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Effectiveness of Dual Space Inquiry Based E-Module on Student Learning Outcomes and Motivation in Work and Energy Material

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ABSTRACT

Physics learning should enable students to achieve strong conceptual understanding and high learning outcomes while remaining actively motivated throughout the learning process. However, learning outcomes and learning motivation in physics remain challenging, particularly in the topic of work and energy, where students often experience difficulties in understanding concepts and actively engaging in learning. Preliminary study findings indicated that students' physics learning outcomes remained low, with a mastery rate of only 22%. Student learning motivation was also suboptimal, as evidenced by low percentages across several motivation indicators. To address these issues, a Dual Space Inquiry-based e-module was implemented as an interactive digital learning resource. This study aimed to examine the effectiveness of the Dual Space Inquiry-based e-module in improving students' learning outcomes and motivation. A pre-experimental method with a one-group pretest-posttest design was employed. The sample consisted of 30 students from class X.E1, selected using purposive sampling. Data were collected via learning outcome tests and learning motivation questionnaires. Results showed that the average learning outcome score increased from 49.67 to 80.50, with an N-Gain of 0.59 (medium category) and an effect size of 1.61. Learning motivation increased from 67.27 to 81.47, with an N-Gain of 0.43 (medium category) and an effect size of 2.391. Paired sample t-test results yielded a significance value of <0.05. Thus, the Dual Space Inquiry-based e-module is effective in enhancing students' learning outcomes and motivation and serves as an alternative digital teaching material for physics instruction.

INTRODUCTION

Education is a conscious and systematic process aimed at developing students' potential to its fullest extent. Amid the rapid advancement of science and technology, education is expected to produce learners who possess strong learning abilities and are capable of adapting to various changes occurring in society. These developments have driven a shift in the learning paradigm from teacher-centered instruction to student-centered learning. In line with these

demands, the Merdeka Curriculum provides teachers with the flexibility to develop instructional strategies, learning models, and teaching materials tailored to students' characteristics and learning needs, thereby creating a more active, meaningful, collaborative, and goal-oriented learning process that supports the optimal achievement of learning objectives across diverse educational contexts and settings (Suryana et al., 2023).

The success of physics learning can be evaluated based on students' learning outcomes after participating in the instructional process. Learning outcomes are important indicators that reflect students' mastery of the competencies associated with the subject matter while also indicating the achievement of learning objectives (Sudjana, 2016; Azis & Ariani, 2025). In addition to learning outcomes, learning motivation is another crucial factor influencing the success of physics learning. Learning motivation refers to the internal drive that encourages students to be enthusiastic, persistent, and committed to achieving learning goals. Students with high learning motivation tend to be more active, persistent, and resilient when facing challenges during the learning process (Uno, 2017).

Problems related to learning outcomes and learning motivation are still evident in physics learning at SMAN 1 X Koto. Daily assessment results indicate that only 22% of students achieved the Learning Objectives Achievement Criteria, while the remaining 78% failed to meet the expected standard. Furthermore, preliminary study results revealed that students' learning motivation was still relatively low, as indicated by scores of 53% for the desire to succeed, 53% for appreciation in learning, 58% for engaging learning activities, and 55% for a conducive learning environment. Observations and interviews with physics teachers and students also showed that students still experienced difficulties in understanding the concept of work and energy, classroom instruction was predominantly lecture-based, and the teaching materials used remained conventional while interactive digital learning materials remained limited.

The low levels of students' learning outcomes and learning motivation in physics are also supported by findings from previous studies. Malotong & Zaky (2022) stated that low physics learning outcomes are caused by students' difficulties in planning and solving physics problems using appropriate concepts and formulas. Similarly, Ausina et al. (2024) reported that poor learning outcomes are influenced by low learning motivation and the use of less effective instructional methods. In addition, the use of unattractive and non-interactive learning materials may also contribute to students' low motivation and poor learning outcomes (Rusmulyanti & Annovasho, 2022).

One factor contributing to these problems is the limited use of teaching materials that facilitate active and meaningful learning. Conventional teaching materials tend to emphasize information delivery and routine exercises, providing limited opportunities for students to independently construct conceptual understanding. Therefore, innovative digital teaching materials are needed to support physics learning that is more interactive, student-centered, and aligned with technological developments. One form of digital teaching material that can be utilized in learning is the e-module. An e-module is an electronic learning module designed to support independent learning and can be accessed through various digital devices, such as computers, laptops, tablets, and smartphones(Asmiyunda et al., 2018). The use of e-modules in physics learning enables students to understand concepts through multiple representations, including text, images, videos, simulations, and interactive activities, thereby supporting effective learning processes and improving students' learning outcomes and motivation in physics learning activities (Yaldi et al., 2024).

Although e-modules offer numerous advantages in supporting the learning process, their effectiveness depends not only on their digital features but also on the instructional model employed during implementation. One inquiry-based learning model that can be integrated with e-modules is the Dual Space Inquiry (DSI) model. The DSI model integrates

digital and physical learning environments through the stages of orientation, conceptualization, exploration, conclusion and assessment, and reflection. Through these stages, students do not merely receive information passively but actively construct conceptual understanding through inquiry and reflective learning activities (Novitra et al., 2025)

Various studies have demonstrated the positive contribution of e-modules to physics learning. Fadillah et al. (2024) reported that the use of e-modules was more effective than conventional instruction in improving students' learning outcomes. Furthermore, Antris & Andromeda (2023) demonstrated that inquiry-based e-modules integrated with experimental videos were able to improve students' learning outcomes. The implementation of inquiry-based e-modules supported by virtual laboratories and digital simulation technologies has also been reported to be effective in improving students' learning outcomes (Hasibuan, 2021; Azis & Ariani, 2025). In addition to contributing to improved learning outcomes, the use of e-modules has also been reported to enhance students' learning motivation during the overall learning process (Kowarin & Efendi, 2025).

Although numerous studies have demonstrated the effectiveness of inquiry-based e-modules in improving students' learning outcomes and learning motivation, most of these studies have not implemented the Dual Space Inquiry model. Furthermore, previous studies have generally focused on only one aspect of learning, either learning outcomes or learning motivation separately. Therefore, studies investigating the effectiveness of Dual Space Inquiry-based e-modules in simultaneously improving students' learning outcomes and learning motivation remain limited.

The topic of work and energy was selected in this study because it is one of the physics topics that students often perceive as difficult. Students generally experience difficulties in understanding the concepts of work, kinetic energy, potential energy, the relationship between work and changes in energy, as well as the law of conservation of mechanical energy because these concepts are abstract and require strong conceptual reasoning skills (Simamora, 2024). Furthermore, mastering this topic requires students to relate physics concepts to real-life phenomena and apply them to solve various problems; therefore, learning approaches that facilitate meaningful conceptual understanding are needed.

Based on the foregoing discussion, the novelty of this study lies in examining the effectiveness of a Dual Space Inquiry-based e-module in simultaneously improving students' learning outcomes and learning motivation on the topic of work and energy. This study aims to analyze the effectiveness of the DSI-based e-module in improving students' learning outcomes and learning motivation. The findings of this study are expected to enrich the empirical evidence regarding the implementation of the Dual Space Inquiry model in physics education by providing evidence of its impact on students' learning outcomes and learning motivation. Furthermore, this study is expected to offer an alternative approach to developing innovative digital teaching materials that support more active, interactive, and student-centered physics learning.

METHODS

This study employed a quantitative approach using a pre-experimental method with a one-group pretest–posttest design. The design was employed to investigate the effectiveness of the Dual Space Inquiry (DSI)-based e-module in improving students' learning outcomes and learning motivation on the topic of Work and Energy. Students' learning outcomes and motivation were measured through pretest and posttest to determine the changes following the implementation of the DSI-based e-module. The research design is presented in Table 1.

Table 1. Research Design

O_1	X	O_2

Pretest	Treatment	Posttest

Source: Sugiyono (2023)

The study was conducted during the even semester of the 2025/2026 academic year at SMAN 1 X Koto. The research proceeded through three stages: planning, implementation, and completion. The planning stage involved preliminary observation, the development of instructional materials and research instruments, and the selection of the research sample. During the implementation stage, students first completed a pretest to assess their initial learning outcomes and completed a motivation questionnaire to gauge their baseline motivation levels. Instruction was then delivered using the Dual Space Inquiry-based e-module, which comprises five phases: orientation, conceptualization, exploration, conclusion and assessment, and reflection. Upon completion of all instructional activities, students took a posttest and completed the motivation questionnaire again. Finally, the completion stage involved data processing, analysis, and interpretation to evaluate the effectiveness of the Dual Space Inquiry based e-module on students' learning outcomes and motivation.

The population for this study consisted of all Grade X students at SMAN 1 X Koto during the 2025/2026 academic year, totaling 148 students distributed across five classes. The sample was selected using purposive sampling based on specific criteria aligned with the research objectives (Sugiyono, 2023). The research sample was selected based on preliminary observations and recommendations from the physics teacher. Class X.E1 was selected as the sample because its physics learning outcomes were low, with a mastery rate of 22%, while 78% of the students had not yet met the Learning Objective Achievement Criteria. Furthermore, the class was deemed to possess characteristics aligned with the research objectives, thereby supporting the optimal implementation of the study. The research sample consisted of 30 students from class X.E1.

The research instruments employed consisted of a learning achievement test and a learning motivation questionnaire. The learning achievement test was used to measure students' conceptual mastery of the Work and Energy topic through pre-test and post-test activities. The test instrument comprised multiple choice questions that met established validity and reliability criteria. The learning motivation questionnaire was developed based on four indicators: the desire and drive to succeed, appreciation for learning, engaging learning activities, and a conducive learning environment. A five points Likert scale was used for the questionnaire.

The research data were analyzed using descriptive statistics. Descriptive analysis was employed to determine the mean, minimum score, maximum score, and standard deviation for both students' learning outcomes and learning motivation. Prior to hypothesis testing, the data were assessed for normality using the Shapiro-Wilk test at a significance level of 0.05. Data exhibiting a normal distribution were analyzed using the Paired Sample t-Test, whereas data not normally distributed were analyzed using the Wilcoxon Signed Rank Test. Improvements in student learning outcomes and learning motivation were analyzed using Normalized Gain scores, calculated with the following formula:

$$N - Gain = \frac{Posttest - Pretest}{Ideal\ Score - Pretest}$$

Table 2. Normalized Gain Criteria

Range	Criterion
$0.70 \leq g \leq 100$	High
$0.30 \leq g < 0.70$	Medium
$0.00 \leq g < 0.30$	Low

$g = 0.00$	No Increase
$-1.00 \leq g < 0.00$	Decrease

Source: Sukarelawa (2024)

The magnitude of the effect of the Dual Space Inquiry-based e-module on students' learning outcomes and learning motivation was evaluated using effect size analysis. Effect size analysis was conducted to determine the strength of the intervention beyond statistical significance. The effect size was calculated using the formula proposed by (Becker, 2000), as follows:

$$SE = \frac{\underline{x}_{posttest} - \underline{x}_{pretest}}{\sqrt{\frac{SD_{pretest}{}^2 + SD_{posttest}{}^2}{2}}}$$

Table 3. Effect Size Categories

Effect Size	Category
$0 - 0.20$	Very Small
$0.21 - 0.50$	Small
$0.51 - 1.00$	Medium
> 1.00	Large

Source: Cohen et al. (2007)

The effectiveness of the Dual Space Inquiry-based e-module was determined based on several assessment criteria. First, there should be a significant improvement in students' learning outcomes and learning motivation after the implementation of the e-module. Second, the N-Gain score should reach at least the medium category, indicating a meaningful increase in students' performance. In addition, the effect size should be categorized as large, demonstrating a strong impact of the intervention. Therefore, the e-module is considered effective if these criteria are fulfilled simultaneously.

RESULTS AND DISCUSSION

Results

Effectiveness of the Dual Space Inquiry-Based E-Module on Student Learning Outcomes Student learning outcomes were obtained through a cognitive ability test administered to 30 students from class X.E1 at SMAN 1 X Koto. Measurements were taken twice: before instruction using the Dual Space Inquiry based e-module (pretest) and after instruction using the same e-module (posttest). The obtained data were then analyzed using descriptive statistics to determine the characteristics of student learning outcomes following the implementation of the e-module.

Table 4. Descriptive Statistics of Student Learning Outcomes

Data	N	Minimum	Maximum	Mean	Standard Deviation
Pretest	30	5	90	49.67	23.742
Posttest	30	50	100	80.50	13.022

Based on the data presented in Table 4, the average student learning outcome increased from 49.67 in the pretest to 80.50 in the posttest after participating in learning using the Dual Space Inquiry-based e-module. This increase of 30.83 points indicates that the e-module was able to enhance students' understanding of work and energy concepts. In addition, the minimum score increased from 5 to 50, suggesting that students with lower initial abilities also experienced substantial improvement in their learning outcomes. The maximum score increased from 90 to 100, indicating that some students were able to achieve optimal mastery of the material after the intervention. Meanwhile, the standard deviation decreased from 23.742 to 13.022, indicating that the variation in students' learning outcomes became smaller after the learning process. Therefore, the implementation of the Dual Space Inquiry-based e-module not only improved students' learning outcomes but also contributed to a more equitable distribution of learning achievement among students.

To assess the level of student learning mastery before and after the intervention, a mastery analysis was conducted based on the Learning Objective Achievement Criteria established by the school, with a minimum mastery score of 75. Students who obtained scores of 75 or higher were categorized as having achieved mastery, while those scoring below 75 were classified as not yet mastered. This analysis was conducted to determine the extent to which the Dual Space Inquiry-based e-module contributed to students' achievement of the expected learning objectives beyond changes in mean scores alone. The results of the mastery analysis for both the pretest and posttest are presented in Table 5.

Table 5. Student Learning Outcome Mastery

Category	Range	Pretest		Posttest	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Mastered	75-100	6	20.00	23	76.67
Not Mastered	0-74	24	80.00	7	23.33
Total		30	100	30	100

Table 5 shows that prior to instruction using the e-module, only 6 students (20.00%) achieved learning mastery, while 24 students (80.00%) did not meet the Learning Objective Mastery Criteria. Following instruction using the Dual Space Inquiry-based e-module, the number of students achieving mastery increased to 23 (76.67%), whereas the number of students who had not achieved mastery decreased to 7 (23.33%), representing an increase in the mastery percentage of 56.67%. This substantial improvement indicates that the Dual Space Inquiry-based e-module not only enhanced students' average learning outcomes but also enabled a greater proportion of students to achieve the expected minimum competency standard. Prior to the intervention, most students were categorized as not yet mastering the learning objectives, suggesting that their initial understanding of the material was relatively low. However, after the implementation of the e-module, the majority of students successfully achieved learning mastery, reflecting a better understanding of the concepts being studied. The considerable shift in the number of students who achieved and did not achieve mastery provides evidence that the Dual Space Inquiry-based e-module contributed significantly to improving student learning outcomes. Therefore, the implementation of this e-module can be considered effective in helping students achieve the learning competencies expected according to the school's established.

To evaluate the effectiveness of the Dual Space Inquiry-based e-module on students' learning outcomes, several statistical analyses were conducted. A normality test using the Shapiro–Wilk method was first performed to determine whether the data met the assumptions required for parametric testing. Subsequently, a Paired Sample t-Test was conducted to examine the significance of differences between pretest and posttest scores before and after

the implementation of the e-module. In addition, N-Gain and effect size analyses were performed to determine the magnitude of learning improvement and the strength of the intervention effect. These analyses provide comprehensive evidence regarding both the statistical significance and the practical effectiveness of the Dual Space Inquiry-based e-module in improving students' learning outcomes. The results of these analyses are presented in Table 6.

Table 6. Statistical Analysis Results of Student Learning Outcomes

Parameter Statistic	Pretest	Posttest
Normality Test (Shapiro-Wilk)		
α	0.050	0.050
Sig. (p-value)	0.398	0.062
Interpretation	Normally distributed	Normally distributed
Hypothesis Test (Paired Sample t-Test)		
α	0.050	
t	-8.266	
df	29	
Sig. (2-tailed)	< 0.001	
Interpretation	There was a significant difference	
N-Gain and Effect Size		
N-Gain	0.59	
N-Gain Category	Medium	
Effect Size	1.61	
Effect Size Category	Large	

Based on Table 6, a normality test was conducted using the Shapiro-Wilk test Prior to hypothesis testing. The results showed significance values of 0.398 for the pretest and 0.062 for the posttest, both of which were greater than 0.05, indicating that the data were normally distributed. Since the assumption of normality was met, a Paired Sample t-Test was performed to examine differences in learning outcomes before and after the intervention. The analysis yielded a t-value of -8.266, a degree of freedom of 29, and a significance value of < 0.001, which was lower than the significance level of 0.05. Therefore, H0 was rejected and H_1 was accepted, indicating a significant difference between the pretest and posttest scores. These findings provide strong statistical evidence that the Dual Space Inquiry-based e-module significantly improved students' learning outcomes.

To determine the magnitude of the improvement in learning outcomes and the strength of the intervention effect, N-Gain and effect size analyses were conducted, as presented in Table 6. The results showed an N-Gain value of 0.59, which falls within the medium category, indicating a moderate improvement in students' learning outcomes after the implementation of the Dual Space Inquiry-based e-module. In addition, the effect size value of 1.61 was categorized as large, suggesting that the intervention had a strong practical impact on students' learning outcomes. The combination of a medium N-Gain and a large effect size indicates that although the increase in scores did not reach the high category, the learning intervention produced a substantial difference between students' pretest and posttest performance. These findings are consistent with the results of the Paired Sample t-Test, which revealed a significant difference between the two sets of scores. Therefore, the Dual Space Inquiry-based e-module can be considered effective in improving students' learning outcomes and providing a meaningful educational impact in learning the topic of work and energy.

Student learning motivation was measured using a questionnaire administered before and after instruction involving the Dual Space Inquiry-based e-module on the topic of work

and energy. This measurement was conducted to determine changes in students' learning motivation following the intervention. The collected data were analyzed using descriptive statistics, including the mean, minimum score, maximum score, and standard deviation, to provide an overview of students' motivation before and after learning. The results of the descriptive analysis of student learning motivation are presented in Table 7.

Table 7. Descriptive Statistics of Student Learning Motivation

Data	N	Minimum	Maximum	Mean	Standard Deviation
Pretest	30	56	76	67.27	5.735
Posttest	30	63	91	81.47	6.135

Based on the data presented in Table 7 students' learning motivation showed a notable improvement after the implementation of the Dual Space Inquiry-based e-module. The mean motivation score increased from 67.27 in the pretest to 81.47 in the posttest, representing an increase of 14.20 points and indicating a positive shift in students' motivation during the learning process. This improvement was also reflected in the increase of the minimum score from 56 to 63 and the maximum score from 76 to 91, suggesting that students with both lower and higher initial levels of motivation benefited from the intervention. Furthermore, the standard deviation changed only slightly from 5.735 to 6.135, indicating that the distribution of students' learning motivation remained relatively consistent after the learning process. These findings suggest that the Dual Space Inquiry-based e-module not only enhanced students' learning motivation but also maintained a relatively balanced level of motivation among students. Therefore, the e-module can be considered effective in fostering students' motivation to participate actively in learning.

To obtain a more detailed understanding of students' learning motivation, an analysis was conducted based on each motivation indicator employed in the study. The indicators included desire and wish to succeed, appreciation in learning, engaging activities, and learning environment. This analysis was performed to identify which aspects of learning motivation experienced the greatest improvement after the implementation of the Dual Space Inquiry-based e-module. The percentage score for each indicator was calculated for both the pretest and posttest stages. The results of the indicator-based analysis of students' learning motivation are presented in Table 8.

Table 8. Students Learning Motivation Based on Indicators

Indicator	Percentage (%)	
	Pretest	Posttest
Desire and wish to succeed	77	80
Appreciation in learning	60	81
Engaging activities	58	75
Learning environment	69	87
Average	66	81
Category	Good	Verry Good

Based on Table 8, all indicators of student learning motivation showed improvement after the implementation of the Dual Space Inquiry-based e-module. The indicator of desire and wish to succeed increased from 77% to 80%, indicating a stronger drive among students to achieve learning success. The appreciation in learning indicator showed a substantial increase from 60% to 81%, suggesting that students became more motivated through meaningful learning experiences and feedback. Similarly, the engaging activities indicator increased from 58% to 75%, while the learning environment indicator showed the greatest improvement, rising from 69% to 87%, indicating that the e-module created a more interactive

and supportive learning atmosphere. These findings suggest that the Dual Space Inquiry-based e-module positively influenced multiple aspects of student learning motivation, including achievement motivation, appreciation of learning, engagement, and perceptions of the learning environment. Overall, the average motivation score increased from 66% (Good) to 81% (Verry Good), demonstrating that the implementation of the e-module had a positive impact on students' learning motivation.

To evaluate the effectiveness of the Dual Space Inquiry-based e-module on students' learning motivation, several statistical analyses were conducted. A normality test using the Shapiro–Wilk method was first performed to determine whether the data met the assumptions required for parametric testing. Subsequently, a Paired Sample t-Test was conducted to examine the significance of differences between pretest and posttest motivation scores. In addition, N-Gain and effect size analyses were performed to determine the magnitude of motivation improvement and the strength of the intervention effect. The results of these analyses are presented in Table 9.

Table 9. Statistical Analysis Results of Students' Learning Motivation

Statistic	Pretest	Posttest
Normality Test (Shapiro-Wilk)		
α	0.050	0.050
Sig. (p-value)	0.287	0.081
Interpretation	Normally distributed	Normally distributed
Hypothesis Test (Paired Sample t-Test)		
α	0.050	
t	-14.200	
df	29	
Sig. (2-tailed)	< 0.001	
Interpretation	There was a significant difference	
N-Gain and Effect Size		
N-Gain	0.43	
N-Gain Category	Medium	
Effect Size	2.391	
Effect Size Category	Large	

Based on Table 9, the significance values obtained from the Shapiro–Wilk normality test were 0.287 for the pretest and 0.081 for the posttest, both of which were greater than the significance level of 0.05. These results indicate that the pretest and posttest motivation data were normally distributed. Since the normality assumption was satisfied, a Paired Sample t-Test was conducted to examine whether there was a significant difference in students' learning motivation before and after the implementation of the Dual Space Inquiry-based e-module. The analysis yielded a t-value of -14.200, a degree of freedom of 29, and a significance value of < 0.001, which was lower than the significance level of 0.05. Therefore, H_0 was rejected and H_1 was accepted, indicating a significant difference between students' pretest and posttest learning motivation scores. These findings provide strong statistical evidence that the Dual Space Inquiry-based e-module significantly improved students' learning motivation.

To determine the magnitude of the improvement in students' learning motivation and the strength of the intervention effect, N-Gain and effect size analyses were conducted, as presented in Table 9. The results showed an N-Gain value of 0.43, which falls within the medium category, indicating a moderate improvement in students' learning motivation after the implementation of the Dual Space Inquiry-based e-module. In addition, the effect size value of 2.391 was categorized as large, suggesting that the intervention had a strong practical

impact on students' learning motivation. The combination of a medium N-Gain and a large effect size indicates that although the increase in motivation did not reach the high category, the learning intervention produced a substantial difference between students' pretest and posttest motivation scores. These findings are consistent with the results of the Paired Sample t-Test, which revealed a significant difference between the two sets of scores. Therefore, the Dual Space Inquiry-based e-module can be considered effective in improving students' learning motivation and fostering active engagement in learning.

Discussion

The results of this study indicate that the use of a Dual Space Inquiry (DSI)-based e-module is effective in improving students' learning outcomes on the topic of work and energy. This is evidenced by the increase in students' average scores after the learning process, the results of the Paired Sample t-Test showing a significant difference between pretest and posttest scores, an N-Gain value of 0.59 categorized as moderate, and an effect size of 1.61 categorized as large. These findings indicate that the use of DSI-based e-modules not only has a statistically significant effect but also provides a substantial practical impact on improving students' learning outcomes.

The improvement in learning outcomes indicates the development of students' cognitive abilities after participating in learning activities using the DSI-based e-module. This finding is consistent with Bloom's concept of learning outcomes, which emphasizes the cognitive domain as one of the essential components of changes in students' abilities following the learning process (Munzenmaier & Rubin, 2013). In this study, learning outcomes focused on the cognitive domain, which was measured using pretest and posttest assessments. Therefore, the improvement in students' scores indicates an enhancement in their understanding of work and energy concepts.

The improvement in students' understanding of work and energy concepts can be explained through the characteristics of the Dual Space Inquiry approach, which integrates two interconnected learning spaces, namely the real learning space and the online learning space. Through the stages of orientation, conceptualization, exploration, conclusion, and reflection, students are provided with opportunities to observe phenomena, identify problems, conduct investigations, construct concepts, and evaluate their learning processes. These activities encourage students to actively engage in the learning process and construct knowledge based on their learning experiences rather than merely receiving information from the teacher.

In the real learning space, students are directly involved in observing phenomena, conducting investigations, participating in discussions, and constructing concepts based on their experiences. Meanwhile, in the online learning space, students utilize the DSI-based e-module to access learning materials, observe images and videos, explore contextual phenomena, complete inquiry-based activities, and conduct independent reflections. The integration of these two learning spaces enables students to connect real-world experiences with theoretical concepts, thereby creating a more meaningful learning process and supporting deeper understanding of work and energy concepts.

In addition to the implementation of the Dual Space Inquiry stages, the improvement in learning outcomes is also supported by the characteristics of the e-module as an interactive digital learning resource. The presentation of materials through images, videos, contextual phenomena, and inquiry-based activities helps students visualize abstract physics concepts,

explore learning materials independently, and increase their engagement during the learning process. These features facilitate students in discovering and constructing knowledge, which ultimately contributes to improved learning outcomes.

The findings of this study are consistent with those of Hasibuan (2021) who reported that inquiry-based e-modules integrated with virtual laboratories improved students' learning outcomes with a moderate N-Gain category. Similar findings were reported by Wahab et al. (2021) and Aeni & Widodo (2022), who found that the use of e-modules in physics learning significantly improved students' learning outcomes. In addition, a meta-analysis conducted by Dhanil et al. (2024) demonstrated that the use of e-modules in science learning positively affected students' learning outcomes. The consistency of these findings further strengthens the evidence that inquiry-based digital learning materials can improve students' learning outcomes by promoting active participation in the learning process and encouraging independent knowledge construction.

However, this study obtained a different N-Gain category from those reported by Antris & Andromeda (2023) and Mutmainnah (2021), who obtained high N-Gain categories. These differences may be influenced by various factors, including students' characteristics, learning materials, instructional duration, and learning environment conditions. Nevertheless, those studies similarly demonstrated that integrating e-modules with inquiry-based approaches positively affects students' learning outcomes. Therefore, the present study further strengthens the empirical evidence regarding the effectiveness of DSI-based e-modules as an alternative digital learning resource in physics education.

In addition to improving students' learning outcomes, the use of DSI-based e-modules was also proven effective in enhancing students' learning motivation. This is indicated by the increase in the average motivation scores, the results of the Paired Sample t-Test showing a significant difference between motivation scores before and after the learning process, an N-Gain value of 0.43 categorized as moderate, and an effect size of 2.391 categorized as large. These findings indicate that the implementation of DSI-based e-modules not only influences students' learning outcomes but also contributes to improving their learning motivation.

The improvement in students' learning motivation can be explained through the characteristics of the DSI-based learning process, which provides active, meaningful, and student-centered learning experiences. Learning activities in the DSI-based e-module engage students in observing phenomena, conducting investigations, participating in discussions, and reflecting on their learning experiences. These activities are consistent with Uno (2017) concept of learning motivation, which states that learning motivation is an internal and external drive that encourages students to engage in learning activities to achieve specific goals. Active involvement throughout the inquiry process can enhance students' curiosity, interest in physics learning, and motivation to achieve learning success.

The integration of real learning spaces and online learning spaces also contributes to improving students' learning motivation. The real learning space provides direct learning experiences through interaction, discussions, and collaborative investigations, while the online learning space offers flexibility for students to access learning materials and engage in independent learning. The combination of these two learning spaces creates more varied learning experiences, thereby increasing students' engagement and motivation throughout the learning process.

Based on the analysis of learning motivation indicators, all indicators showed improvement after the implementation of the DSI-based e-module. Inquiry activities provided students with opportunities to independently discover concepts, express their ideas, receive feedback, and develop confidence in their own abilities. Furthermore, the use of digital media, such as images, videos, and contextual phenomena, made the learning process more engaging and supported the creation of an active and conducive learning environment.

The findings of this study are consistent with those of Surani et al. (2025) and Kurniawati (2020), who reported that the use of e-modules could improve learning motivation by providing more engaging and flexible learning experiences. Fahlevi & Maghfiroh (2023) also found that inquiry-based electronic learning materials were effective in enhancing students' learning motivation. Furthermore, Kowarin & Efendi (2025) and Rahmawati et al. (2025) reported that interactive e-modules and inquiry-based learning increased students' engagement throughout the learning process.

The contribution of this study lies in the implementation of the Dual Space Inquiry approach within a digital e-module, which focuses not only on improving students' learning outcomes but also on developing their learning motivation. Unlike previous studies that mostly examined the use of e-modules or inquiry-based approaches separately, this study integrates real learning spaces and online learning spaces within a single learning design to support students' overall engagement. Therefore, the Dual Space Inquiry-based e-module can serve as an alternative digital learning resource that supports physics learning that is more active, interactive, flexible, and student-centered.

CONCLUSION

This study demonstrated that the Dual Space Inquiry-based e-module was effective in improving students' learning outcomes and learning motivation in the topic of work and energy. The effectiveness of the e-module was evidenced by a significant increase in students' learning outcomes, supported by a medium N-Gain category and a large effect size. In addition, students' learning motivation increased significantly after the implementation of the e-module, as indicated by the improvement in motivation scores and all measured motivation indicators. The integration of dual space inquiry activities encouraged students to actively observe phenomena, formulate problems, conduct investigations, draw conclusions, and reflect on their learning experiences. These learning experiences facilitated students' construction of conceptual understanding and promoted active engagement throughout the learning process. Furthermore, the e-module provided a more interactive and meaningful learning environment that supported both cognitive and motivational aspects of learning. Therefore, the Dual Space Inquiry-based e-module can be considered an effective and innovative digital teaching material for enhancing students' learning outcomes and learning motivation in physics learning.

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