



## Multi-Representation-Based Recitation Program with Local Wisdom Leads to Improve Students' Concept Mastery on Newtonian Mechanics Topics

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Received  
21 April 2022

Revised  
01 June 2022

Accepted for Publication  
06 June 2022

Published  
02 July 2022



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### Abstract

This study aims at exploring an increase in students' conceptual understanding on the topic of Newtonian mechanics after receiving a recitation program containing conceptual practice questions with contexts containing local wisdom and various representations, as well as describing difficulties in working on Newtonian mechanics questions. The research method used is the mix method - embedded experimental model with one group pretest and posttest design. The research was conducted on 20 students of class X. The instrument to measure students' conceptual mastery was in the form of 10 multiple choice questions and to measure the difficulties faced by students was an unstructured interview guide. The research data were analyzed using inferential tests so that the results showed that there were differences before and after the recitation program with a gain value of 0.60 in the medium category and the impact strength value of 1.87 in the high category. on students' mastery of concepts. The difficulties faced by students in general are interpreting physics symbols and understanding the meaning of the problem to determine the right equation to solve the problem. The implications of the research results on education are that it can be an alternative in increasing students' mastery of concepts and identifying student difficulties for evaluation to optimize the next learning process.

**Keywords:** recitation program, multirepresentation, local wisdom, mastery of concepts

### Abstrak

Tujuan penulisan artikel ini adalah menganalisis peningkatan penguasaan konsep siswa pada topik mekanika newton setelah menerima program resitasi yang berisi soal latihan konseptual dengan konteks bermuatan *local wisdom* dan representasi beragam, serta mendeskripsikan kesulitan – kesulitan dalam mengerjakan soal mekanika newton. Metode penelitian yang digunakan yakni *mix method - embedded experimental model* dengan *one group pretest and posttest design*. Penelitian dilakukan pada 27 siswa kelas X. Instrumen untuk mengukur penguasaan konsep siswa berupa 10 soal pilihan ganda dan untuk mengukur kesulitan yang dihadapi siswa adalah pedoman wawancara tak terstruktur. Data penelitian dianalisis menggunakan uji inferensial sehingga didapatkan hasil terdapat perbedaan sebelum dan sesudah pemberian program resitasi dengan nilai gain 0,60 dengan kategori sedang dan nilai kekuatan dampak 1,87 dengan kategori tinggi, sehingga dapat disimpulkan terdapat pengaruh signifikan program resitasi berbasis multirepresentasi bermuatan *local wisdom* terhadap penguasaan konsep siswa. Kesulitan yang dihadapi siswa secara umum yaitu menginterpretasi simbol – simbol fisika dan memahami maksud dari soal untuk menentukan persamaan yang tepat untuk menyelesaikan soal. Implikasi hasil penelitian terhadap pendidikan yaitu dapat menjadi alternatif dalam meningkatkan penguasaan konsep siswa dan identifikasi kesulitan siswa guna evaluasi untuk mengoptimalkan proses pembelajaran selanjutnya.

**Kata Kunci:** program resitasi, multirepresentasi, local wisdom, penguasaan konsep.

## 1. Introduction

Newtonian mechanics is a topic that is closely related to the phenomena of everyday life. This topic has a high essence because it is closely related to the phenomenon of force and motion, namely in traditional games such as manatahan, nekeran, and tug of war [1]. Although the topic of Newtonian Mechanics has a high essence, the level of mastery of students' concepts in the learning process is still low. The level of mastery of students' concepts in the learning process can be seen based on the average pretest and posttest values of 59.90 and 83.30 on a scale of 100.00 [2]. The low level of mastery of students' concepts is often found when providing explanations related to a phenomenon in everyday life [3], inconsistent with the use of style concepts [4], and when solving a problem presented in a different context and representation [5]. In addition, based on the results of the questionnaire analysis of student needs, there were 55.56% of students who stated that teachers or educators were still lacking in linking physics learning with local wisdom. These data indicate that Newtonian Mechanics is a physics topic that has complex, complicated, abstract characteristics, and requires the ability to master and manage changes between different multi-representations [6].

The low mastery of students' concepts on the topic of Newtonian Mechanics is caused by less contextual learning [7]. Contextual learning can make physics learning more relevant [8]. Thus, physics is a learning that is relevant to real-life [9]. Therefore, contextual physics learning needs to be applied, one of which is through local wisdom content.

Learning with local wisdom is able to optimize students' mastery of concepts to integrate science with the culture [10]. By integrating local wisdom into learning, learning objectives will be more effectively achieved [11], [12]. In addition, learning physics will be easier to understand and master when explained using local wisdom [13].

The integration of local wisdom into physics learning will be of higher quality if students are supported by good concept mastery skills. However, efforts to achieve good mastery of concepts are often constrained by students' prior knowledge in building concepts that are not true at the previous level, even experiencing misconceptions, namely the incompatibility between the concepts possessed by students and scientific knowledge [14]. Students need to be encouraged to solve physics problems that are often presented in various multi-representations. This is based on the research findings of Sutopo [15] that the presence of multiple representations affects the success of students in solving physics problems. Therefore, the integration of local wisdom into this multi-representation needs to be packaged in the form of a recitation program.

The recitation program is an exercise program to help students experience difficulties in understanding concepts that are still difficult to experience after being taught in class [16]. The provision of a recitation program that is presented in the form of practicing conceptual questions accompanied by feedback can help students confirm the concepts that have been understood [17]. The use of practice questions along with feedback on each answer option that is well designed will be able to deepen students' mastery of concepts. The recitation program needs to pay attention to the suitability factor for learning during the COVID-19 pandemic, be innovative, and interesting and integrated with local wisdom so as to make students enthusiastic about learning.

Research on the recitation program that has been carried out by researchers is mostly in the field of classical mechanics studies, especially on the topic of kinematics [18], on the topic of rotational dynamics [19], [20], and on the topic of forces and motion. In addition, during the last decade research related to recitation has also been developed by several researchers as has been done Gladding et al., [21] using the Powerpoint program to present questions and feedback. Ryan et al [22] using Apache Software Foundation Flex (Flash) to present questions and feedback in a computer problem-solving coach. Sutopo et al [23] using Wondershare Quiz Creator to create the recitation program.

Of all the recitation programs that were developed previously, the recitation program used did not contain any question content that could present conceptual and relevant problems. Each topic needs to contain a sufficient number of conceptual questions and are presented in various contexts and presented in various representational formats. For this reason, to achieve contextual and conceptual learning objectives that are more relevant to each topic, the integration of local wisdom into multi-representation can be packaged in the form of a recitation program.

Based on the problems above, it is necessary to conduct research entitled "Recitation Program Based on Multi-Representation with Local Wisdom Loading to Improve Students' Concept Mastery

on the Topic of Newtonian Mechanics". This study aims to analyze the increase in students' conceptual understanding on the topic of Newtonian mechanics after receiving a recitation program that contains conceptual practice questions with contexts containing local wisdom and various representations, as well as to describe students' difficulties in working on Newtonian Mechanics questions.

## 2. Research methods

The research method used in this study is the mix method - embedded experimental model with one group pretest and posttest design [24]. Quantitative data in the form of Newton's Mechanics test results and qualitative data based on the results of interviews by respondents.

The instruments used are a questionnaire on student needs using google form, unstructured interviews, and a package of concept mastery questions on the topic of Newtonian Mechanics, totaling 10 multiple-choice questions that have been developed based on the indicators of mastery of concepts as listed in Table 1 and have been tested for validity and reliability values by experts. The instrument for taking student needs analysis data is in the form of a positive questionnaire of 18 statements.

**Table 1.** Indicators Per Item Pretest and Posttest

Question Indicator	Question Number
Explaining Newton's First Law	1, 5, 9
Analyzing phenomena by relating Newton's II Law	2, 6
Analyzing phenomena by relating Newton's III law	3, 7, 10
Proving phenomena based on the concept of force	4, 8

The subjects taken were 27 students of class X IPA who had obtained the topic of Newtonian Mechanics. The sample selection used purposive sampling taking into account the development of covid-19 and suggestions from physics subject teachers.

The research was conducted from January 2022 to April 2022. The research took place online using a zoom meet and was divided into several meetings. The first meeting on January 18, 2022, was in the form of problem identification. The second meeting on February 1, 2022, was the development of test instruments, interview sheets and student needs questionnaires. The third meeting on 15 February 2022 was instrument validation. This validation is used to determine the validity and reliability of the items. The fourth meeting on March 1, 2022, is the pretest. The fifth meeting on March 15, 2022, was to provide a recitation program and strengthen concepts and practice questions. The sixth meeting on April 1, 2022, is the posttest. The total time required in this study is four months (January to April 2022).

The use of the recitation program is carried out after learning to clarify the concept of Newtonian mechanics. Then the quantitative data were analyzed using the paired sample t-test. Next, the effect size calculation is used to find out how strong the impact given by the treatment is to increase students' mastery of concepts [25], while the calculation of the class average N-gain  $\langle g \rangle$  is carried out to determine the level of improvement in students' mastery of concepts. The results of unstructured interviews are qualitative data in four stages, namely 1) data collection; 2) data reduction; 3) data presentation; 4) drawing conclusions.

## 3. Results and Discussion

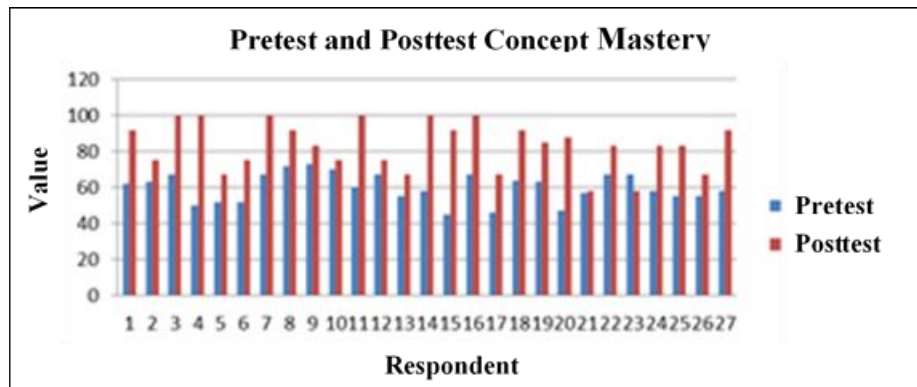
The statistical descriptions of the students' pretest and posttest scores are presented in Table 2. The distribution of the scores of pretest and posttest scores is in the range -1 to +1, so the two sets can be said to be normally distributed. Thus, the significance of the difference in pretest and posttest scores can be tested using the t-test.

**Table 2.** Pretest and Posttest Data on Student Concept Mastery

Statistics	Pretest	Posttest
Number of Samples (N)	27	27
Mean ( $\bar{X}$ )	59.90	83.30
Median	60.00	83.00

Modus	67.00	100.00
Standard Deviation	7.99	13.44


Based on the pretest and posttest data on students' conceptual mastery obtained as shown in Table 2, it can be seen that the average score obtained in the posttest (83.30) of students' conceptual mastery is higher than the average pretest score (59.90) of students' conceptual mastery. To make it easier to compare the value of students' conceptual mastery, it is presented through the diagram Figure 1.



**Figure 1.** Pretest and Posttest Data Diagram of Student Concept Mastery

Based on the diagram in Figure 1, it can be seen that the posttest score (83.30) of students' conceptual mastery is higher than the pretest score (59.90) of concept mastery, so it can be concluded that students' conceptual mastery has increased significantly after using the recitation program. The number of students who get a score is greater than the student's pretest score. The average posttest score of students was 83.30 then the average student pretest score was 59.90. The highest value of the posttest of student concept mastery is 100.00, while the highest score of the pretest of concept mastery is 73.00. The recitation program generally increases students' mastery of concepts. A significant increase can be seen in the pretest and posttest of question number 7 which is shown in Figure 2. In the pretest there are 22.22% correct answers and in the posttest 66.67% correct answers. In working on question number 7, both children A and B have the same magnitude of pull force, but the frictional force experienced by the two children is different so that students choose the wrong answer, which assumes that when A loses (dragged towards B) while B remains still then B exerts a greater pulling force than A.

7. Students A and B play tug of war using a light rope, not stretched, but strong, as shown in the picture. If A loses (being dragged towards B) while B remains still, which of the following explanations is correct?



A.  $F_{B \rightarrow A} > F_{A \rightarrow B}$  and  $f_{S_B} > f_{S_A}$   
 B.  $F_{B \rightarrow A} > F_{A \rightarrow B}$  and  $f_{S_B} = f_{S_A}$   
 C.  $F_{B \rightarrow A} = F_{A \rightarrow B}$  and  $f_{S_B} > f_{S_A}$   
 D.  $F_{B \rightarrow A} = F_{A \rightarrow B}$  and  $f_{S_B} = f_{S_A}$   
 E.  $F_{B \rightarrow A} > F_{A \rightarrow B}$

**Figure 2.** Problem Number 7 Newtonian Mechanics

The pretest normality test using the Kolmogorov-Smirnov Test formula was obtained  $0.14 > 0.05$ , so it can be said that the pretest value was normal. Meanwhile for the posttest  $0.12 > 0.05$  so that it can be concluded that the posttest value is normal. Pretest is used to determine the mastery of the

initial concepts that students have regarding the topic of Newtonian mechanics. The pretest was conducted before giving the recitation program to students. The average result of the pretest score is 59.90. The posttest was conducted after giving a multi-representation-based recitation program containing local wisdom on the topic of Newtonian mechanics. Posttest is used to determine the mastery of students' concepts after receiving a multi-representation-based recitation program containing local wisdom on the topic of Newtonian Mechanics. The results of the posttest average value of 83.30.

The results of the t-test obtained a significance value of 0.00, the value is less than 0.05, so it can be concluded that there are differences in students' mastery of concepts before and after giving the recitation program. The increase in mastery of concepts is known through the normalized gain test. The average value of the normalized gain test is 0.602 and is included in the medium category. So that learning with multi-representation-based recitation programs containing local wisdom has an effect on students' mastery of concepts in the medium category. The strength of the impact of increasing pretest and posttest can be measured using the value of effect size and normalized mean gain. The effect size test shows the results of 1.87 are included in the high category, so that the multi-representation-based recitation program containing local wisdom has a significant effect on increasing students' mastery of concepts.

Based on the research results, the recitation program is effective in increasing students' mastery of concepts, because students are given the opportunity to analyze contextual problems through integrating local wisdom in real life related to the application of Newtonian Mechanics topics. This makes students master the concept of Newtonian mechanics as a whole and stimulates students to solve problems. Taqwa [26] stated that the use of the recitation program had a strong influence on increasing mastery of concepts. In addition, Rivai's research [27] mentioned that students' mastery of concepts in terms of the description of physics concepts and the application of physics concepts increased after the recitation program was implemented. Multi-representation-based learning is able to have a positive influence on students' mastery of concepts as evidenced by an increase in mastery of concepts with moderate criteria.

The difficulty of students based on the results of the interviews is that students tend to experience errors when determining the direction of the force and movement of objects, so that students are wrong in analyzing how the force works or the requested quantity in other words difficulties in interpreting symbols in the topic of Newtonian Mechanics. In addition, some students also tend to have difficulty in analyzing phenomena using Newton's I, II, III laws in everyday life so that they tend to experience errors in understanding the questions being tested.

This research has implications in the field of education, namely it can be an alternative in increasing students' mastery of concepts and identifying student difficulties in order to create an optimal learning process. This research is limited only to the topic of Newtonian Mechanics, and it is hoped that it will be carried out on other topics by taking into account the difficulties that have been studied previously.

#### 4. Conclusions and Recommendations

The study's findings showcase that there are differences before and after the recitation program with a gain value of 0.60 in the medium category and the impact strength value of 1.87 in the high category, so it can be concluded that there is a significant effect of the multi-representation-based recitation program with local content. wisdom on students' concept mastery.

The difficulties faced by students in general are interpreting physical symbols and understanding the meaning of the problem to determine the right equation to solve the problem. The implications of research results on education are that it can be an alternative in improving students' mastery of concepts and identification of student difficulties for evaluation to optimize the next learning process.

Research on multi-representation-based recitation programs containing local wisdom to increase students' mastery of concepts needs to be done on other physics topics by taking into account the difficulties that have been studied previously.

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