also discussed in art form 1, where a fighter stands on the ground so that an action-reaction pair occurs between the human and the ground, as well as energy input from the muscles (Deveci et al., 2025; Rahimi et al., 2024).

Figure 2. Movement in Stance 1 category A2

In Figure 2, the pat-comb-break movement, this move combines defense and attack techniques. So, it can be analyzed based on Newton's concept III "Every action will cause a reaction of equal magnitude and opposite direction".

$$\sum F_{Action} - \sum F_{Reaction} = 0 \quad \ldots (4)$$

$$\sum F_{Action} = \sum F_{Reaction} \quad \ldots (5)$$

In the Pat movement, the aim is to attack and repel attacks from the opponent. Physics concepts are analyzed when a fighter's hand claps; the arm muscles exert a force on the hand to move forward (Oughannou et al., 2025; Sunarya et al., 2024). The combing motion, in the form of a sweeping or swiping motion with the hands and feet, can be analyzed using Newton's third law in applying a force to the target level. The fighter's body is balanced to withstand the combative force to fit the target. Then, push with a full forward push, for example, when giving a push to your opponent, your hands are in front. So that when applying a forward pushing force to the opponent, the body stabilizes itself so that it is not completely pushed backwards with the foot behind the back to produce optimal pushing force (Puspita et al., 2024). To analyse the physics concepts applied to this system, we need to look at the application of Newton's Laws in the context of rigid body equilibrium, which includes two conditions: translational equilibrium and rotational equilibrium. Translational equilibrium requires the sum of the forces acting on the system to be equal to zero, namely the gravitational force (W) acting downwards at the center of mass of the stick and the normal force (N) acting upwards from the hand, so that.

$$\sum F_y = 0 \quad \ldots (6)$$

$$\sum F_y = N = m.g \quad \ldots (7)$$

Rotational equilibrium requires that the sum of the moments of force about an arbitrary point, such as a hand point, be equal to zero.

$$\sum \tau = 0 \quad \ldots (9)$$

Suppose the length of the stick is (L) and the center of mass is in the middle of the length of the stick, the moment of gravitational force about the point of the hand is

$$\tau_W = W.\frac{L}{2} \quad \ldots (10)$$

While the normal force from the hand does not produce a moment because it acts at the pivot point. For rotational equilibrium:

$$\sum \tau = \tau_W = W.\frac{L}{2} \quad \ldots (11)$$

In a realistic context, there is an additional force from the hand that makes the total moment zero (Ilyas et al., 2023; Yusuf & Wekke, 2020). The image shows the gravitational force (W) acting downwards on the center of mass of the stick and the normal force (N) acting upwards from the human hand. Visualization of the art of Toya Pencak Silat in python, shows it,

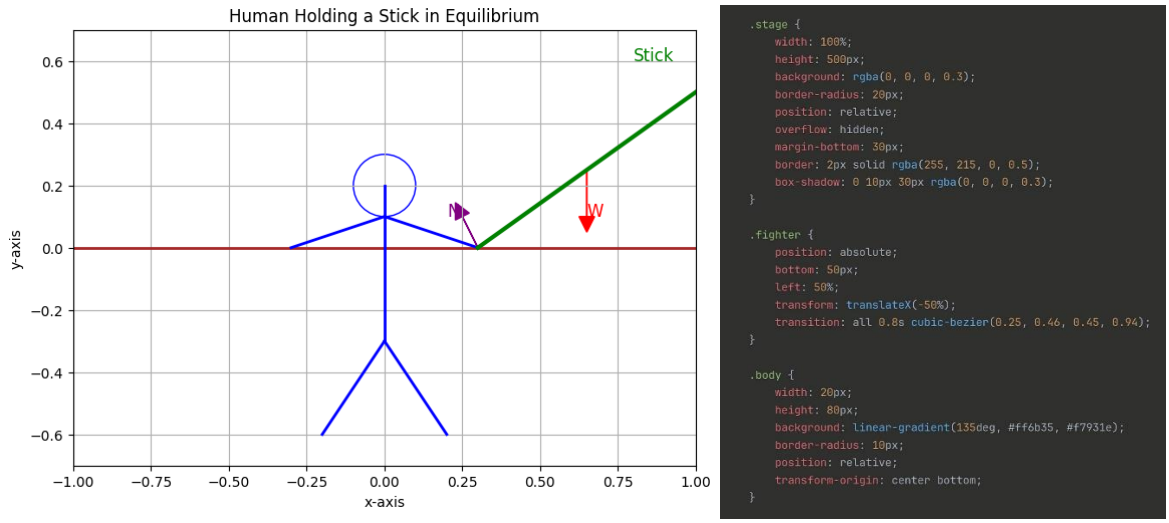

Figure 4. Visualization of the art of Toya Pencak Silat in python

This program aims to illustrate the concept of equilibrium of a rigid body with a human holding a stick. In this system, two main forces act on the stick: the gravitational force (W), which acts downwards on the center of mass of the stick, and the normal force (N), which acts upwards from the human hand. This program visualizes how these forces interact to keep the stick in equilibrium, according to Newton's Law of translational equilibrium (sum of forces equals zero) and rotational equilibrium (sum of moments of forces equals zero). Apart from this, other techniques in pencak silat can be applied to physics concepts, namely breathing techniques to strengthen oneself from collisions with objects (Putri et al., 2024).

The breathing processing technique goes through 3 stages, starting with energy collection. The fighter will learn breathing techniques to increase energy and harden his muscles, which will improve the practitioner. Fighters usually cannot move faster than the previous level; this is due to a decrease in speed. Next, the second stage is focused on

the release of explosive energy (Chinaka, 2021). At this stage, special techniques are needed, such as attacks, pushes, blocks, and even avoidance. In this second stage, a fighter's speed will gradually return to its original level and may even exceed it. The third stage emphasizes the integration of breath into all silat movements.

A martial artist must master these three stages to breathe smoothly and produce energy when needed to compete. The entire breathing pattern, understanding, and implementation are taught at this stage under the supervision of a coach. One of the breathing techniques commonly used in pencak silat when breaking stones is diaphragmatic breathing. This technique involves contracting and relaxing the diaphragm muscle to inhale and exhale deeply. Diaphragmatic breathing helps to maximize oxygen intake and improve respiratory control. Breathing techniques help fighters to get enough oxygen to produce energy through cellular metabolism. This energy is important to support intense and explosive physical movements when a martial artist breaks rocks. In addition, diaphragmatic breathing can increase focus and concentration on movements. This is important to achieve accuracy and precision when breaking the rock, thus increasing the chances of the rock breaking. Calming the mind using diaphragmatic breathing is also needed by martial artists to be more focused and controlled when carrying out rock breaking movements (Fayda-Kinik & Cetin, 2025).

Newton's Third Law states that "for every action, there will be a reaction of equal magnitude and opposite direction". In the context of breaking stones, action is the impact force from the fighter's hand to the stone, and reaction is the force of equal magnitude and opposite direction from the stone to the fighter's hand. Therefore, diaphragmatic breathing helps the fighter to generate a more potent impact force against the rock. This is due to diaphragmatic breathing, which helps fighters to get enough oxygen and increases focus and concentration. The stronger impact force of the martial artist produces a stronger reaction from the stone. According to Newton's Third Law, the reaction force from the stone to the fighter's hand is equal in magnitude and opposite in direction to the impact force from the fighter's hand to the stone. In addition, the strong reaction force of the stone helps the martial artist to break the stone. So the more potent the reaction force of the stone, the greater the chance that the stone will break. Diaphragmatic breathing and Newton's Third Law are not directly related to the process of breaking pencak silat stones. However, diaphragmatic breathing helps the fighter to produce a more potent impact force, which then produces a stronger reaction from the stone and helps break the stone (Sunaryo et al., 2021).

In pencak silat competitions, several key concepts of physics, especially those derived from Newton's laws of motion, come into play. Newton's First Law, the Law of Inertia, states that an object at rest will remain at rest, and an object in motion will remain in motion unless an external force acts on it. In pencak silat competitions, this law can be seen in the stance and balance of the martial artist. Fighters maintain a stable position so as not to be easily moved or dropped, indicating inertia (Alnsour, 2024; Heinich et al., 1982). Likewise, when a fighter moves towards an opponent, their body tends to continue

in that direction until they decide to stop or change direction, emphasizing the importance of strategic planning to determine the timing of attacks and evasions. Newton's Second Law, the Law of Acceleration, states that the acceleration of an object is directly proportional to the total force acting on it and inversely proportional to its mass (F = ma) (Rabu et al., 2023). This law is very important for understanding the power behind punches and kicks in a match. The force of a punch or kick depends on the mass of the striking limb and the acceleration achieved, with faster acceleration resulting in a more potent punch. Movement and dexterity are also regulated by these laws, as a fighter's ability to accelerate or decelerate increases their ability to launch rapid attacks and perform evasive maneuvers (Harsanto et al., 2024; Rahardja et al., 2022). Therefore, pencak silat training focuses on maximizing force output and minimizing response time. Newton's Third Law, the Law of Action and Reaction, states that for every action, there is an equal and opposite reaction. In the context of pencak silat, this law can be seen in the recoil of blows (Dost, 2024). Practically speaking, pencak silat training involves strength training to increase the mass and strength that a fighter can exert, speed and agility training to increase acceleration and quick changes in movement, as well as balance and coordination training to maintain stability and regulate the power of action and reaction during battle (Ihsan & Yohandri, 2023).

Based on an interview with the physics subject teacher at YPM 2 Sukodono High School, Anggita Noviasari, S.Pd., physics plays a crucial role in studying and understanding pencak silat. Understanding the principles of physics can increase the efficiency of movement. In movement efficiency, there are concepts such as momentum, torque, and balance, which help the fighter move more efficiently and effectively. Additionally, increase strength and speed, such as punches and kicks, by developing technique. The physics concept of torque includes twisting and twisting techniques in pencak silat to control an opponent.

The physics concept of balance also includes stance techniques, which are important to maintain body balance and allow the fighter to move nimbly. Finally, there is the concept of Newton's three laws. Newton's First Law, which states that "an object will remain at rest or move uniformly in a straight line unless there is a force acting on it", is reflected in pencak silat movements, which maintain a state of rest and a state of movement (Hwang et al., 2020; Prihadyanti & Aziz, 2023). The state of rest when the silat is in a stance, the forces acting on his body are balanced so that the silat remains in a state of rest. Newton's Second Law, which states that "the acceleration of an object is proportional to the force acting on it and inversely proportional to its mass," is reflected in pencak silat movements, which involve acceleration and changes in direction of movement. The concept of acceleration that governs when a martial artist punches or kicks, the fighter uses his muscles to apply force to objects (for example, hands or feet). The greater the force applied, the greater the acceleration of the object (Nkosi et al., 2024).

The concept of changing the direction of movement when a martial artist rotates or changes direction involves using muscle force to change the direction of his body's

momentum. The greater the force exerted, the faster the body changes direction (Idris et al., 2025; Luo et al., 2024). Newton's Third Law, which states that "for every action, there is always a reaction of equal magnitude and opposite direction", is reflected in the interactions between fighters, both when attacking and defending. When attacking, the fighter hits or kicks the opponent, and the fighter applies force to the opponent (Dwikoranto et al., 2023). According to Newton's third law, the opponent will exert an equal and opposite force on the fighter. Then, when defending, the fighter blocks the opponent's punch or kick and counters with a forceful counterattack. According to Newton's third law, the opponent will exert an equal and opposite force on the fighter. The high school teacher agreed and felt helped by the combination of physics subjects with the cultural heritage of pencak silat as a medium for local Indonesian wisdom (Wahyuni et al., 2023).

Figure 7. Application of physics concepts to pencak silat in YPM 2 Sukodono High School students, Sidoarjo Regency

The application of Newton's Third Law in pencak silat can be integrated into technological visualization as an effort to bridge the understanding between physics theory and martial arts practice. Every movement in pencak silat, whether a punch, kick, or block, always involves action and reaction, which is the core of this law. By utilizing technology-based visualization, the interaction of forces that occur can be displayed more concretely through simulations, animations, or interactive models (Nasuiton et al., 2025). This allows observers to see how the action force applied by the body produces a reaction force from the opponent or the environment, so that physics concepts are not only understood abstractly, but also in an applied context.

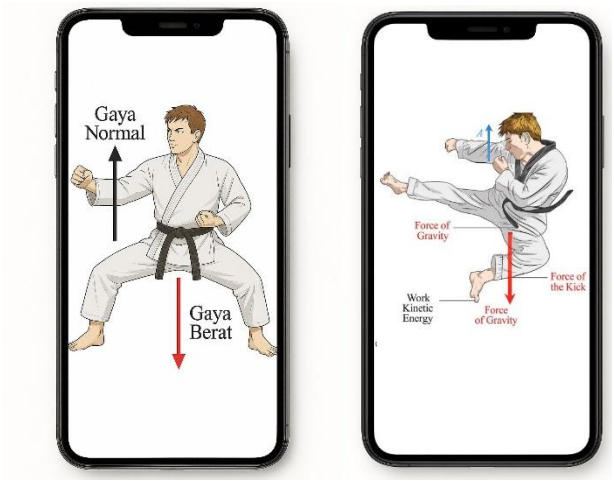

Figure 3. Visualization design of pencak silat in 2D application

In addition to strengthening conceptual understanding, the integration of Newton's Third Law into technological visualization also serves as an engaging and meaningful learning innovation. Visualizations designed from a combination of theoretical studies and practical experience enable students and pencak silat practitioners to analyze movements in greater depth. Thus, technology serves not only as a tool for explaining the laws of physics but also as a means to raise awareness of the importance of science in traditional cultural and sporting activities. This approach is expected to enrich physics learning methods while preserving pencak silat through a modern scientific perspective.

The benefit of applying 2D visualization technology in pencak silat and Newton's Third Law is that it provides a more transparent and simpler picture of the action-reaction relationship in each martial arts movement, making it easier for students and practitioners to understand the physics concepts involved. Through two-dimensional visualization, the interaction of forces can be displayed concisely yet informatively, thus simplifying the process of movement analysis, increasing the effectiveness of learning, and encouraging the integration between science and traditional sports.

Discussion

The application of local wisdom media, such as pencak silat, in physics education can effectively engage students and contextualize learning. Start by introducing pencak silat as an integral part of local culture and its relevance to physics, explaining how physical principles underlie its movements and techniques (Rosana & Fauziah, 2023). Demonstrate Newton's First Law by showing stable martial arts moves and discussing inertia, then illustrate Newton's Second Law by calculating the force of a kick or punch using mass and acceleration. Newton's Third Law can be proven through blocking techniques, highlighting action and reaction forces (Ayasrah et al., 2024). Incorporate practical applications such as strength training, speed and agility training, and balance training to reinforce these concepts. Reflect on how understanding these principles can improve performance in silat and other activities, and encourage students to create projects that connect physics to silat. This approach not only deepens students'

appreciation of their cultural heritage but also shows the practical application of theoretical concepts, making learning more interesting and relevant (Habibbulloh et al., 2024).

Two important aspects need to be understood in the educational context. The use of behavioristic principles, such as positive and negative reinforcement and external stimuli, can influence student behavior in understanding physics concepts in class. On the other hand, motivation theories such as self-determination theory, self-efficacy, and expectancy-valence play an important role in increasing students' motivation and learning achievement in physics (Mutakinati et al., 2018; Zakaria & Sucahyo, 2024). The level of student motivation, both intrinsic and extrinsic, as well as the role of the teacher and the learning environment in creating supportive conditions, also influences the physics learning process. For example, students who are driven by strong intrinsic motivation tend to achieve better learning outcomes. In contrast, teachers who can create a supportive learning environment can boost students' motivation in studying physics. By understanding and integrating these two theories, a more holistic physics learning can be developed for students' understanding and engagement in the subject. The following are the results of applying the level of motivation to learn physics in high school students, the Bar Diagram motivates learn shows it.

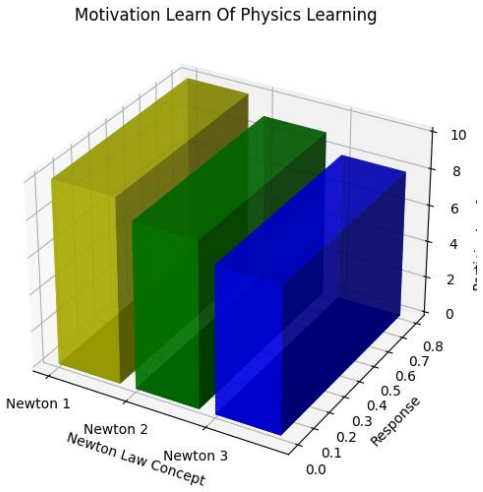

Figure 8. Bar result motivation learning in Newton law concept

Based on the code analysis provided, students from SMA YPM 2 Sidoarjo show a pretty good level of motivation to learn physics, especially related to understanding the concept of Newton's laws. In the resulting three-dimensional bar diagram, students' positive response values are pretty significant for each concept of Newton's law, indicating strong interest and motivation in studying physics. Although there is no specific information about the factors that influence learning motivation, the comparison between Newton's law concepts suggests that students may have a slightly higher interest in some Newtonian concepts compared to others. However, for a deeper understanding, further analysis may be needed to consider factors such as teaching methods, learning environment, and personal interests in shaping students' levels of

learning motivation. Thus, students at SMA YPM 2 Sidoarjo show a positive level of motivation in studying physics, especially related to the concept of Newton's laws, but further analysis is needed for a more comprehensive understanding of the factors that influence their learning motivation (Pospori et al., 2020; Rosana & Fauziah, 2023).

CONCLUSION

Fundamental Findings: The integration of local wisdom of pencak silat into learning Newton's laws through 2D technology-based visualization can increase students' motivation and conceptual understanding because the action-reaction concept is presented in a more concrete, contextual, and culturally close way. **Implications:** This approach not only enriches physics learning strategies with ethnoscience nuances, but also contributes to the preservation of local culture while strengthening the relevance of science in everyday life through the use of technological visualization. **Limitations:** The use of samples is limited to a small community (teachers, athletes, and a few students), and the visualization is still simple in 2D format, so it has not fully explored the complex dynamics of movement. **Future Research:** It is necessary to develop more interactive technology-based media, for example, 3D animation or augmented reality, and involve a wider sample so that the effectiveness of ethnoscience integration in physics learning can be tested more comprehensively and sustainably.

AUTHOR CONTRIBUTIONS

Azar Zakaria contributed to the conceptual framework, research design, and validation process; **Muhammad Satriawan** was involved in methodology development, and data analysis; **Rahmatta Thoriq Lintangesukmanjaya** was sourcing references, and drafting the manuscript; **Utama Alan Deta** handled data management; **Khoirun Nisa** was involved in methodology development and project coordination. All listed authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

No conflict interest.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

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