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Developing Stem-Based Ryleac Model Science Learning Devices for Sound Material Learning Outcomes of Eighth Graders at SMP Negeri 2 SatapAsparaga

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ABSTRACT

Sri JuwitaKatili. 2023. Developing STEM-Based Ryleac Model Learning Devices for Eighth Graders for Sound Material Learning Outcomes of Eighth Graders at SMP Negeri 2 SatapAsparaga. Thesis, Physic Education Department Postgraduate Universitas Negeri Gorontalo. Supervisor 1 Dr. TirtawatiAbdjul, S.Pd., M.Pd and supervisor 2 Dr. Sc. YayuIndriati Arifin, S.Pd., M.Si. This research develops valid and practical STEM-based ryleac model learning devices effective for student learning outcomes. This was research and development using the 4-D model (Define, Design, Develop, and Disseminate). Ten subjects partook in the limited test, whereas the extensive one was conducted at two classes, which were eighth graders at classes A (20 students) and B (22 students) at SMP Negeri 2 SatapAsparaga in the academic year of 2021/2022. The results demonstrated that 1) The developed STEM-based ryleac model learning devices were valid according to experts, 2) The learning device was practical, exhibited by the good mean score in the learning implementedness category and positive student responses to learning implementedness, and 3) Learning device effectiveness was determined based on a) student activities, categorized as good and very good and b) Student learning outcomes, tested using limited and extensive tests, scored 0.74 at high and medium categories, indicating the effectiveness of STEM-based ryleac model learn devices.

INTRODUCTION

Learning implementation consistently adapting to era development can impact successful education. The use of learning approaches within this context becomes paramount. Some approaches can be applied in the 21st century learning, e.g., science, technology, engineering, and mathematics or STEM approach. STEM integrates science, technology, technique, and mathematics into learning. The approach develops 21st century skills or 4K (collaboration, communication, creativity-innovativeness, and criticality). It can also stimulate students in reasoning, analyzing, solving problems, creating, and deploying many different technological products in learning.

The implementation of science, technology, technique, and mathematics needs suitable learning models, such as ryleac. The learning model combines inquiry and learning cycle ones. It was developed by building on some learning theories: constructivism theory, Piaget's theory, Vigotsky's theory, David Ausubel's theory, and constructivism learning theory (Abdjul, 2019:20). Ryleac learning stages/syntax include: 1) engagement, 2) orientation, 3) problem formulation, 4) hypothesis formulation, 5) data collection through explorative activities, 6) hypothesis testification, 7) explanation, 8) elaboration, 9) conclusion drawing, and 10) evaluation.

The results of science learning observation at SMP Negeri 2 SatapAsparaga point out that science learning at junior high schools were more frequently held in class and using lecturing methods. Science learning at schools were more often teacher-centered, making students only listen to teachers' explanations. Accordingly, teachers were active in teaching, and students were passive in learning. Teachers actively shed light on physic formulas using media assistance at schools and problem exercises, causing boredom in students and making them sleepy during physic learning, while an effective learning process requires all components inflecting learning to support each other to achieve goals. Most students also deemed science, specifically physics with its sound materials, is abstract and difficult. They were merely given exercise practices about formulas but do not understand the physis meaning. Perceived difficulties and boredom decreased student interest in learning physics, bringing about minimum learning results.

Student difficulties in learning physics and minimum learning outcomes are two serious issues teachers have to confront. They make students passive and less interact with others. Teachers, in addition, cannot make learning devices employing learning models congenial to the administered materials. They must endeavor to instill basic scientific thinking in students, allowing students to learn independently and develop creativity while solving problems during the learning process. Students need to be placed as learning subjects, and teachers should act as mentors and facilitators.

An effort to make student skills congruent with the 2013 Curriculum is teachers exerting learning devices which can enhance student potencies. K13 Learning Device for Junior High School constitutes **a set of tools to optimize learning activities, and the set has to be handled by teachers or**

educating workers, especially at a junior high school level. It functions as guidance for implementing effective and efficient learning methods during the teaching-learning process at class. The 2013 Curriculum focuses on structural changes and keeps being updated on era development, covering cultural, scientific, or technological development. The curriculum, particularly in the part of learning devices, has no significant changes. For example, the syllabus still acts as guidance for developing lesson plans (RPP).

Learning devices are composed of the syllabus, lesson plans (RPP), student worksheets (LKPD), assessment sheets, student books, teacher books, and learning media (Susdarwati& Cari, 2016). Learning devices are of crucial importance for teachers, who exploit them to prepare and implement learning, and for students, who leverage them at laboratories, outside, or inside classes. Most of the teachers, and yet, are identified as using learning devices as sole formality and abandoning outcomes or skills procured by students. A preponderance of teachers disregards the crucial importance of learning devices as they maintain no desire to make efforts they regard as useless. It deescalates education quality in Indonesia. Learning devices are supposed to afford guidance and directions to teachers, allowing a systematic and patterned learning process. They also orient teachers during the learning process, enabling them to implement learning without the necessity to remember. We, grounded on the background spelled out above, are interested in performing research on learning development under the title "Developing STEM-Based Ryleac Model Science Learning Devices for Sound Material Learning Outcomes of Eighth Graders at SMP Negeri 2 SatapAsparaga."

METHOD

This was research and development using the 4D model proposed by Thiagarajan, Semmel, & Semmel (1974). The 4-D development model encompassed four stages, i.e., Define, Design, Development, and Disseminate. This model was claimed as apt to be wielded because this research essentially aimed to create a learning device product using ryleac as the learning model.

Data Analysis Technique

Data analysis was performed to acquire the proofs of reliability, practicality, and effectiveness of the developed product. Data from experts/practitioners were analyzed to determine learning device validity analyzed theoretically and consistently on the grounds of learning device components.

a. Validity Test

Each component on expert/practitioner team validation sheets was conferred a score of 1-4. The calculation was deploying the following formula.

$$\bar{x} = \frac{\sum x_i}{n}$$

Where:

$\bar{x}$: mean score acquired

xi : the score acquired by student i

n : the number of question items

The interval of learning device validity criteria, predicated on the calculation of the learning device assessment above, was acquired and pointed out in Table 1.

Table 1 Criteria for Learning Device Practicality

Mean Score (%)	**Category**
$\bar{x} > 4.2$	Very Valid
$3.4 < \bar{x} \leq 4.2$	Valid
$2.6 < \bar{x} \leq 3.4$	Acceptable
$1.8 < \bar{x} \leq 2.6$	Not Valid
$\bar{x} \leq 1.8$	Very Impractical

(Azwar, 2012:134)

b. Product Practicality Test

1. Student Response

This analysis was undertaken to identify if the developed devices met criteria for practicality based on student evaluation. The formula to measure student response questionnaire was (Azwar, 2012:134):

$$\%\ \text{student response} = \frac{acquired\ score}{maximum\ score}\ x\ 100\%$$

The category for student response percentage is shown in Table 2.

Table 2 Student Response Classification

Achieved Percentage (%)	**Predicate**
86-100%	Very Good
76-85%	Good
60-75%	Acceptable
55-59%	Poor
≤ 54%	Very Poor

2. Learning Implementedness Observation

This analysis was carried out to identify whether implementedness of the science learning process at class met criteria for practicality. The observation results of learning implementedness could be measured using the following formula (Ngalim, 2002:103).

Implementedness percentage = $\frac{Frequency\ \ of\ implemented\ \ item}{Total\ item}$ x 100%

The devices were hence considered practical by learning implementedness if the implementedness percentage reached above 75%.

Table 3 Learning Implementedness Classification

Achieved Percentage (%)	**Predicate**
86-100%	Very Good
76-85%	Good
60-75%	Acceptable
55-59%	Poor
≤ 54%	Very Poor

c. Product Effectiveness Test

1. Analysis of Student Learning Result Test

The collected data on the outcomes test could be analyzed using the following formula.

$$P = \frac{\sum Acquired\ score}{\sum Total\ score} x\ 100\%$$

Where:

P : completeness percentage

F : the number of students completing

N : total number of students

Assessment criteria by Purwanto (2002:103) are shown in Table 4.

Table 4 Category for Student Learning Outcomes

Achieved Percentage (%)	**Predicate**
86-100%	Very Good
76-85%	Good
60-75%	Acceptable
55-59%	Poor
≤ 54%	Very Poor

RESULT AND DISCUSSION

The STEM-based ryleac model learning devices developed using the 4D development model (Define, Design, Develop, and Disseminate) by Thiangarajan & Semmel (1974) were elaborated below.

Define Stage

This stage included five key steps, namely pre-post-analysis, student analysis, task analysis, conceptual analysis, and learning objective formulation.

Design Phase

Some activities in this phase were test construction, media selection, format selection, and initial learning device design.

Develop Phase

The result from define and design stages was the initial design of a learning device, hereinafter called as draft I. After the learning device using a realistic approach was designed in the form of draft I, a validity test was conducted by experts (expert review), and a field test was also performed. Validation was the first step in this phase. Experts' validation focused on the format, content, and language of the developed learning device. The validation delivered validation scores, correction, critiques, and suggestions for revising and fining-tune the learning devices. The revision result was learning devices which was valid and hereinafter called as draft II.

Disseminate Phase

The disseminate phase covered packaging, printing STEM-based ryleac model learning devices for sound materials, and socializing them through limited distribution to science teachers who were expected to employ the devices at class. Distribution was also undertaken through international journal publication, which was on the submission process at present.

Quality of STEM-Based Ryleac Model Learning Devices

Development research required developed product quality tests, covering a validity test, practicality test, and effectiveness test. Table 5 suggests the results of the STEM-based ryleac model learning device quality test by validators.

Table 5 The Results of Validators' General Assessment of Learning Devices

No.	Validated Device	V1	V2	V3	Mean	Category
1	Syllabus	3.89	3.89	4.00	3.92	Very Valid
2	Lesson plan	3.72	4.00	3.90	3.87	Very Valid
3	Learning material	4.00	3.90	3,90	3.93	Very Valid
4	Student worksheet	3.89	3.89	3.78	3.85	Very Valid
5	Learning outcome test	3.75	3.75	3.87	3.79	Very Valid

2. Limited Test Result

The following explanation is concerned about the results of the STEM-based ryleac model learning device practicality and effectiveness analysis.

a. Practicality

Nieven in Abdjul (2019:25) argued that practicality was determined by learning implementedness and student response questionnaires. The results of the analyses of learning implementedness and student response questionnaires are explained below.

Learning Implementedness

The implementedness of the STEM-based ryleac model learning grounded on test 1 on meetings 1 and 2 is demonstrated in Figure 1.

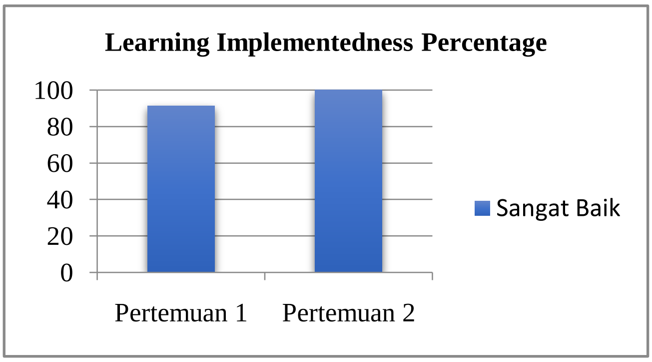


Figure 1 Learning Implementedness of the Limited Class

Figure 1 exhibits the minimum effort made by teachers on meeting 1. In terms of teacher activities during the learning process, there were 30 learning steps teachers carried out. The percentage of 96.7%, as such, indicated 29 activities teachers implemented, and the percentage of 3.3% indicated one activity teachers did not implement. The unimplemented activity was conferring appreciation to student groups with good performance.

Student Response

Student responses to learning implementednes related to the STEM-based ryleac model were delivered after the learning process to elicit student responses to the developed learning devices. Students were instructed to respond to questionnaire items and choosing one of the following options, which were Extremely Agree (SS), Agree (S), Less Agree (KS), Disagree (TS), and Extremely Disagree (STS). Figure 2 points out the results of the analysis of student responses to the STEM-based ryleac model learning.

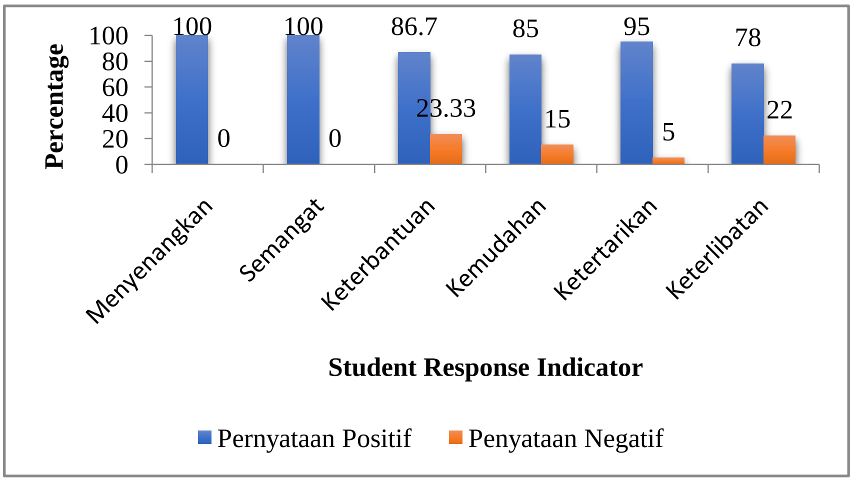


Figure 2 Student Responses to STEM-Based Ryleac Model Learning Devices in the Limited Class

Figure 2 shows, in terms of student responses, that the mean percentage of students with positive responses to all response indicators (fun, spirit, efficiency, helpfulness, attractiveness, and engagement) was reached 87.4%. It suggested that student responses to the STEM-based ryleac model learning devices to study science, specifically sound materials, were good.

b. Effectiveness

Effectiveness of STEM-based ryleac model learning devices were examined using the indicators student activities, observation, and learning outcome tests.

Student Activity

Student activities were investigated through a limited test only performed on ten students in two meetings during the classroom learning process. Figure 3 demonstrates the results of student activity analysis during learning using STEM-based ryleac model learning devices.

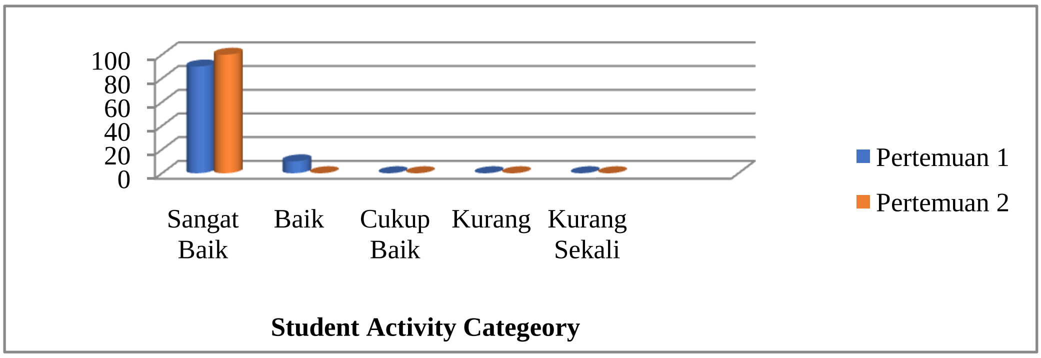


Figure 3 Student Activity Category in the Limited Test Class

Figure 3 exhibits the mean percentages of student activities on meetings 1 and 2, in which 70% and 90% students indicated good activities (meeting 1), and 30% and 10% indicated good ones (meeting 2). It could be concluded hence that learning using STEM-based ryleac model learning devices could activate students in participating in science learning, specifically sound materials.

Student Learning Outcome Test

Learning device effectiveness was also observed based on test outcomes. Figure 4 points out data on pretest and post-test mean scores.

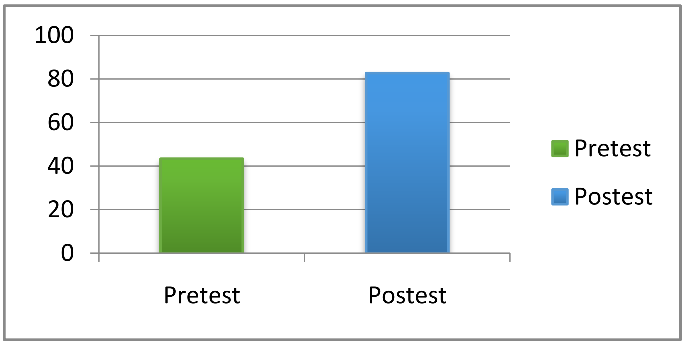


Figure 4 Pretest and Post-test Mean Score

A mean score of 43.3, as shown in Figure 5, was acquired by ten students partaking in the pretest. It suggested that 100% students participating in the pretest did not achieve completeness. Students scored 82.7 on average in the post-test. Out of ten students partaking in the post-test, 20% students scored < 75, implying their incompleteness. The N-Gain test analysis result demonstrated that the student learning outcome test resulted in 0.69, categorized as medium.

It could be concluded, in so doing, on the grounds of activity results and learning outcome tests, that the developed learning devices were effective and reliable to use in science learning, especially sound materials, and could proceed to the extensive test.

3. **Extensive Test Results**

a) **Kepraktisan Perangkat Pembelaajran Model Ryleac Berbantuan STEM**

Learning practicality was observed predicated on implementedness and student responses. The following explanations are associated with the results of the STEM-based ryleac model learning device practicality test.

Learning Implementedness

Learning implementedness was studied from teacher classroom activities. Figure 5 indicates learning implementedness by teachers using STEM-based ryleach model learning devices scrutinized on eighth graders classes A and B in the academic year of 2021/2022.

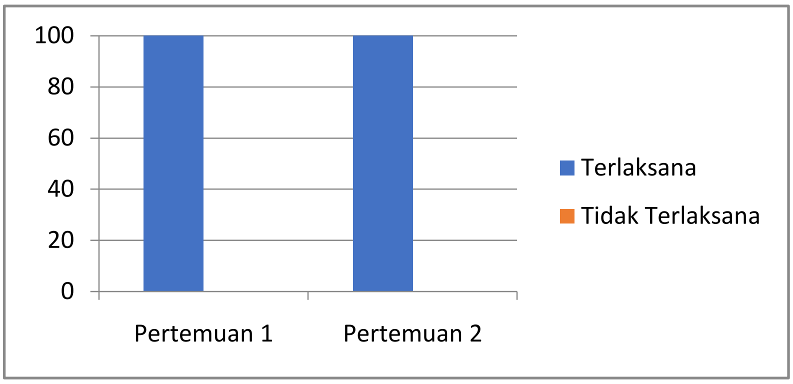


Figure 5 The Percentage of Learning Implementedness from Class A

Figure 5 points out that the mean percentage of learning implementedness on meetings 1 and 2 reached 100%, categorized as very good. Figure 6 shows learning implementedness from class B.

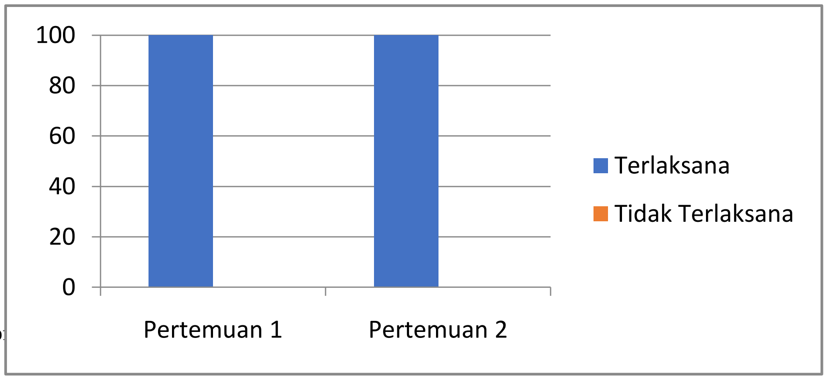


Figure 6 The Percentage o

Figure 6 suggests that the mean percentage of learning implementedness from class B on meetings 1 and 2 reached 100%, categorized as very good.

Student Response

Student responses, based on the results of the analysis undertaken, are demonstrated in Figure 7.

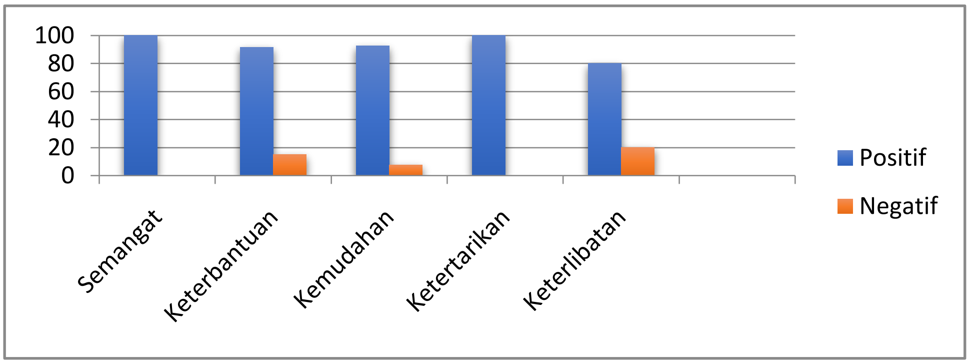
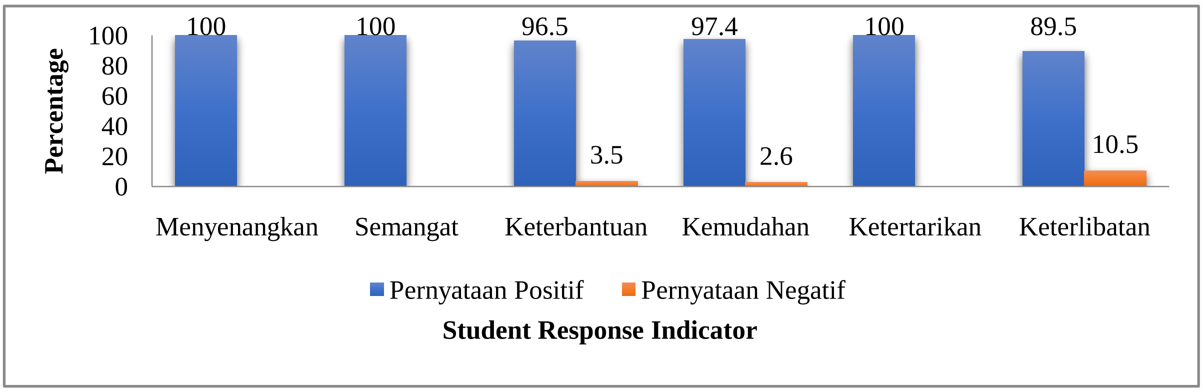


Figure 7 Class A Student Responses to STEM-Based Ryleac Model Learning Implementation

The percentage of students with positive responses to all response indicators (fun, spirit, efficiency, helpfulness, atrractiveness, and engagement, building on Figure 7, achieved 88% on average. Figure 8 exhibits class A student responses to STEM-based ryleac model learning.



The percentage of students with positive responses to all response indicators, as exhibited by Figure 8, was 97.2% on average.

Data on class A and B student response questionnaire delivered us a conclusion that student responses to STEM-based ryleac learning model devices were very good.

b) STEM STEM-Based Ryleac Model Learning Device Effectiveness

The effectiveness of STEM-based ryleac model learning devices in this research was scrutinized on the grounds of student activeness and class A and B student learning outcome test results.

Student Activity

Figure 9 indicates the results of the analysis of class A and B student learning activities.

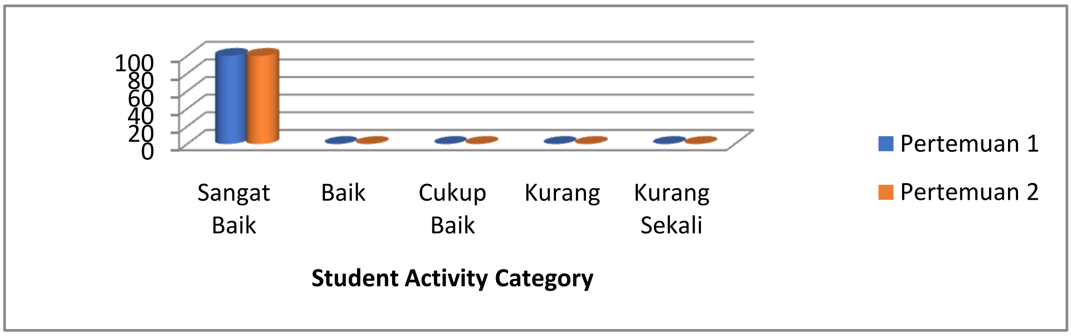


Figure 9 Student Learning Activity Category from Class A

Figure 9 points out that the average percentage on meeting 1 achieved 100%, categorized as very good. The results of the class B student activity analysis is pointed out in Figure 10.

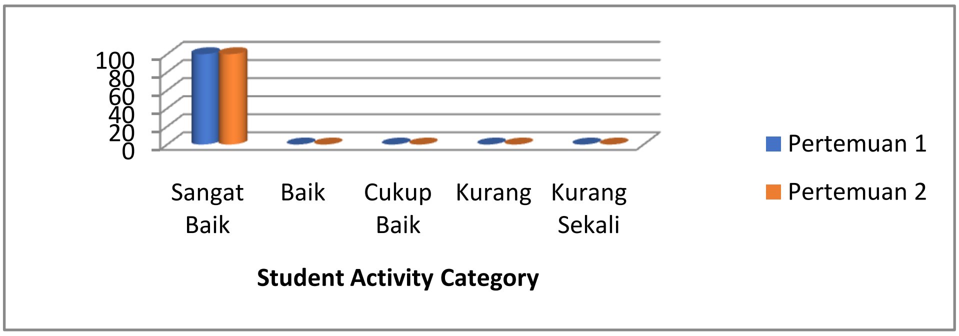


Figure 10 Student Learning Activity Category from Class B

Figure 10 shows that the mean percentage of student activities on meeting 1 was 100%, categorized as very good.

The results of the analysis of data on class A and B student activities gave us a conclusion that learning using STEM-based model learning devices could activate students in carrying out science learning, especially sound materials.

Student Learning Outcome Test

Another indicator of learning device effectiveness, besides learning activities, was learning outcome test results. Figure 11 suggests the mean scores of class A and B student learning outcomes acquired from an extensive test.

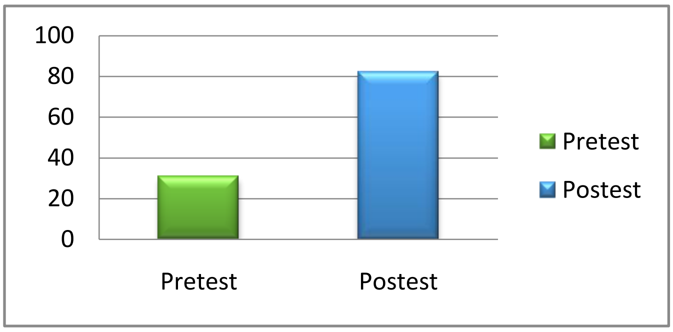


Figure 11 Class A Pretest and Post-Test Mean Score

It is demonstrated in Figure 11, that the mean score acquired from the pretest was 30.7 from 20 students. 100% students partaking in the pretest, that being so, did not attain completeness. The post-test resulted in a mean score of 82.3. Classically, out of 20 students partaking the post-test, 20% scored < 75, exhibiting that they did not reach completeness, whereas 80% others did. The N-Gain test analysis results resulted in 0.74 for student learning tests, categorized as high. The results of learning outcome tests are pointed out in Figure 12.

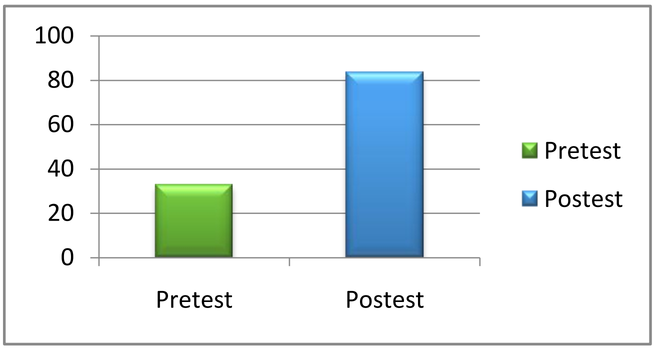


Figure 12 Pretest and Posttest Mean Score from Class B

Figure 13 indicated that the mean score of the pretest and post-test from class B was 32.7 and 83.3, respectively. Classically, out of 22 students participating in the post-test, 21.1% acquired scores < 75. The students were therefore identified as having completed yet, whereas 78.9% others had. The N-Gain test analysis results attested to that the student learning outcome test result was 0.65, categorized as medium.

It could be concluded thus, predicated on activity, observation, and learning outcome test results, that the developed learning devices were effective and reliable to use for science learning, particularly sound materials.

CONCLUSION

The following conclusions were drawn based on data analysis and research result discussion.

a) The define stage encompassed pre-post-analyses, student character analysis, task analysis, conceptual analysis, and learning objective formulation.

b) The design stage encompassed test construction, media selection, and the developed learning device format selection.

c) The develop stage encompassed initial design, expert validation, and limited and extensive tests.

d) The disseminate stage encompassed STEM-based ryleac model learning device distribution.

The quality of the STEM-based ryleac model science learning devices developed, based on validity, practicality, and effectiveness to use, met the following criteria:

a) Valid, based on validators' evaluation which was then categorized as very valid.

b) Practical, based on the learning implementedness analysis resulting in a percentage of 96.7% with a very good category and student positive responses from classes A and B at a percentage of 100%.

c) Effective, based on student activities, which were categorized as very good, and a learning outcome test using N-Gain, whose the results were 0.71 and 0.74 from classes A and B, categorized as high.