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Enhancing Student Understanding of Basic Physics Concepts Through Mobile Science Experiments: A Study at Thung Kula Pittayakom School, Surin Province

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Abstract

This study focuses on designing and evaluating a series of fundamental physics experiments facilitated by a Mobile Science (MS) vehicle at Thung Kula Pittayakom (TKP) School in the sub-district of Surin province. The study's primary objectives were to design engaging physics activities that enhance student learning, evaluate students' understanding of physics concepts before and after these activities, and utilize the MS vehicle to deliver the experiments. Six physics experiments were conducted, including simple circuit assembly, multimeter usage, simple harmonic motion, friction, light refraction, and spring constant. Each activity lasted 90 minutes and involved active student participation. Student comprehension was assessed through pre-tests and post-tests administered before and after the experiments. The results indicated a statistically significant change in scores across all laboratory activities. Specifically, the post-test scores surpassed the pre-test scores in each lab, with average score increases ranging from 3.644 to 5.096 points. These indicated that the experiments' interactive, hands-on nature significantly improved students' grasp of fundamental physics concepts. The MS unit was shown to be a convenient and helpful resource for conducting educational activities in schools. This study provides valuable insights for designing engaging and effective physics learning activities in the future.

Keywords: Fundamental Physics, Active Learning, Mobile Science, Pre-post Test, Physics Laboratory

1. Introduction

The 21st century has seen a growing emphasis on life and work skills, especially in STEM fields (science, technology, engineering, and mathematics). These fields drive the innovations and advancements needed for global societal and economic development (Bybee, 2013; Hsu & Fang, 2019). The ability to solve problems, think critically, and demonstrate creativity is recognized as essential for students to adapt to the rapidly changing demands of life and work (Herald et al., 2017). Therefore, teaching science involves more than memorizing information and concepts; it also entails helping students develop an understanding of the technology and natural world around them. Interactive learning is a powerful tool for cultivating various skills that students can apply in the future, mainly through experiments and hands-on activities (Hofstein & Lunetta, 2004). To ensure greater comprehension and long-term knowledge retention, researchers and educators have developed instructional strategies that promote experiential learning (Hofstein & Lunetta, 2004).

Learning through the Active Learning process is widely recognized as one of the most effective teaching methods for developing students' knowledge, understanding, and critical thinking skills across various subjects, particularly in challenging areas such as science, chemistry, biology, and physics (Freeman et al., 2014). This learning model emphasizes actively engaging students in learning rather than passively receiving information. Students participate in problem-solving, hands-on experimentation, and collaborative work, which enhance learning more effectively than traditional lectures or rote memorization alone (Prince, 2004). Providing students with opportunities to engage in scientific activities allows them to understand complex content better. Experiments and practical activities stimulate critical thinking and inquiry, essential for developing higher order thinking skills and systematic problem-solving (Hake, 1998). This is particularly true in physics, where concepts are often linked to abstract theories that may be difficult to grasp without concrete experimentation. Instruction that relies solely on lectures has limitations in helping students fully understand physics concepts such as motion, electrical measuring instruments, or magnetic field theory (Mazur, 2014). Learning through experimentation in physics allows students to explore and verify the theories they have learned, connecting academic knowledge with real-world experiences. Experiments enable students to visualize and comprehend principles that may have seemed complex in theory. By engaging in practical activities, students gain first-hand experience, fostering understanding and problem-solving skills in real-world situations (Redish & Burciaga, 2004). Moreover, active learning in physics education helps foster interest and motivation, encouraging students to engage more deeply in their learning. Many researchers have found that student participation in the learning process improves learning outcomes, fosters a positive attitude toward the subject, and enhances commitment to learning challenging subjects like physics (Knight & Burciaga, 2004). Additionally, Active Learning can help bridge the learning gap among students with varying abilities or prior knowledge. Students who previously viewed physics as complex or disconnected from real life can see its relevance to everyday situations through activities that involve real-world applications. Using electrical measuring instruments, conducting friction experiments, or working with multimeters in laboratory settings helps students perceive physics as understandable and practical (Hofstein & Lunetta, 2004).

Recent research has also focused on students' comprehension of specific physics concepts such as electrical circuits, motion, and friction. Studies have shown that students often struggle with the concept of electrical circuit connections, with many failing to understand the relationship between current, resistance, and voltage(Olaogun et al., 2023; Sokoloff, 1996). Similarly, misconceptions about motion and forces, particularly in the context of Newton's laws, are prevalent, as students often find it difficult to apply theoretical knowledge to real-world scenarios (Bani-Salameh, 2017; Graham et al., 2013)

(Nadelson et al., 2018). Furthermore, students' understanding of friction is often oversimplified, with many failing to grasp the complexities of static and kinetic friction in different contexts (Besson et al., 2007; Lin & Singh, 2012; Walsh et al., 2020). These misconceptions can impede students' ability to fully comprehend and apply fundamental physics principles. According to Sarapak and co-workers (Sarapak et al., 2025), improving conceptual understanding in physics remains a challenge for students, especially in complex topics like Newton’s laws and motion (Sarapak, Kong-In, et al., 2025).

In the context of schools in rural and remote areas, many face significant challenges due to a need for more infrastructure, teaching equipment, and specialized personnel. Physics is one of the subjects most affected by these shortcomings, as it requires theoretical understanding and hands-on experience through laboratory experiments. However, the absence of well-equipped physics laboratories and the shortage of skilled teachers in remote areas limit students' opportunities for effective learning. This issue exacerbates educational inequality between urban and rural schools (Lamsal, 2015). Many rural schools cannot provide the necessary resources, forcing students to rely solely on theoretical instruction, which may not be sufficient to develop a deep understanding of physics (Sokoloff & Thornton, 1997). Moreover, the lack of qualified physics teachers in remote areas further compounds the problem, as these schools lack personnel with the skills and expertise needed to teach physics and guide students in conducting experiments. This situation is particularly challenging given that physics is often perceived as one of the most difficult subjects, requiring strong content knowledge and advanced teaching skills. In some cases, general science teachers are required to teach physics, which can result in suboptimal learning outcomes for students (Bybee & Fuchs, 2006). Teachers need to be capable of effectively explaining theoretical concepts and leading physics experiments to ensure students can fully understand the subject. This disparity in education quality affects students' learning experiences and has long-term consequences for their interest in STEM fields and future career opportunities. Bridging this gap requires targeted interventions, including improved access to resources, teacher training, and innovative approaches such as MS labs, which could help provide rural students with the hands-on learning opportunities necessary for mastering physics and developing a passion for science.

One effective solution to address these challenges is the implementation of an MS lab designed to bring essential equipment and expertise to schools in remote areas. This initiative was applied at TKP school in Surin Province, aiming to give students access to physics experiments they had never experienced before. This research aims to bridge the gap between theoretical learning and practical experience, enhancing students' understanding of physics concepts (Gibson & Chase, 2002)The MS lab allows students to engage in the following experiments: (i) electrical circuit connection, (ii) use of a multimeter, (iii) study of harmonic motion, (iv) spring constant experiments, (v) investigation of friction coefficients, and (vi) study of light phenomena such as reflection and refraction. These experiments reinforce students' understanding of fundamental physics principles and cultivate a positive attitude toward science, making physics more accessible and engaging for students (Zacharia, 2003). Thus, using an MS lab presents a promising approach to overcoming the challenges of teaching physics in remote areas. Students can learn physics more effectively by directly bringing experimental tools and expertise to schools and developing a positive attitude toward science. Teachers are supported in delivering higher-quality instruction. Addressing these limitations is crucial to reducing educational inequality and ensuring all students have equal access to a robust physics education.

2. Methodology

The "MS to School" initiative aims to (i) enhance students' understanding, (ii) increase engagement with scientific concepts through interactive, hands-on learning experiences, and (iii) reduce educational inequality. This program focuses on bringing modern scientific education directly to schools, particularly remote or underserved ones. The MS lab has various scientific tools and materials to facilitate experiments and activities across different physics topics. The program consists of daily laboratory activities, each lasting approximately 90 minutes. It targets middle school students (grades 7-10), with sessions accommodating approximately 12-13 students per lab.

Labs: The program includes six distinct laboratory activities focusing on key physics concepts:

1. Simple Circuit Connection: Students learn about electrical circuits, components, and current flow by constructing basic circuits using batteries, wires, and light bulbs.
2. Multimeter Usage: This course teaches students how to use a multimeter to measure voltage, current, and resistance, providing them with practical skills applicable to real-world situations.
3. Simple Harmonic Motion (pendulum): An exploration of oscillatory motion through experiments involving pendulums and springs, allowing students to observe and analyze the characteristics of harmonic motion.
4. Finding the Spring Constant: An experiment to determine the spring constant (k), studying the relationship between the force applied to a spring and its displacement from the equilibrium position, based on Hooke's Law, which states that the force exerted on a spring is directly proportional to its displacement.
5. Friction: Hands-on experiments demonstrate friction's effects across different surfaces and materials, helping students understand the forces involved in motion.
6. Refraction and Reflection of Light: Activities that allow students to experiment with prisms, mirrors, and lenses, illustrating the principles of light behavior and optical phenomena.

Each lab activity was designed to be hands-on, with students actively participating in experiments and discussions. Assessments were conducted before and after the activities to measure students' understanding and knowledge gains, ensuring that learning objectives were met. Additionally, students' attitudes toward science were evaluated.

Data Collection. This study's data collection process involved two main stages: pre-test and post-test assessments. The pre-test was administered before each experiment to evaluate the students' initial understanding of the key concepts explored during the hands-on activities. This allowed for establishing a baseline measurement of the student's knowledge. After completing the experimental activities, a post-test was immediately conducted to assess the knowledge gained from the hands-on learning experiences. The post-test was designed to measure how much the students' understanding of the concepts had improved following their participation in the experiments. Both the pre-test and post-test scores were then compared to assess the overall impact of the hands-on activities on students' conceptual understanding.

Data Analysis. For data analysis, statistical methods were applied to evaluate the effectiveness of the learning activities. Paired t-tests were conducted to compare the pre-test and post-test scores of the same group of students. The paired t-test was used to determine whether there were significant differences in the student's performance before and after the intervention. A significance level of **0.05** was adopted, meaning that a p-value of **0.05** or lower would indicate that the differences observed between the pre-test and post-test scores were statistically significant. This analysis provided a robust means of assessing whether the hands-on learning activities led to meaningful improvements in the student's understanding of physics concepts.

Table 1: Fundamental information about the students who participated in the MS program (n = 73).

Fundamental information		Total	Percentage (%)
Gender			
	Male	51	69.9
	Female	22	30.1
High school students			
M1	Male	11	64.7
	Female	3	17.6
M2	Male	8	53.3
	Female	7	46.7
M3	Male	15	55.6
	Female	12	44.4
M4	Male	12	70.6
	Female	5	29.4

Participants. The MS lab activity, organized to promote hands-on learning in physics, involved 73 student participants, as summarized in Table 1. A gender-based analysis revealed a noticeable disparity, with male students significantly outnumbering female students. Specifically, there were 51 male students, accounting for 69.9% of the participants, compared to only 22 female students, representing 30.1%. When broken down by grade level, in Grade 7 (M1), 11 male students participated, making up 64.7%, while only three female students (17.6%) participated. In Grade 8 (M2), there were eight male students (53.3%) and seven female students (46.7%). In Grade 9 (M3), 15 male students (55.6%) participated, alongside 12 female students (44.4%). Finally, in Grade 10 (M4), the number of male participants was 12 (70.6%), whereas only five female students (29.4%) were involved. These numbers suggest that male students consistently participated more in the MS lab activities across all grade levels.

3. Results and discussions

3.1 Pre- and Post-Test Score Analysis

Based on the experiments conducted with 73 students across six different physics labs, significant improvements in students' learning and understanding were observed in all activities.

According to table 2, descriptive statistics of pre-tests and post-tests across each lab experiment, the mean values, standard deviations (S.D.), pre-test to post-test difference scores, t-tests, and p-values were analyzed. The values in the different columns represent the change in incorrect answers from the pre-test to the post-test for each lab activity. These differences highlight the improvement in students' understanding following the activities. The results demonstrate that the observed changes are statistically significant, as indicated by a p-value less than 0.05. The analysis was conducted using the Excel software. By comparing the pre-test and post-test scores through statistical analysis using the t-test at a 0.05 significance level, it was evident that the average post-test scores increased significantly for each lab, as shown in Table 2. It substantially improved learning outcomes after students participated in hands-on activities through the MS lab. The results of each lab were as follows:

Lab 1: The experiment on simple electrical circuit connections showed a pre-test mean score of 3.466, which increased to 7.233 in the post-test, with an average difference of 3.767. The statistical t-test value was 19.556, with a significance level 0.000, indicating that this activity significantly enhanced students' understanding of electrical physics concepts.

Lab 2: The experiment using the multimeter to measure various electrical quantities had a pre-test mean score of 1.932, while the post-test mean rose to 6.945, with an average difference of 5.014. The t-test value was 16.048, with a significance level 0.000, suggesting that this activity helped improve students' understanding of electrical measurement tools.

Lab 3: The experiment on simple harmonic motion (SHM) had a pre-test mean score of 2.397, which increased to 7.397 in the post-test, with an average difference of 5.000. The t-test value was 18.403, with a significance level of 0.000, highlighting a substantial improvement in students' understanding of harmonic motion.

Lab 4: The experiment on spring and tensile force recorded a pre-test mean score of 1.959, increasing to 6.781 in the post-test, with an average difference of 4.822. The t-test value was 23.117, with a significance level 0.000, demonstrating a significant enhancement in students' comprehension of spring-related physics.

Lab 5: The friction experiment had a pre-test mean score of 1.877 and a post-test mean of 5.521, with an average difference of 3.644. The t-test value was 10.008, with a significance level 0.000, indicating a marked improvement in students' learning about friction.

Lab 6: The experiment on light reflection and refraction had a pre-test mean score of 2.356, with a post-test mean of 7.452, yielding an average difference of 5.096. The t-test value was 16.684, with a significance level 0.000, showing that students significantly enhanced their understanding of optical phenomena.

Table 2: Comparison of Pre- and Post-Test Scores by Lab Experiment

		Mean	S.D.	Different	t-test	sig.
Lab1	Pretest	3.466	1.313	3.767	19.556*	0.000
	Post test	7.233	1.112			
Lab2	Pretest	1.932	1.383	5.014	16.048*	0.000
	Post test	6.945	1.961			
Lab3	Pretest	2.397	1.421	5.000	18.403*	0.000
	Post test	7.397	2.152			
Lab4	Pretest	1.959	1.296	4.822	23.117*	0.000
	Post test	6.781	0.989			
Lab5	Pretest	1.877	1.394	3.644	10.008*	0.000
	Post test	5.521	2.001			
Lab6	Pretest	2.356	1.240	5.096	16.684*	0.000
	Post test	7.452	2.082			

3.2 Learning Outcomes from MS Lab Activities

Overall, the results from all six labs demonstrate that the learning activities within the MS lab significantly contributed to students' understanding of physics. The increase in post-test scores across all labs indicates that practical, hands-on learning through the MS Lab enhances students' comprehension of physics, particularly in experimental and applied contexts. These findings further emphasize that MS lab activities are crucial in making learning more enjoyable and effective. Engaging students in hands-on experiments enables them to develop a deeper understanding of complex topics, often challenging when taught solely through theoretical methods. The analysis also shows that MS lab activities foster problem-solving skills and critical thinking in physics. The statistically significant differences across all labs demonstrate that this learning mode effectively enhances students' scientific knowledge. From the discussion of these results, it can be concluded that the science labs used in this research not only enhance students' understanding of physics content but also improve analytical thinking and problem-solving skills, which are at the core of STEM education. This practical learning approach allows students to gain experiences that can be applied in real-life situations, such as using electrical measurement tools, understanding object motion, and analyzing light refraction. These are valuable skills both academically and in everyday life. The substantial increase in post-test scores compared to pre-test scores reflects a marked improvement in students' understanding after participating in the learning activities in each lab. Additionally, the differences observed across labs suggest increased interest and comprehension of physics when students are actively involved in hands-on activities that allow them to connect theory to practice concretely. Developing lab experimental skills, such as electrical circuit connections, electrical measurements, and understanding friction, helps build students' confidence in learning science. Hands-on learning enables students to observe outcomes and correct misconceptions during the experiments immediately. Furthermore, including project-based or supplemental programs fosters teamwork and encourages students to explore multiple solutions to their problems.

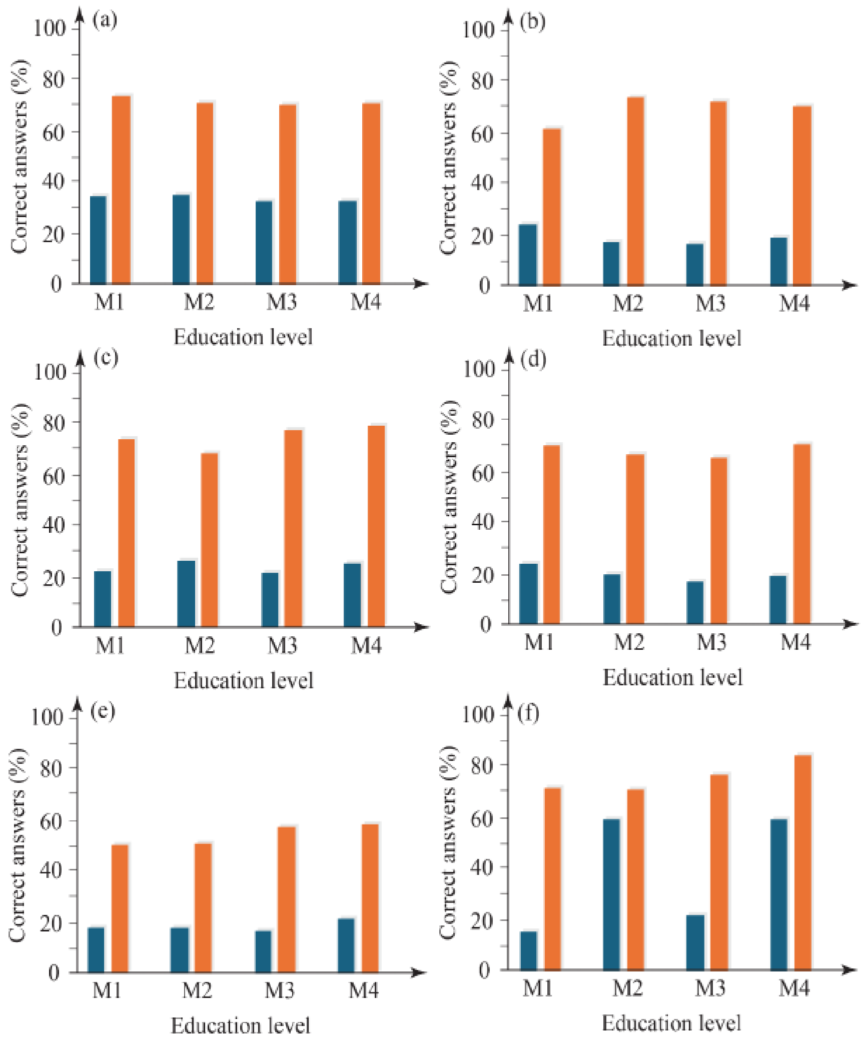

Figure 1. Examination Results for Grades 7–10 (M1–M4) by Lab Activity

According to figure 1, the results of students' performance on 7th through 10th grade (M1–M4) examinations. Each section of the figure presents data for specific laboratory activities: (a) Lab 1, (b) Lab 2, (c) Lab 3, (d) Lab 4, (e) Lab 5, and (f) Lab 6. The comparative analysis across different labs illustrates student performance trends and highlights improvement areas, demonstrating the positive impact of experiential learning on students' scientific knowledge. The colours blue and orange represent in the pretest and post-test, respectively.

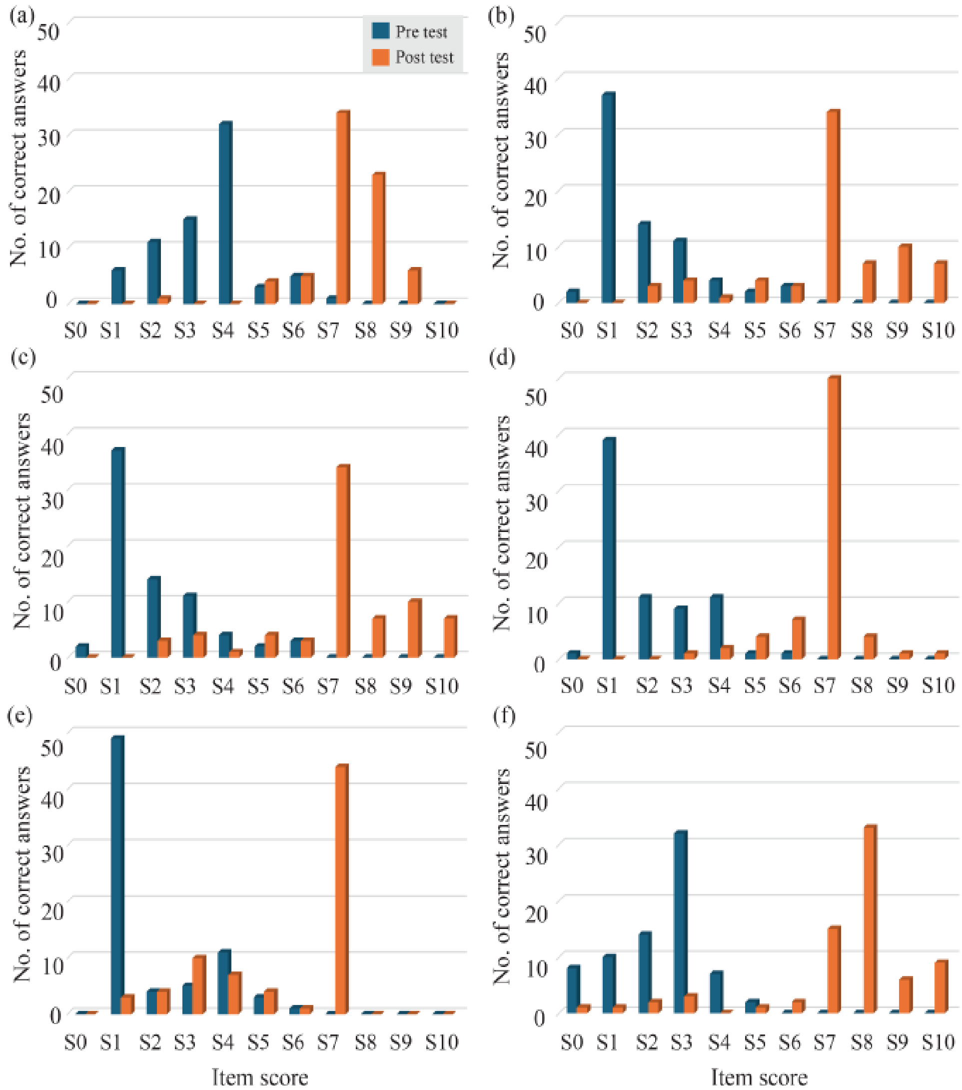

Figure 2. Student Performance Summary for Each Lab

According to figure 2, summary of total scores for each lab. This figure presents the total scores achieved by students across different labs. S0 refers to a score of 0 points. The scores for each lab are categorized as follows: (a) Lab 1, (b) Lab 2, (c) Lab 3, (d) Lab 4, (e) Lab 5, and (f) Lab 6. These results highlight performance trends and learning outcomes for each lab activity.

The results of this study align with existing research that underscores the effectiveness of hands-on learning and the use of pre-test and post-test evaluations in science education. For instance, a survey conducted by Mertler Issaka (Issaka, 2020), demonstrated that implementing inquiry-based learning, coupled with pre-and post-testing, resulted in significant improvements in students' understanding of scientific concepts, similar to the findings observed in the MS lab.

Table 3: Examples of Questions for Analysis of Student Pre- and Post-Lab Test Responses

	Most of the incorrect answers	Most of the correct answers
Lab1	Which device should be used to measure electric current? a. Ammeter b. Voltmeter c. Barometer d. Ohmmeter	Which factor does not affect the resistance of a conductor? a. The color of the conductor b. The type of conductor c. The temperature of the conductor d. The length of the conductor
Lab2	If you want to connect a circuit to measure electric current, how should you connect the circuit? a. In series b. In parallel c. In series and parallel d. None of the above	To measure resistance, which symbol should you set the multimeter to? a. Ω b. V~ c. A~ d. Hz
Lab3	When the length of the pendulum string is increased, what happens to the period of oscillation? a. The period of oscillation increases b. The period of oscillation decreases c. It does not affect the period of oscillation d. None of the above	What is the most critical factor in a simple harmonic pendulum experiment? a. The length of the string b. The weight of the pendulum bob c. The speed d. The temperature
Lab4	Which statements are correct for simple harmonic motion (spring)? 1. When the object's displacement increases, the object's acceleration decreases. 2. The net force acting on the mass is greatest when the object's velocity is minimal. 3. If the amplitude of oscillation decreases, the frequency of oscillation increases. 4. If the object's mass increases, the oscillation period also increases. a. 1 and 2 b. 2 and 3 c. 2 and 4 d. 1 and 4	Which of the following is not a characteristic of simple harmonic motion? a. The direction of the force is always toward the equilibrium point. b. The force causing the motion is proportional to the displacement. c. The object has its maximum velocity at the equilibrium point. d. The period of the motion is directly proportional to time.
Lab5	An object weighing 10 newtons is moving on a surface with a coefficient of kinetic friction of 0.3. Calculate the kinetic frictional force. a. 0.3 newtons b. 3 newtons c. 30 newtons d. 300 newtons	Object A has a coefficient of static friction of 0.5, and object B has a coefficient of static friction of 0.2. What does this mean about the static friction of both objects? a. Object A moves more easily than object B. b. Object A moves more difficultly than object B. c. Both objects move with the same ease or difficulty. d. The information provided needs to be more comprehensive to determine.
Lab6	What is the refraction of light? a. The change in the direction of light at the boundary between two media causes the light to bend back toward the first medium. b. The characteristic of disturbance that spreads out and moves as oscillations or waves. c. The phenomenon where light changes direction when it passes through media with different densities, resulting in a deviation from its original path. d. All the above is correct.	Which of the following is the equation used to calculate the refractive index? a. $n_1 \text{Sin}Ø_1 = n_2 \sin Ø_2$ b. $n_1 = n_2$ c. $n_1/\text{Sin}Ø_1 = n_2/\sin Ø_2$ d. $d\text{Sin}Ø_1 = n$

Additionally, Mertler found that engaging students in experimental activities led to higher post-test scores, with statistically significant differences as measured by t-tests, indicating that practical experiences significantly enhance learning outcomes. These findings support the premise that hands-on activities when assessed through rigorous testing methodologies, deepen students' comprehension of physics and foster essential skills such as critical thinking and problem-solving. Moreover, research by Trundle et al. (Trundle et al., 2002) highlighted the importance of experiential learning in improving students' conceptual understanding, further reinforcing the results of the current study. By comparing these results with previous studies, it becomes evident that integrating practical learning experiences, along with structured assessments, is a powerful approach to improving science education and enhancing student engagement across various educational settings.

As shown in the table, the results from the experiments illustrate a comparison of pre-test and post-test scores among middle school students (M1 to M4) who participated in the MS lab activities. The findings indicate that the post-test scores for all groups significantly exceeded their pre-test scores. Notably, the M1 group achieved the highest post-test score of 75% correct answers, an increase from a pre-test score of 36% correct answers. Similarly, other groups (M2 to M4) demonstrated comparable improvements. The overall average scores revealed a significant enhancement, with pre-test scores averaging 35% correct answers and post-test scores averaging 72% correct answers. These results suggest that the scientific experimentation activities conducted through the MS lab effectively promote students' understanding and scientific capabilities. The significant increase in post-test scores across all groups reflects the learning outcomes of active participation in hands-on experiments and engagement with relevant equipment and simulations about each topic. The remarkable score increase in the M1 group may indicate that these students exhibited the highest enthusiasm and receptiveness to new experimental activities. This could be attributed to their initial exposure to science education at the middle school level, which was a novel experience for them. In contrast, while the M2 to M4 groups also experienced an increase in post-test scores, their scores were relatively close, potentially due to these students having a more developed foundation in scientific knowledge, which may have resulted in a slower adaptation to the new learning experiences at higher levels. Implementing MS labs for conducting scientific experiments enhances students' skills and knowledge. Furthermore, these activities foster long-term interest and competence in science education.

Figure 2 illustrates the overall scores ranging from S0 to S10, based on a 0 to 10 scoring scale derived from pre-test and post-test results. A significant score change was observed across all groups after the experimental activities. Pre-test scores mostly ranged from 1 to 4 points, while post-test scores showed substantial improvement, with most students scoring between 7 and 8 points. For example, as shown in Figure 1a, before the experiment (pre-test), S4 had the highest frequency, with 32 students scoring 4 points. However, after participating in the activities, the post-test results. The overall score increased to 7 points, with 34 students achieving this score, indicating a significant improvement in students' understanding of the subject matter. Additionally, it is noteworthy that some students achieved scores of S8 (8 points) and S9 (9 points) on the pre-test. After the experimental activities, post-test results showed that 23 students scored S8 and six students scored S9, demonstrating substantial progress. Table 3 illustrates some questions with the highest correct and incorrect responses. Similarly, across labs 2 through 6, post-test scores were consistently higher than pre-test scores, clearly highlighting the effectiveness of the experimental activities in enhancing students' comprehension.

3.3 Change in Student Attitudes Toward Science

The study revealed that middle school students participating in MS lab activities exhibited a significantly positive attitude toward science. As illustrated in Table 4, the attitude assessment results showed that most students expressed interest and enjoyment in learning science, with an average score of 3.40. Furthermore, students acknowledged the importance of science in their lives and future, as reflected by an average score of 3.64. This recognition was particularly pronounced in applying scientific knowledge to problem-solving and developing essential scientific skills. Although some students perceived science as challenging, with an average score of 2.84, most demonstrated a commitment to continually improving their skills in this subject area, as shown by an average score of 3.48. This indicates a strong intrinsic motivation among students to face the challenges of learning science and a readiness to deepen their knowledge of the subject. The evaluation underscores the significance of instructional strategies fostering interest and positive attitudes toward science, such as implementing MS labs emphasizing hands-on learning and active student engagement. In addition to the increased interest in science, the findings highlighted that most students developed problem-solving skills by participating in the MS Lab activities. Students demonstrated an enhanced ability to connect learned content with real-life applications, achieving an average score of 3.20. This reflects the success of activities designed to promote learning through practical engagement. Moreover, students exhibited improved confidence in conducting scientific projects or activities, with an average score of 2.84, a crucial factor in promoting holistic learning in science. The study also noted a positive shift in students' attitudes toward homework and related science activities, with many students reporting that science homework felt easier after participating in the activities, yielding an average score of 3.00. This suggests a deeper understanding of the subject matter facilitated by MS labs. While some students still found science challenging, most viewed it as an exciting challenge and were willing to confront difficulties to enhance their comprehension of the material, as indicated by an average score of 3.64. Finally, the evaluation of scientific attitudes demonstrated the development of positive perspectives toward future learning in science, with most students intending to continue enhancing their scientific skills and knowledge, as shown by an average score of 3.48. This strongly indicates the effectiveness of hands-on learning activities, reflecting sustained motivation to learn and a growing long-term interest in science.

Table 4: Descriptive Statistics for the Science Attitude Questionnaire

Items	Description	Mean	S.D.
1	I enjoy reading about science.	3.08	0.57
2	My school offers science courses.	3.52	0.87
3	My school provides after-school tutoring programs in science.	2.56	0.87
4	I find enjoyment in watching science-related television programs.	3.52	0.87
5	I do not wish to learn more about science.	2.56	1.16
6	I do not find science enjoyable.	2.32	0.90
7	There are additional science courses available for me to choose from.	3.04	0.93
8	I do not appreciate the challenges presented by science.	2.72	0.98
9	I have a fondness for science.	3.40	0.76
10	I excel in projects related to science.	2.84	0.75
11	Science is too tricky for me.	2.84	0.90
12	I perform well in science subjects.	2.92	0.81
13	I need help managing advanced science content.	2.80	0.71
14	Science is easy.	3.04	0.84
15	I am not worried about examinations in science.	3.08	0.86

16	I need help in science.	3.12	0.93
17	I do not understand science.	3.00	0.76
18	Homework in science is easy.	3.00	0.76
19	Science is fundamental.	3.64	0.81
20	What I learn in science has no value to me.	2.16	1.14
21	Science is essential.	3.64	0.91
22	I want to study science.	3.40	0.82
23	Studying science will not benefit me.	2.20	1.12
24	Science is a good subject.	3.64	1.04
25	I care about my progress in science.	3.52	0.87
26	Science has no value to justify my time spent understanding it.	2.56	1.08
27	I dislike more complex content in science.	2.60	0.87
28	I would like to participate in additional after-school programs in science.	2.84	0.90
29	I am interested in learning about careers that involve the application of science.	3.20	1.00
30	I am interested in advanced programs related to science.	3.04	0.73
31	I am interested in something other than discovering new methods for applying science.	2.76	1.13
32	Science is only a tiny part of the future I envision.	2.40	1.15
33	I intend to continue developing my abilities in science.	3.48	0.77
34	I will continue to find joy in facing challenges in science.	3.64	1.11

According to table 4, descriptive statistics of science attitude questionnaire responses from students at TKP school following participation in the physic MS activities. This presents the questions from the science attitude questionnaire along with their corresponding mean scores and standard deviations (S.D.). After engaging in the mobile physics classroom's interactive and hands- on learning experiences, the data reflects students' perceptions and attitudes toward science.

4. Conclusion

The study developed and implemented a MS Lab at Thung Kula School in Surin Province, featuring six physics laboratory activities: simple electrical circuit connections, multimeters, simple harmonic motion experiments, spring experiments, friction analysis, and light refraction and reflection. 73 middle school students participated in these activities, using assessment methods including pre-test and post-test evaluations and an assessment of attitudes toward science. The results indicated a statistically significant change in scores across all laboratory activities. Specifically, the post-test scores surpassed the pre-test scores in each lab, with average score increases ranging from 3.644 to 5.096 points. This improvement demonstrates that students enhanced their learning and understanding of the content after participating in the activities. Additionally, t-test analyses revealed statistically significant differences between pre-test and post-test scores for all labs ($p < 0.05$). The attitude assessment further indicated that students' interest and confidence in learning science significantly increased, with many reporting heightened enthusiasm for the subject and a belief in their ability to succeed in science due to the engaging and accessible hands-on experiments. This research concludes that MS labs offer a practical, experiential learning approach that enhances understanding and fosters positive attitudes toward science among students. It suggests that such methodologies should be adapted and implemented in other areas to promote practical learning in science education.

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