The Effectiveness of Work-Energy Recitation Program in Improving Concept Mastery and Encouraging Changes in Student Resource Activation

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Abstract

The Moodle-based work-energy recitation program has been developed as a form of self-help program to improve concept mastery and analyze changes in student resources. The work-energy recitation program consists of conceptual questions in many problem contexts and is equipped with direct feedback on each choice option, so that it can provide a new perspective on student thinking and trigger the activation of the right resources. This study aims to analyze the effect of the work-energy recitation program on improving concept mastery and changes in student resource activation before and after using the program. The study used quasi-experimental designs conducted at the Department of Physics with research subjects being 78 students who were taking the Fisika Dasar I course, selected through cluster random sampling. The research data were obtained based on the results of concept mastery tests, perception questionnaires, and student activity logs in the work-energy recitation program which were then analyzed using paired t-tests, n-gain, crosstabulation, and correlation tests. The results showed that the n-gain of concept mastery was 0.22, which falls into the low category but indicates a significant improvement. The changes in student resource activation reflected a positive indication based on the results of the crosstabulation analysis of student answer choices, from shifts in pretest to posttest answers. These findings illustrate the effectiveness of the work-energy recitation program in providing positive contributions to improving students' conceptual mastery. The work-energy recitation program also succeeded in improving students' resource activation using resources that were appropriate to the context of the problem. Most students who used the work-energy recitation program also gave positive responses and showed quite good enthusiasm for the program, both in terms of learning motivation and usefulness.

Keywords: work, energy, recitation, concept mastery, resource

INTRODUCTION

In recent years, physics education researchers have shown a greater focus on students' ideas about physics phenomena and how they impact subsequent learning. These researchers emphasize how students' intuitive knowledge does not match the understanding of experts. Researchers have adopted different perspectives on students' intuitive knowledge, mainly through the perspectives of misconception theory and resource theory. The label misconception is used to refer to a false understanding that is contrary to scientific facts (Engelhardt and Beichner, 2004), which is deeply embedded in students' knowledge structures (Scherr, 2007; Sabo, Goodhew and Robertson, 2016). These misconceptions tend to develop during the learning process, stemming from students' empirical knowledge and intuitive representations of the physical world (Vosniadou, 2019). The research agenda for adherents of misconception theory focuses more on identifying and correcting false understandings or erroneous concepts (Scherr, 2007). This misconception are persistent and resistant to change, making them significant barriers to new learning and requiring considerable effort to overcome (Docktor and Mestre, 2014; Schwartz, Tsang, and Blair 2016b).

On the other hand, resource theory views students' knowledge as something dynamic and contextual, where errors often occur due to their inability to activate the right cognitive resources according to the context of the problem (diSessa, 2018; Docktor & Mestre, 2014; Ng & Woods, 2018). Research with a resource theory approach focuses on identifying and refining students' potentially useful but inappropriately applied intuitive ideas (Docktor & Mestre, 2014; Harrer et al., 2013; Sabo et al., 2016). According to resource theory, students almost always have good reasons for thinking because their thinking is based on ideas that are useful in many situations (Scherr, 2007). Scherr & Hammer, (2009) also argue that students possess resources for thinking about knowledge that they receive, discover, or infer from other knowledge, which they may activate depending on the situation. Lecturers can develop students' ideas by linking various physics concepts and providing relevant scientific experiences to solve problems (Sabo, Goodhew and Robertson, 2016; Tsania Nur Diyana, Sutopo and Sunaryono, 2020). The task of educators is to provide learning opportunities for students to build as many correct resource context association patterns as possible, while weakening incorrect resource context association patterns (Docktor and Mestre, 2014; Wood *et al.*, 2014). Therefore, this study adopts resource theory as a framework for understanding how students activate different resources when solving physics problems.

In this study, student resource activation refers to the activation of students' existing knowledge or ideas when interpreting and solving a physics problem, which may be appropriate or inappropriate depending on the context of the problem. The activated resources may be appropriate or inappropriate depending on the context of the problem. In this study, resource activation is identified from students' answer choices, where each option represents a particular way of reasoning about the concept. Several previous studies have shown that students still have difficulty in applying physics concepts, especially the concept of work-energy (Maries and Singh, 2016; Rivaldo *et al.*, 2020). Students' difficulties in learning work and energy are not limited to mathematical manipulation but also involve difficulties in selecting and applying the appropriate physical principles. Previous studies have reported difficulties in understanding work as a dot product of force and displacement, applying the work-energy theorem and conservation of mechanical energy (Rivaldo *et al.*, 2020). Recent findings also indicate that students may incorrectly apply the conservation of energy principle without considering the conditions and context of the problem. These difficulties suggest that students may possess relevant conceptual knowledge but do not always apply it appropriately when solving problems.

One of them is in the context of 2 objects with different masses moving with an initial velocity v_0, given the same force F so that they move the same distance s. Instead of using the work-kinetic energy theorem to solve problems, students tend to use the definition of kinetic energy $Ek = \frac{1}{2} mv^2$ (Rivaldo *et al.*, 2020). Then students also have difficulty in applying the work-mechanical energy theorem, such as tending to enforce the conservation of mechanical energy without considering whether the assumption is in accordance with the context of the problem at hand (Lindsey, Heron and Shaffer, 2009). This shows that despite having difficulty in solving problems, students already have a good basic understanding of the concept of the definition of kinetic energy and mechanical energy. These students' thoughts are considered productive and potentially useful (Khisman, Abu Tayeh and Al-rsa'i, 2020; Halilović *et al.*, 2021; Liu and Fang, 2023). Therefore, instead of considering these difficulties as misconceptions, this study views them as students' failure to activate certain contextually appropriate resources as believed by resource theory (Docktor and Mestre, 2014; diSessa, 2018).

The process of activating this resource takes a long time, so it is not enough if it is only done in formal classroom learning. Therefore, it is necessary to deepen the material outside the classroom which is given to students through recitation sessions (Thacker *et al.*, 2014), making it a form of personal guidance (Maries and Singh, 2016). Recitations need to contain conceptual questions and be accompanied by quick feedback (Sutopo, Jayanti and Wartono, 2017; Richards, Jones and Etkina, 2020; Taqwa, Amalina and Suyudi, 2022). Seeing the need for students to independently remediate understanding and encourage the activation of appropriate resources according to context, technological advances allow recitation activities to be carried out through online platforms, thus providing flexibility in learning (Klein *et al.*, 2021). Researchers developed a moodle-based work-energy recitation program as an effective tool to help students deepen the material outside the classroom, overcome time constraints, and respond to student needs directly.

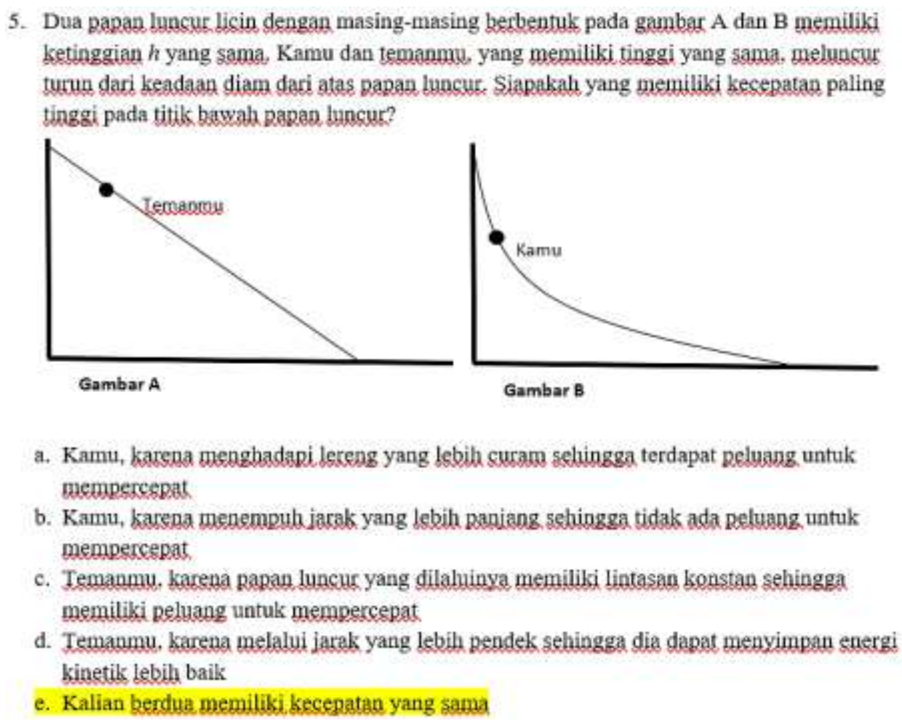
The work-energy recitation program developed in this study contains multi-context questions accompanied by feedback. Feedback contains information about the resources used by students and identifies inaccuracies in their use in the context of the problem. The goal is to help students correct inappropriate thinking and generate new ideas about how to approach the problem (T. N. Diyana, Sutopo and Sunaryono, 2020; Klein *et al.*, 2021). Feedback is also designed to strengthen student understanding (T. N. Diyana, Sutopo and Sunaryono, 2020; Taqwa, Amalina and Suyudi, 2022). Feedback shows the thinking used by each student in answering questions, both knowledge that is applied according to context and still in the form of piecemeal knowledge. This study also considers how the size of student behavior when accessing the program may affect their increased mastery of concepts. The objectives of this study were to determine the effectiveness of the work-energy recitation program in improving students' mastery of concepts, analyze changes in student resource activation after using the work-energy recitation program, determine the effect of the length of time accessing the program on increasing mastery of work-energy concepts, and determine students' perceptions regarding the use of the work-energy recitation program.

METHODS

This study involved 78 undergraduate students of Physics Education who were taking Fisika Dasar I at the State University of Malang. The research design used was a quasi-experimental with one group pretest-posttest design. The study began with a pretest to measure students' initial knowledge, then continued with the use of the work-energy recitation program as an intervention. After the intervention, a posttest was conducted to evaluate students' conceptual changes. The moodle-based work-energy recitation program was provided as a form of in-depth program that students accessed independently outside of formal learning. Student activities while using the program will be automatically recorded in the activity log as a trace of their access. At the end of the learning, a survey was conducted on students to determine their perceptions of the use of the work-energy recitation program.

The concept mastery test instrument in this study consisted of 18 multiple-choice questions. Instrument validity was tested using Pearson Product-Moment correlation at a 5% significance level, while reliability was assessed using Cronbach’s Alpha. Out of 22 items, 18 were retained based on empirical validity and indicator representation, yielding reliability coefficients of 0.417 (pretest) and 0.539 (posttest). Each question was designed with answer choices that describe the resources used by students. The questions covered various important concepts such as the definition of work, the work-kinetic energy theorem, the work-potential energy theorem, and the work-mechanical energy theorem. The questions were adapted from several test instruments on the physport website (https://www.physport.org/assessments/) such as the Energy Concept Assessment (ECA), Energy and Momentum Conceptual Survey (EMCS), Mechanics Baseline Test (MBT).

For example, in question number 5, it describes the situation of two skateboards with the same height but different slopes. Question number 5 can be seen more clearly in FIGURE 1.


5. Dua papan luncur licin dengan masing-masing berbentuk pada gambar A dan B memiliki ketinggian *h* yang sama. Kamu dan temanmu, yang memiliki tinggi yang sama, meluncur turun dari keadaan diam dari atas papan luncur. Siapakah yang memiliki kecepatan paling tinggi pada titik bawah papan luncur?

a. Kamu, karena menghadapi lereng yang lebih curam sehingga terdapat peluang untuk mempercepat
b. Kamu, karena menempuh jarak yang lebih panjang sehingga tidak ada peluang untuk mempercepat
c. Temanmu, karena papan luncur yang dilaluinya memiliki lintasan konstan sehingga memiliki peluang untuk mempercepat
d. Temanmu, karena melalui jarak yang lebih pendek sehingga dia dapat menyimpan energi kinetik lebih baik
e. Kalian berdua memiliki kecepatan yang sama

FIGURE 1. Question Number 5

Students are asked to determine the highest speed achieved by a person at the lowest point of the skateboard, when launching from a stationary state. Option (a) illustrates the understanding that a steeper slope will increase a person's speed when launching because it is considered to have a greater gravitational force. This understanding is often influenced by everyday experiences, such as when playing on a curved slide or water ride, where objects tend to move faster on a steeper track.

Option (b) shows the activation of the resource “over time, a moving object will eventually lose its speed.” This is based on everyday experience that a moving object will eventually stop. Option (c) shows the activation of the resource of the relationship between speed and path length, where the highest speed will be achieved on the first skateboard, because the path traveled is flatter and more constant, giving the object a greater opportunity to accelerate. This is based on the understanding that the shorter the path traveled (such as on a steep skateboard), the faster people will reach their destination without losing much speed. Option (e) shows the activation of the resource that the change in kinetic energy is the same as the negative change in potential energy. Because both skateboards have the same height and people start at the same speed, the final speed is the same.

Data analysis in this study involved several steps. Data from the pretest and posttest were compared to see if there was a difference in total scores using a paired t-test. Furthermore, N-Gain was used to measure how much improvement in concept mastery was experienced by students after participating in the recitation program. Changes in students' resource activation on the concept of work and energy before and after using the recitation program were analyzed using cross tabulation, and the results are presented in tabular form. To determine the correlation between the length of time students access the work-energy recitation program with their increased mastery of the concept, a non-parametric correlation test was conducted using the Rank Spearman Correlation Test. Conclusions were drawn based on the results of the Wilcoxon Signed Rank Test, N-gain analysis, crosstabulation, and Spearman Rank correlation analysis. The results were interpreted according to the relevant statistical and descriptive indicators for each research objective.

RESULTS AND DISCUSSION

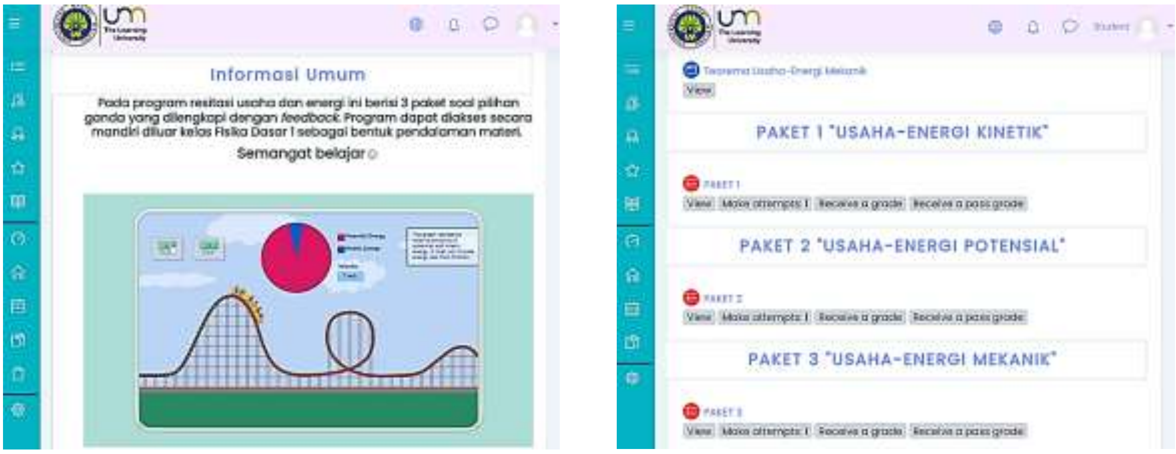
Description of The Work-Energy Recitation Program

The work-energy recitation program was developed based on the results of a literature review related to the difficulties experienced by students when reasoning about work-energy. The Moodle-based work-energy recitation program is accessed by students outside of Fisika Dasar I learning as a form of deepening their understanding of the concept of work-energy which can be freely accessed at any time via mobile devices or laptops. On the other hand, the Moodle-based work-energy recitation program allows monitoring of each student's progress, providing direct and easy feedback, and supporting independent learning.

The Moodle-based work-energy recitation program used in this study contains conceptual questions related to work-energy and is packaged in the form of 3 multiple-choice question packages, including package 1 on the work-kinetic energy theorem, package 2 on work by the earth's gravitational force, and package 3 on the work-mechanical energy theorem. The conceptual questions presented in the recitation program are in the form of multiple choices equipped with feedback on each choice option. Other options are also available as accommodation for other thoughts of students that are not listed in the choices. Feedback is given directly to students on both correct and incorrect options, which allows students to identify and correct inappropriate thinking. Questions, answers to multiple-choice options, and feedback are developed based on students' understanding and interpretation of the concept of work-energy resulting from literature studies (Ding, 2007; Sabo, Goodhew and Robertson, 2016) and the researcher's experience during learning observations in Fisika Dasar I classes. Both questions and feedback in these three packages have been analyzed and received suggestions from the supervising lecturer. The initial display of the Moodle-based work-energy recitation program is presented in FIGURE 2.

FIGURE 2. Login Page View

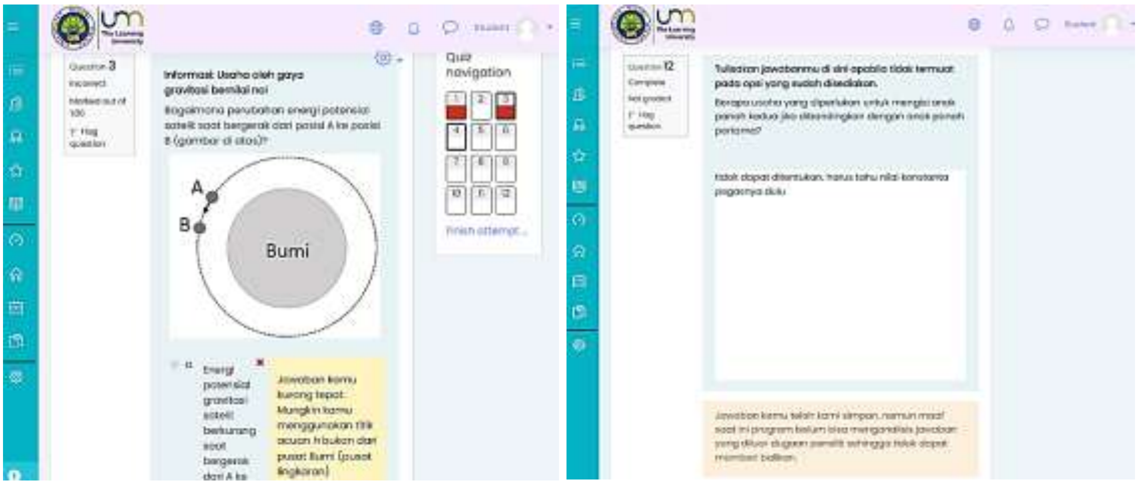
The initial display of the program includes student identity in the form of a name and password. This is given to avoid bias that may occur during the use of the program and to create a track record for each student activity when accessing the work-energy recitation program. The second page is the main menu of the work-energy recitation program which consists of general information, instructions for use, a summary of the material, and a package of questions presented in FIGURE 3.



(a) (b)

FIGURE 3. (a) Work-Energy Theorem Course Page, (b) Work-Energy Recitation Program Features

There are three question packages that students must complete, package 1 contains 16 questions related to the definition of work and the work-kinetic energy theorem. Package 2 contains 6 questions related to work by the earth's gravitational force. Package 3 contains 13 questions related to the work-mechanical energy theorem. These three question packages must be completed by students, where each package contains conceptual questions in the form of multiple choices with each choice option reflecting the resources activated by students in solving the problem. Other options are also provided to record student answers that have not been accommodated in the program, in detail can be seen in FIGURE 4. Other student answers will be automatically recorded in the system, then analyzed and can be discussed while studying in class.



(a) (b)

FIGURE 4. (a) Question and Feedback View, (b) Accommodation of alternative answers from students that are not available in the choices

When students start a session of working on questions in a package in the recitation program, the time of work will be automatically recorded in the system. Furthermore, to check whether the answer chosen by the student is correct or not, they need to click the "check" menu, then feedback will appear that must be read until finished. If the answer is correct, a green check mark will appear; conversely, if the answer is wrong, a red cross will appear. More clearly presented in FIGURE 5.

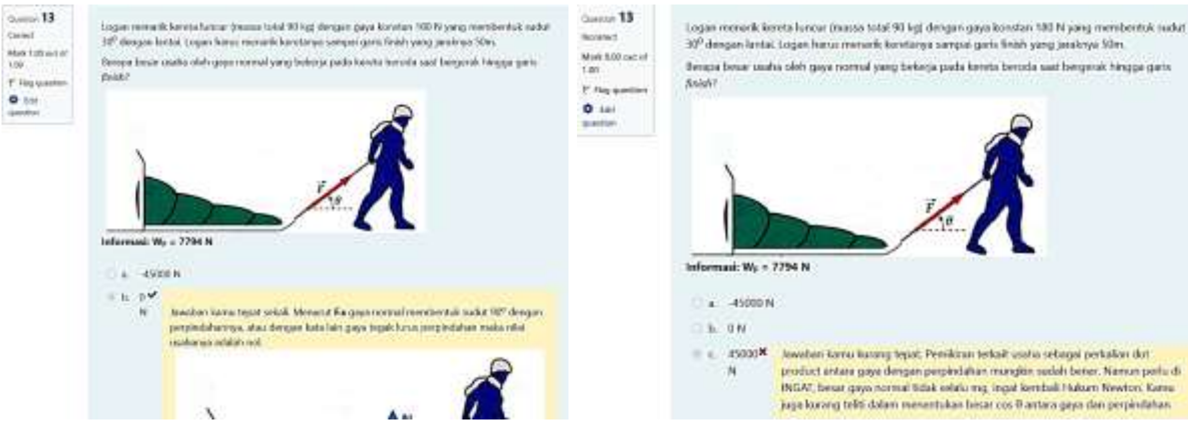


FIGURE 5. (a) Example of correct answer, (b) Example of wrong answer

Both correct and wrong answers will be accompanied by related feedback. Students who answer correctly can proceed to the next question by clicking the "next" button. However, if the answer is wrong, students must try to answer a similar question again by clicking "try another question like this". After answering all the questions in one package, students will see a review of the problem solving, as shown in FIGURE 6.

FIGURE 6. Review Page

The review page presents details of the start time, status, completion time, amount of time required to complete, grades, and a summary of each answer and feedback. Learning with the work-energy recitation program is carried out outside of Fisika Dasar I lecture hours where students access the program freely without time limits. Monitoring of student activity when accessing the work-energy recitation program outside of lecture hours is carried out through activity records in the program.

Effectiveness of the Work-Energy Recitation Program in Improving Students' Concept Mastery

The effectiveness of the work-energy recitation program is reviewed based on changes in pretest and posttest scores, the results of the pretest and posttest score difference test, and n-gain. Statistical descriptions of students' pretest, posttest, and n-gain scores are presented in TABLE 1. The pretest data were not normally distributed, determined by a significance value of 0.035 < α (0.05) Saphiro Wilk, while the posttest data were normally distributed with a significance of 0.073 > α (0.05) Saphiro Wilk.

TABLE 1. Pretest-Posttest Score Statistical Data

Description	**Pretest*	**Posttest*	*N-gain*
Mean	4.28	8.21	0.22
SD	-	2.43	
Max Score	10	16	
Min Score	0	3	

*Scoring scale from 0 to 22

Table 1 shows that the average pretest of students was 4.28, then increased during the posttest with an average of 8.21. The increase reached 3.93 with a maximum value of 22. Before analyzing n-gain, it was first tested whether the pretest and posttest data were statistically different using non-parametric statistics with the Wilcoxon Signed Rank Test. The results of the Wilcoxon test obtained a significance value of 0.000 < α = 0.05, meaning that there was a significant difference in the average between the pretest and posttest values. The difference between the pretest and posttest values means that n-gain analysis can be carried out.

Based on the n-gain calculation, the average result was 0.22, indicating an increase. This study yielded relatively low N-gain scores (Sutopo & Waldrip, 2014). Based on the results presented in Chapter IV, ten students obtained low N-gain scores (>0.1), necessitating further investigation. The researcher analyzed the learning behaviors of these ten students regarding their use of the recitation program to determine the extent of their active engagement—specifically, how they utilized the program to deepen their understanding of work and energy concepts outside of the Basic Physics I class—and how this engagement contributed to their mastery of the concepts. This finding shows that the effort-energy recitation program is effective in improving students' mastery of concepts. In line with previous findings by Diyana et al., (2020b) which stated that recitation containing questions accompanied by feedback can help students remediate wrong thinking. Providing conceptual questions in various contexts and accompanied by feedback can also improve conceptual mastery (Taqwa, Amalina and Suyudi, 2022) and help identify undetected weaknesses (Klein *et al.*, 2021).

The data on the increase in students' pretest to posttest scores as viewed from n-gain appeared to vary, so grouping was carried out based on the n-gain interpretation criteria as described in TABLE 2.

TABLE 2. Improving Students' Concept Mastery Based on N-Gain Interpretation Criteria

N-Gain	Number
N-gain < 0.25	42
0.25 ≤ *N-gain* < 0.45	34
0.45 ≤ *N-gain* < 0.65	2
N-gain ≥ 0.65	0

Furthermore, to find out how students' mastery of concepts on each question item increased before and after using the work-energy recitation program, this can be seen in FIGURE 7.

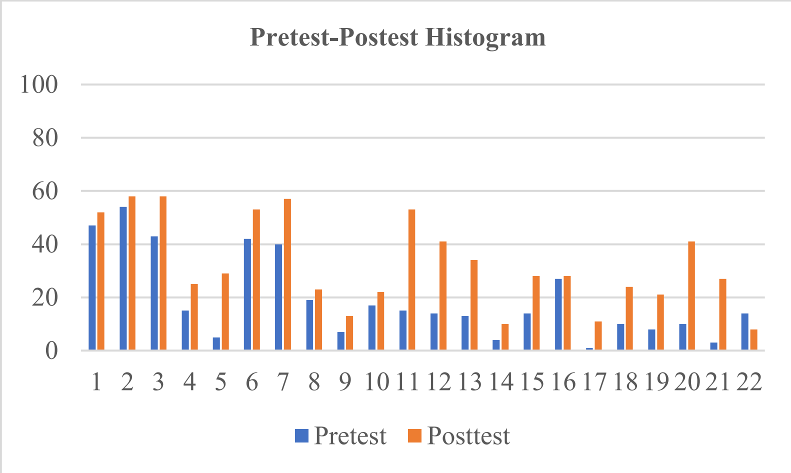


FIGURE 7. Comparison of the Number of Students Who Answered Each Question Item Correctly in the Pretest and Posttest

Based on Figure 7, there was an increase in scores for each question except question number 22. During the pretest, there were 14 students who answered correctly. However, during the posttest, only 8 students managed to answer correctly. In fact, question number 22 is not an easy problem, students are faced with the problem of determining the magnitude of the normal force at the lowest point of an object sliding on a semicircular track. The problem of question number 22 involves the application of the concept of work-energy in Newton's Law. In solving the problem, students tend to rely on Newton's First Law and ignore the important aspect that the value of the normal force (N) is not always the same as the weight of the object (mg) in the context of this question. It should be understood that the object in the context of question number 22 does not stop at the lowest point, but continues to move along the semicircular track.

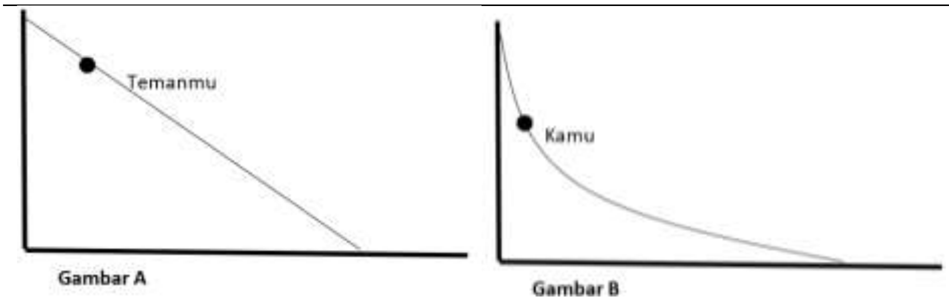
Then there is another finding from this study, namely that there are ten students who show indications of relatively low improvement. Although in most cases the recitation program has a very significant impact on improving students' mastery of concepts, in this case, the acquisition of concept mastery scores was found to be quite low for 10 students. Therefore, the researcher re-examined the reasons behind the low posttest scores of students. In addition, it is important to detect differences (if any), related to the length of time students access the program. Students with low gain are likely to demonstrate learning through the recitation program they do, therefore there is a need to focus on these students. This will be discussed in more detail in the section on the effect of length of time accessing the program on increasing concept mastery.

Changes in Student Resources Before and After Using the Work-Energy Recitation Program

Changes in student resources before and after using the work-energy recitation program can be seen from the shift in pretest to posttest answers analyzed using crosstabulation. As an illustration of these changes, TABLE 3 presents the results of students' pretest and posttest on one of the questions.

TABLE 3. Example Questions on the Mechanical Work-Energy Theorem Sub-Material

5. Two smooth slides, shaped as shown in figures A and B, have the same height, h. You and a friend—who are of the same height—slide down from rest starting at the top of the slides. Who has the highest speed at the bottom of the slide?



Opsi Jawaban	*Resource* yang diaktivasi
A. You, because you are facing a steeper slope, creating an opportunity to accelerate.	Based on everyday experiences—such as using slides or curved water rides—it is often observed that objects move faster along curved paths.
B. You, because you are covering a longer distance, leaving no opportunity to accelerate.	Activating the concept of friction—specifically the idea that "a moving object eventually slows down"—based on everyday experience, where students recognize that an object in motion will ultimately come to a stop.
C. Your friend, because the ramp they are on has a constant path, allowing for the possibility of accelerating.	Determining speed based on track inclination—combined with a constant track—offers the potential to continuously accelerate the movement of the sliding person.
D. Your friend, because covering a shorter distance allows them to better conserve kinetic energy.	Based on the uniform linear motion equation GLB s=vt, a short path involves a brief duration, resulting in less loss of speed compared to a longer path. This interprets time in terms of speed at a specific point.
E. The two of you have the same speed.	Based on the Law of Conservation of Mechanical Energy, $\Delta Ek = -\Delta Ep$; since the initial height and speed of the person on both slides are the same, their final speeds are also the same.

Then the distribution of students' answers in solving problem number 5 is presented in TABLE 4.

TABLE 4. Cross Tabulation of Student Answers to Question Number 5

		Posttest						
		A	**B**	**C**	**D**	***E**	**F**	**Total Pretest**
Pretest	**A**	15	0	5	2	10	0	32
	B	1	0	1	0	1	0	3
	C	3	2	5	0	17	0	27
	D	1	0	0	0	0	0	1
	***E**	1	0	1	0	13	0	15
	F	0	0	0	0	0	0	0
	Total Posttest	21	2	12	2	41	0	

***Correct answer**

To solve problem number 5, students need to understand the conditions for the application of the Law of Conservation of Mechanical Energy. The Law of Conservation of Mechanical Energy applies if there is only work by the earth's gravitational force (internal force) acting on the system. During the pretest, the majority of students chose option A (32 students) which showed an understanding that steep slopes have a greater gravitational force, making people slide at high speeds. This idea emerged based on everyday experiences, such as when using curved slides or water rides, where it is often seen that objects move faster on curved tracks. Several previous studies have also shown that students tend to prefer knowledge that they gain from everyday experiences, which makes the knowledge more meaningful and relevant to them (Lee and Fradd, 2002; Luykx and Lee, 2007; Silseth, 2018).

Then 27 students chose option C and tended to associate speed with the slope of the track. Students assume that a constant track has the opportunity to continue to accelerate the movement of people sliding, unlike the track on the second skateboard which, although initially steep, eventually becomes flat, which may be interpreted as a loss of opportunity to maintain or increase speed. On the other hand, only 1 student chose option D, and 15 students chose option E (the correct answer).

However, many students seem to activate knowledge of the Law of Conservation of Mechanical Energy without first verifying whether the principle holds in the context of the given problem. They need to consider the forces acting on the system, especially whether there are external forces acting in addition to gravity. This is where the work-energy recitation program comes in handy, which provides students with the opportunity to solve problems in a context that requires them to consider the conditions under which the Law of Conservation of Mechanical Energy applies. The feedback provided in this program helps students understand that under some conditions, such as the presence of work by external forces, the principle of Conservation of Mechanical Energy does not hold. This process supports the development of students' "intuitive refinement," where they are encouraged to reflect on and refine their initial understanding (Elby, 2001). Students are guided to find appropriate ways to integrate the right knowledge into their thinking (Scherr, 2007).

After using the work-energy recitation program, 28 students who previously chose options A (10 students), B (1 student), and C (17 students) during the pretest, appeared to shift their choices and switched to choosing option E which was the correct answer. Although the other 15 students consistently chose option A, most of them had succeeded in improving their understanding of the concept. Based on Table 4, it appears that the number of students who were able to answer correctly increased from 15 during the pretest to 41 during the posttest. This means that the work-energy recitation program as a supporting tool has succeeded in improving the activation of students' resources to understand that when there is no work by external forces acting on the system, the Law of Conservation of Mechanical Energy applies. On the other hand, the direct feedback provided in the recitation program can provide students with the opportunity to correct their intuition, analyze the inappropriateness of the resources they activate, and guide them in using more appropriate resources (T. N. Diyana, Sutopo and Sunaryono, 2020).

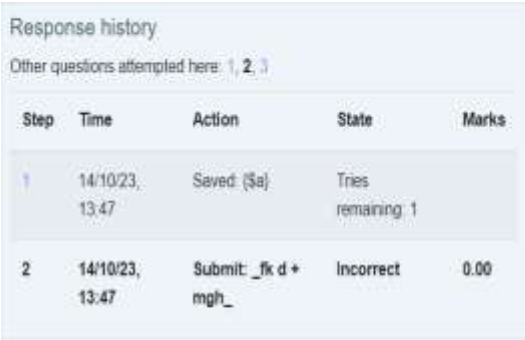
The Effect of Program Access Time on Improving Concept Mastery

The length of access time that indicates the extent of student involvement in the process of recalling knowledge in the work-energy recitation program, is a key variable that needs to be analyzed to determine its influence in improving mastery of the work-energy concept. Monitoring of student activity when accessing the work-energy recitation program outside of class is done through activity records in the program, as shown in FIGURE 8.

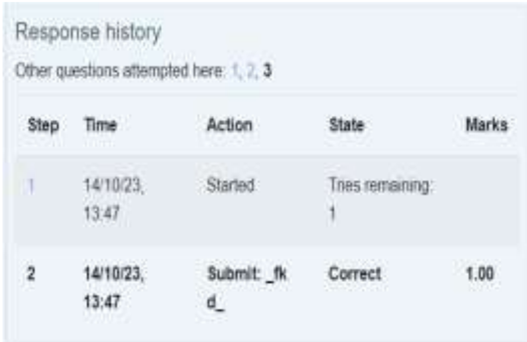
FIGURE 8. (a) Student's 2nd Attempt in Answering Questions, (b) Student's 3rd Attempt in Answering Questions

Based on monitoring student access time recorded in the moodle activity log, it shows that most students have actively used the work-energy recitation program as a form of their deepening of the work-energy material.

Students have been actively involved in accessing the questions in all packages, it can be seen that a number of students changed their answers several times within a certain time frame until they finally managed to answer the questions correctly according to the context. However, there are also a number of students who have not maximized their use of the program. Some students are seen only focusing on working on questions by relying on the feedback that is already available. While others are observed only opening the program and working on questions without understanding them in depth and choosing answers randomly. The details of this can be seen in FIGURE 9.


Response history
Other questions attempted here: 1, 2, 3

Step	Time	Action	State	Marks
1	14/10/23, 13:47	Saved: {$a}	Tries remaining: 1	
2	14/10/23, 13:47	Submit: _fk d + mgh_	Incorrect	0.00


Response history
Other questions attempted here: 1, 2, 3

Step	Time	Action	State	Marks
1	14/10/23, 13:47	Started	Tries remaining: 1	
2	14/10/23, 13:47	Submit: _fk d_	Correct	1.00

(a) (b)

FIGURE 9. (a) Student's 2nd Attempt in Answering Questions, (b) Student's 3rd Attempt in Answering Questions

This finding reflects that students have not utilized the optimal work-energy recitation program, especially in the context of understanding and responding to the feedback provided. Students who spent more time in the recitation program reported significant gains compared to students who accessed the program carelessly, only reading questions and feedback without doing in-depth understanding. This finding highlights the importance of students' active involvement in the thinking process, rather than simply relying on feedback from researchers.

The average duration of students when accessing the program consisting of 3 question packages was 331.5 minutes. Then the researchers conducted an analysis of student learning behavior in using the recitation program to understand the extent to which students actively accessed the program as a form of learning assistance outside of Fisika Dasar classes that led to success in mastering the concepts of work and energy. The main objective of the study was to explore whether the length of time students accessed the recitation program had an effect on increasing their mastery of concepts. To find out, a Spearman Rank correlation test was conducted. The results of the Spearman Rank correlation test showed a sig. (2-tailed) value of 0.04 <0.05, which means that there is an effect of the length of time accessing the recitation program on increasing students' mastery of concepts.

In fact, for the Fisika Dasar I course with a load of 3 credits, students should spend 360 minutes of independent study time outside the classroom in two weeks assuming 60 minutes per credit multiplied by the number of credits. However, the average student accesses the recitation program for 331.5 minutes. More interestingly, 10 students with low gains of less than 0.1 (such as students 18,38,40,65,68,69,71,75,76,77) show a tendency to spend less than 300 minutes accessing the program. On the other hand, students who allocate more than 300 minutes are able to achieve significant improvements in grades (n-gain > 0.1). These findings indicate that students who spend more time in the recitation program tend to experience better improvements. These findings are reinforced by research by Klein et al., (2021) which states that basically the duration of learning has an effect on student learning achievement, in this context it means that the length of time accessing the recitation program has a significant effect on increasing student concept mastery.

Student Perceptions Regarding the Use of the Work-energy Recitation Program

The work-energy recitation program as an assistance program outside the formal classroom has been proven to improve students' conceptual mastery of the topic of work and energy as evidenced by the results of the statistical tests that have been presented in the previous section. However, to find out how students perceive the recitation program, both in terms of benefits, language, program design, and other factors, further investigation is needed to explore their views and opinions by filling out a perception questionnaire. The total number of respondents who filled out the questionnaire was 78 students in the Fisika Dasar class who had used the work-energy recitation program. The questionnaire contained 19 questions to investigate several aspects including (1) aspects of learning motivation; (2) usefulness; (3) use of technology; and (4) program readability. The description of the student perception questionnaire items is described in TABLE 5.

TABLE 5. Student Perception Questionnaire on the Use of Work-Energy Recitation Program

Aspect	Item	SS	%	S	%	TS	%	STS	%
Learning Motivation	A1	50	64.1	28	35.9	0	0.0	0	0.0
	A2	42	53.8	34	43.6	2	2.6	0	0.0
	A3	10	12.8	57	73.1	7	9.0	4	5.1
	A4	32	41.0	39	50.0	4	5.1	3	3.8
	A5	5	6.4	19	24.4	49	62.8	5	6.4
Usefulness	B1	46	59.0	32	41.0	0	0.0	0	0.0
	B2a	44	56.4	33	42.3	1	1.3	0	0.0
	B2b	39	50.0	37	47.4	1	1.3	1	1.3
	B3	30	38.5	46	59.0	2	2.6	0	0.0
	B4	37	47.4	41	52.6	0	0.0	0	0.0
Use of Technology	C1	17	21.8	47	60.3	13	16.7	1	1.3
	C2	37	47.4	40	51.3	1	1.3	0	0.0
	C3	21	26.9	42	53.8	14	17.9	1	1.3
Program Readability	D1	32	41.0	46	59.0	0	0.0	0	0.0
	D2	33	42.3	43	55.1	2	2.6	0	0.0
	D3	27	34.6	43	55.1	5	6.4	3	3.8
	D4	39	50.0	39	50.0	0	0.0	0	0.0
	D5	42	53.8	36	46.2	0	0.0	0	0.0
	D6	35	44.9	39	50.0	3	3.8	1	1.3

Specifically, there are four aspects that appear in the perception questionnaire, the first is learning motivation. After using the work-energy recitation program, students generally reflect a fairly high level of motivation, as evidenced by the average student response to the five questionnaire items in the learning motivation aspect of 35.6% strongly agree, 45.4% agree, 15.9% disagree, and 3.1% strongly disagree. This indicates that most students think the work-energy recitation program increases their motivation in learning work-energy. However, there are some students who disagree so that the recitation program still needs to be developed so that students are more interested and not bored when using it.

The usefulness aspect describes the benefits that students feel from the recitation program that has been created, including whether the recitation program contributes to strengthening students' conceptual understanding, whether the feedback given on the program can help identify conceptual difficulties and improve understanding. The average student response to the six (B1, B2a, B2b, B3, B4) questionnaire items in the program's usefulness aspect was 50.3% strongly agree and 48.5% agree. This shows that the developed work-energy recitation program is useful as a program to deepen understanding of work-energy material. However, there were 1% of students who disagreed and 0.3%

strongly disagreed, which shows that there is still room for program development to provide more optimal benefits to students.

The aspect of technology use reflects the extent to which students are helped by the use of recitation programs that utilize technology, including whether students like learning using computers (programs) rather than using paper and are more efficient because they can be accessed anytime and anywhere. The average student response to items on the aspect of technology use was 32.1% strongly agree, 55.1% agree, 12% disagree, and 0.9% strongly disagree. The fourth aspect is program readability related to the extent to which the display and instructions in the recitation program can be easily understood and interpreted by students. This includes question items that ensure that the program template is attractive, then the images, colors, types, and font sizes are of good quality, whether the images in the recitation program support the explanation, and the language used is easy to understand. Most of the student responses to the six questionnaire items were 44.4% strongly agree, 52.6% agree, 2.1% disagree, 0.9% strongly disagree.

However, there are still students who are constrained in terms of language and writing so that the recitation program still needs to be developed further to make it easier for students to understand the content of the program well. In general, the results of research related to student perceptions of the recitation program that has been developed show that the recitation program is considered to be able to provide benefits for increasing mastery of concepts, is easy to use, and has an attractive appearance. This shows that the recitation program that has been developed is effective in helping students deepen the material on work-energy. Then based on the results of the percentage of student perceptions, the aspect of usefulness dominates with the highest percentage of agreement of 50.3% strongly agree and 48.5% agree, compared to other aspects such as motivation, technology, and readability. This shows that usefulness is an aspect that provides them with greater benefits. This finding is consistent with research (Ivanjek *et al.*, 2022) which highlights that students feel great benefits from the recitation program. On the other hand, learning with the help of interactive programs and accompanied by attractive displays can also help increase motivation and make a positive contribution to improving students' mastery of concepts (Klein *et al.*, 2021).

CONCLUSION

Based on the research results, it shows that the developed work-energy recitation program has succeeded in increasing students' conceptual mastery. This is evident from the results of the Shapiro-Wilk Test which showed a significant difference between the pretest and posttest scores, as well as an average n-gain score of 0.22. Although the average n-gain was low, some students showed significant improvement. Before using the recitation program, students tended to activate inappropriate resources according to the context, such as applying the concept of the Law of Conservation of Mechanical Energy to solve all problem contexts without considering the conditions for its validity. The shift in answers from the pretest to the posttest showed a change towards activating more appropriate resources. The length of time students accessed the recitation program which showed active involvement had a positive effect on increasing their conceptual mastery, as evidenced by the results of the Spearman Rank Correlation Test which showed a significance of 0.040 <0.05. Students' perceptions of the work-energy recitation program were dominated by the aspect of usefulness, with 50.3% strongly agreeing and 48.5% agreeing, outperforming other aspects such as motivation, technology, and readability. However, this study is limited by the use of a one-group pretest-posttest design without a control group, which restricts causal interpretations regarding the program's effectiveness. Furthermore, the current recitation program is implemented via a Moodle-based online platform. Future research could develop the program into a mobile application or an offline version to enhance accessibility and enable students to interact with the material under various learning conditions.

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