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# Effectiveness of Problem Based Learning Device Development to Improve Generic Science Skills

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**Abstract**: This development research aims to develop an effective problem-based physics learning device model to improve students' generic science skills. The type of research used is Research and Development (R&D) using a 4D model. This 4D model consists of four stages, namely Define, Design, Develop and Disseminate. The effectiveness of the learning device was obtained based on the analysis of the observation sheet on the implementation of the lesson plans from three observers was then determined using the calculation of the Interjudge Agreement (IJA) and the N-Gain test. Based on the results of the research that has been carried out, the results of the IJA calculation analysis show that the implementation of learning is above 75% with the N-Gain test results of 0.54 are in the medium category, while the average value for the pretest value is 36.91 and the average posttest value 68.75. So, it can be said that the problem based model of physics learning tools used is effective in improving the generic science skills of students.

**Keywords:** Problem Based Model; Generic Science Skills; Physics learning

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## Introduction

In the world of education, the curriculum is something so important. The curriculum itself to described as a regulatory system that so used to guide teaching and learning activities. The education curriculum so far has undergone several changes. Curriculum changes in the world of education certainly have goals, one of which is to complete the previous curriculum. The current curriculum is the 2013 curriculum (K13). Wherever in K13, the ability to think at a higher level is one of the demands that students must have. One of the components included in the higher order thinking skills section is the generic science skills.

According to (Gunawan, 2017) generic abilities are abilities related to the same attitudes and values as knowledge. Inline this statement, (Susilawani et. al., 2019) states that generic science skills (GSS) is an ability achieved by students with mastery of competence. The achievement of the intended competence depends on the teaching materials that students get (Agustinaningsih et al., 2014). This generic science skills needs to be developed by adjusting the selection of the learning model used to support the achievement of good students' generic abilities. The purpose of developing generic science skills is that the knowledge and skill obtained from learning results can be applied in real life and answer the challenges of the times (Jiniarti et. al., 2019). Where this study, a problem-based learning model (PBL) was used from many existing learning models.

The reason for choosing the PBL model in this study is because it is by the level of psychological maturity and learning ability in transferring knowledge to students, especially at the upper secondary level. In addition, the PBL model is also supported by constructivism theory in which students can form and discover their knowledge independently (Ambarita *et. al.*, 2016). The PBL model itself is defined as a learning

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process that presents real problems in life to be solved by students through a scientific approach (Hastuti et. al., 2016). The PBL model is a learning model that begins by presenting meaningful problems as a stimulus to students and can provide convenience for conducting investigations (Trianto, 2009). So this PBL model is suitable to be used as an alternative to improve the GSS of students. This has been proven by Dibyantini & Azaria (2020) in their research, where the application of the PBL model affects increasing students' GSS.

The problems found through observations at MAN 1 Mataram are the lack of teachers paying attention to the students' GSS due to time constraints and besides that, many target materials must be given to students so that in learning the teacher chooses an alternative to using the lecture method. Such learning activities make not a few students feel bored and not interested in participating in learning. This problem later became one of the factors that affected the students' GSS. Especially now that learning is carried out remotely (online) due to the impact of the Covid-19 pandemic so that it becomes a new challenge for educators in conducting learning. The need for adaptation to the way of learning, therefore researchers are trying to develop a problem-based model of physics learning tools to improve students' generic science skills. The development of these learning tools aims to determine the effectiveness of the learning tools made to improve the GSS of students at MAN 1 Mataram.

## Method

The type of research used is Research and Development (R&D). R&D is a type of research that is descriptive with gradual work procedures in producing and testing educational products (Yuliandriati et. al., 2019). This R&D research model uses the Thiagarajan development model or 4D model. The intended 4D models include:


**Figure 1.** Stages of Research and Development

The learning system in it concerns the processing and selection of teaching resources, strategies, and evaluation of awareness (Hayati et. al., 2015). The research subjects for the development of this problem-based physics learning device were students of class XI MIA 3 at MAN 1 Mataram, totaling 28 students. The research instruments used include learning tools consisting of the syllabus, lesson plans, student worksheets, and GSS questions as well as data collection instruments consisting of interview sheets, validation sheets, learning implementation observation sheets, and GSS question sheets. The learning tools that are made are adapted to the syntax of the problem-based learning model used.

The data collection technique used in this development research for the validity of the learning device is to use a Likert scale. The calculation of the validity of the device aims to determine the validity or feasibility of the developed device. Meanwhile, to measure the implementation of learning, it is obtained from the score given by the observer on the implementation observation sheet, which is then analyzed using the following Interjudge Agreement (IJA) equation.

$$IJA = \frac{A_y}{A_y + A_N} \times 100\% \quad \text{..... (1)}$$

Description:
$A_y$= activities carried out
$A_N$= activities that are not carried out

Learning devices are categorized as suitable for use if the implementation of learning reaches 75% (Saputri & Dwisiswi, 2016)(Saputri & Dwisiswi, 2016)(Saputri & Dwisiswi, 2016).

The increase in the generic ability of students' science is determined by using the following Standard Gain equation.

$$Std\ g < g >= \frac{\bar{X}_{after} - \bar{X}_{before}}{\bar{X}_{max} - \bar{X}_{before}} \quad \text{..... (2)}$$

Description:
$\bar{X}_{after}$ = post-test mean score
$\bar{X}_{before}$ = pre-test mean score
$\bar{X}_{max}$ = maximum score

Based on the Standard Gain value that has been obtained, then the GSS are grouped according to Table 1.

**Table 1.** Interpretation of Standard Gain

| Score <g> | Classification |
|---|---|
| 0.70<g<1.00 | High |
| 0.30<g<0.70 | Medium |
| 0.0<g<0.30 | Low |

(Arsanty & Wiyatmo, 2017)

## Result and Discussion

This research aims to determine the effectiveness of the development of the PBL model device in improving the generic ability of science on elasticity material which was carried out in a limited trial located at MAN 1 Mataram in class XI MIA 3. There are four stages of research according to the 4D model used.

*Define*

At the Define stage, an analysis of the learning tools will be made carried out to determine learning objectives that are following basic competencies and indicators of competence achievement on elasticity material. The definition stage carried out includes an initial analysis which is an activity to find out how the picture is when learning takes place. The initial analysis carried out was in the form of an interview with a physics teacher at MAN 1 Mataram conducted before the Covid-19 pandemic occurred.

Furthermore, at the definition stage, a task analysis is also carried out which is a procedure in determining the content of teaching materials in outline on the subject matter of elasticity based on Core Competencies and Basic Competencies by K13. After carrying out the task analysis, concept analysis is also carried out, namely the identification of concepts in the material to be taught, then details and the preparation of mapping of learning materials is carried out.

Finally, the activities carried out at the definition stage are the formulation of learning objectives, the formulation of learning objectives is a specification based on Core Competencies and Basic Competencies in this case is Basic Competencies 3.2 on elasticity material.

*Design*

The next stage is Design where several steps are taken to prepare the product to get a draft which is then validated by a team of experts and practitioners. The products compiled are learning tools and data collection instruments. The learning tools in question include the syllabus, lesson plans, LKPD, GSS test instruments that have been adapted to the PBL model syntax, then the intended data collection instruments include interview sheets, validation sheets, and learning implementation observation sheets.

*Develop*

The third stage is the Develop stage, at this stage a limited learning device test is carried out to get consistent and effective results, the goal is to modify the type of learning material design through validation and expert assessment (Rajabi et. al., 2015). In addition, the development stage is a stage in producing a developed product. At the development stage, several steps are carried out starting with validation or assessment by experts and practitioners related to the developed device, then continued with limited testing of the device, and finally an assessment by several observers related to the implementation of learning based on the device made. The device development trial in this study was carried out at MAN 1 Mataram by involving 28 students in class XI MIA 3 as many as 28 students.

Before the device begins to examine, that device is analyzed for validity. Device validity is obtained based on assessment experts and practitioners, where the learning tools made by the researchers as a whole fall into the excellent category, which means that the learning tools can be used. The application of learning tools that have been validated is limited to class XI MIA 3. The effectiveness of learning devices is given test at the initial meeting (before it is done at the end of the learning meeting (after all topics have been taught) and the test instruments are developed in accordance with the learning indicators (Tama et. al., 2020).

Based on the results of the learning that has been done, the implementation of knowledge is then analyzed. The analysis was carried out using the IJA equation and obtained the average percentage of learning implementation at each meeting. Details of the percentages for each of these meetings can be seen in Table 2.

**Table 2.** Acquired Percentage of Learning Implementation

| Meeting to- | Percentage of Execution (%) | | | Average (%) |
|---|---|---|---|---|
| | Observer 1 | Observer 2 | Observer 3 | |
| 1 | 100 | 88.88 | 100 | 96.29 |
| 2 | 83.33 | 88.88 | 94.44 | 88.88 |
| 3 | 94.44 | 83.33 | 83.33 | 87.03 |

Based on Table 2, the average percentage of implementation obtained from the three observers shows a percentage value of ≥75%, which means that the learning tools are effective to use. However, there are several obstacles experienced by researchers in implementing learning in class XI MIA 3 at MAN 1 Mataram, among others, limited internet access for students so that not all students can participate in every series of learning. The lack of student participation in answering the questions given, as well as the limited teaching time during online learning is carried out at MAN 1 Mataram.

In addition, the effectiveness of learning devices is also measured by the N-Gain test. The N-Gain test was obtained from the results of the pretest and posttest of students with the number of questions consisting of 12 items in the form of descriptions. The average gain of N-Gain for all students of class XI MIA 3, totaling 28 people, can be seen in Table 3 below:

**Table 3.** GSS Average Gain with N-Gain

| $\bar{X}Pre$ | $\bar{X}Post$ | *N-Gain* | Category |
|---|---|---|---|
| 36.83 | 68.75 | 0.54 | Medium |

The average value obtained based on the tests that have been carried out can be seen in Table 3 for the pretest is 36.83 with the highest score being 81.25 and the lowest score being 10.42 while the average posttest

score is 68.75 with the highest score being 100 and the lowest score being 29.17. Furthermore, the increase in students' GSS is measured using the standard gain equation divided into three categories which could be seen in Table 1. The results analysis obtained that is standard gain value in Table 3 is 0.54 means there is an increase in the students' GSS on the medium category. The specification of the number of students based on the pretest and posttest scores can appear in Table 4.

**Table 4**. GSS Category Specifications with N-Gain test

| N-Gain Score | Category | Number of Students | Percentage (%) |
|---|---|---|---|
| 0.71<g<1.00 | High | 15 | 53.57 |
| 0.30<g<0.70 | Medium | 3 | 10.71 |
| 0.0<g<0.30 | Low | 10 | 35.71 |

Based on the description in Table 4, that the number of students who experienced an increase in GSS was much greater than the number of students who did not experience an increase in GSS. So that it can be said, there is an increase in the generic science skills of students, although the increase is not too significant due to limitations in conducting pretest and posttest, namely the availability of time and internet access which causes some students to be hampered in collecting answers so that it exceeds the predetermined time limit.

So, based on the percentage of learning implementation and the obtained N-Gain value, it can be said that the development of problem-based learning tools that are made effective to improve students' generic science skills with the percentage of learning implementation exceeding 75% and the N-Gain value is in the medium category. This is also supported by research that has been conducted by (Dibyantini et. al., 2021) that the application of problem-based learning tools affects improving students' generic science skills. Correspondingly (Tama et. al., 2020) stated that the application of problem-based learning has been well proven in improving higher-order thinking skills.

The significant increase in students' GSS occurred in the indicators of symbolic language and building concepts. The improvement for each GSS indicator used is shown in Figure 2.

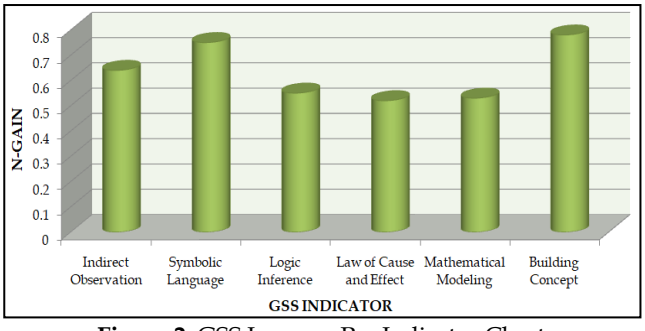


**Figure 2**. GSS Increase Per Indicator Chart

There is a significant increase in the indicators of symbolic language and building concepts due to the indicators of symbolic language students case-hardened to understand the equations to units of the material being taught, other things that support the high indicators of symbolic language students are because in learning students are given examples of problems and how to solve it, especially in formulating a Hooke's law equation, especially in series and parallel circuits to solve problems. Overall, it can also be seen how the improvement of students' concepts for elasticity material, where this material is dividual into three subs. The following are the details of increasing the concept of students' elasticity material which can be seen in Table 5 elasticity learning material.

**Table 5**. Specification of Elasticity Concept with N-Gain test

| Sub Material | Number of Questions | N-Gain | Category |
|---|---|---|---|
| Characteristics of Objects | 5 | 0.71 | High |
| Hooke's Law | 5 | 0.40 | Medium |
| Hooke's Law on Series and Parallel Springs | 2 | 0.72 | High |

*Disseminate*

The dissemination stage is the final stage in the 4D model development research. This stage is carried out after the product is made valid and effective (Susdarwati et. al., 2016). The dissemination stage is carried out by extensive field trials. However, in this study, the disseminated stage was not carried out due to the limited conditions currently experienced during the Covid-19 pandemic.

## Conclusion

Based on the results of research, data analysis, and discussion, it can be concluded that the development of problem-based model physics learning tools is effective for improving the generic science skills of students in the medium category.As for suggestions for further development research, in the application of learning tools, especially in online learning to provide additional time in collecting assignments so that students can complete these tasks optimally and if conditions do not allow for face-to-face activities, then the teacher should choose e-learning media that can support learning optimally.

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