

# Development of Digital Portable Auto Design Microscope Learning Media to Increase the Understanding of Concepts and Problem-Solving Abilities of Students

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## ABSTRACT

The purpose of this research is to develop learning media in the form of portable digital auto microscope design to improve understanding of concepts and problem-solving abilities. The results showed that the learning media in the form of portable digital microscope auto design is very feasible to use in learning. This can be seen from the results of expert validation 97.78%. After getting the results of validation then the effectiveness of this media is tested on the understanding of concepts and problem-solving abilities. The results of the effectiveness test showed that this media was very effective in increasing the understanding of the concepts and abilities of students in two schools namely SMP IT Putra and SMP IT Putri Mataram. The effectiveness test results show that there is an increase in the score of students in pre-test and post-test.

**Keywords:** Digital portable, Auto Design Microscope, Understanding of Concepts, Problem-solving abilities.

## 1. INTRODUCTION

The implementation of education in Indonesia refers to the national education system contained in Law Number 20 Year 2003 concerning the National Education System, Article 1 number 1 states that education is a conscious and planned effort to create an atmosphere of learning and learning process so that students actively develop potential himself to have spiritual strength, self-control, personality, intelligence, noble character, and the skills needed for himself, society, nation and state [1]. The development of education is inseparable from the important efforts to form a qualified young generation by increasing the quality of education. Good education is education with the availability of qualified educators in terms of planning and implementing learning and evaluating learning outcomes [2].

The development of education in the world is also inseparable from the development of the industrial revolution that occurred in the world, because indirectly changes in the economic order also change the educational order in a country. The industrial revolution began with the Industrial Revolution 1.0 occurring in the 18th century through the invention of the steam engine, allowing for mass production of goods. Around 1970 through the use of computerization, and the 4.0 Industrial Revolution itself occurred in around 2010 through intelligence engineering and the internet of things as the backbone of the movement and connectivity of humans and machines [3].

Facing the Era of the Industrial Revolution 4.0 in the field of education, motivation alone is not enough in realizing the ideals of making Indonesia 4.0, there must be concrete form and hard work for the Indonesian

government and all of us in welcoming the era of digitalization [4]. One concrete effort to deal with this era is to improve the quality of education [5].

Education in Indonesia is still relatively low and has not yet succeeded optimally, even more so for learning science. The main problem in education in Indonesia is the low learning outcomes in schools. Learning outcomes are meant not only in the aspect of cognitive abilities but also in aspects of attitude or attitude towards science [6].

Survey results at the Integrated Islamic Junior High School Putra and Putri Mataram (SMP IT Mataram) that many of them do not like even afraid of some lessons, especially science and mathematics lessons [7]. This is due to several factors, among which are the media and scenarios that are less innovative in the learning process, which means that the teaching and learning process that is held is generally based on material (content based) [8]. In the learning process, students are less encouraged to develop thinking skills. The learning process in the classroom is directed at the child's ability to memorize information. Children's minds are forced to understand the information they remember to connect it with everyday life [9].

The development of science and technology has brought very significant changes to various dimensions of human life, both in terms of economics, socio-culture, and education. Rapid changes in all sectors of life must be a driving force for schools and colleges to be able to adapt and innovate in order to keep up with changes and developments very quickly in the global arena [10]. Mobile lately known as smartphones or gadgets can be a supporting medium for the creation of creative learning. Utilization of a smartphone equipped with a camera that produces high Image Quality will be a medium that will facilitate learning activities.

The existence of this gadget with various features in it can provide convenience in teaching various science learning materials in schools. One of them is light material and optical devices, the existence of this gadget will be a supporter of learning activities, given the availability of instructional media that is still very minimal, such as a microscope. Microscopes available in schools now have many drawbacks, some of which can only work well if used in a luminous room. So, it takes innovation to design a portable digital auto design microscope that can be used in a variety of circumstances.

Talking about global challenges, of course many bills and homework must be met by students. Among them is the ability to understand a material concept and the ability to solve problems [11]. In science there is a request to process ways of thinking, conducting investigations, building knowledge and its relation to technology and society. This becomes a basic supplement in studying

science to develop scientific processes so that students' mindset is formed [12].

Science learning activities must involve students in their investigations and be able to integrate skills, attitudes, and knowledge to understand the science concepts [13]. Science learning activities emphasize direct learning to develop students' competencies in exploring and understanding nature scientifically [14]. Furthermore, the purpose of science education is to create students who master the concepts and their relationships to solve problems in everyday life [15].

The importance of problem-solving skills is in line with the opinion issued by the National Council of Teachers of Mathematics (NCTM) in 2000 which states that the problem-solving ability must be possessed by every student to support the quality of human resources. Students who are trained to have the ability to solve problems will be able to compete globally because they are able to integrate these abilities to solve real problems in the real world [16].

This skill is one of the intellectual properties or the ability to produce or produce products. Therefore, a development research entitled "development of portable auto design digital microscope learning media to remind students of the concept understanding and problem-solving ability of junior high school students on light material and optical devices".

## 2. METHOD

This research is a research and development that uses the Dick and Carey development model. The Dick and Carey development model has ten stages of development: (1) Formulating Specific Learning Objectives; (2) Student and Context Analysis; (3) Instructional Analysis; (4) Identification of Learning Objectives; (5) Developing Tools or Instruments; (6) Developing Learning Strategies; (7) The use of teaching materials; (8) Designing and carrying out formative evaluations; (9) Revise the draft learning program; (10) Designing and developing summative evaluations [17].

The product developed is a portable auto design digital microscope learning media to improve understanding of concepts and problem-solving abilities of students of grade VIII junior high school in light material and optical devices. The data used are data obtained from the results of the validation of the media experts, then analysed using component percentages based on the Likert scale in Table 1.

**Table 1.** Scoring instrument questionnaire

Answer	Score
Very good	5
Good	4
Enough	3
Minus	2
Very Poor	1

Then the score is calculated to determine the percentage of components with the following equation:

$$P_{(k)} = \frac{S}{N} \times 100\% \quad (1)$$

Where:

$P_{(k)}$  = Percentage of components

$S$  = Total component score of research results

$N$  = Maximum number of scores

The percentages obtained are then transformed into intervals as in Table 2.

**Table 2.** Range of percentages and qualitative criteria

Percentage (%)	Criteria
85-100	Very Worthy
69-84	Feasible
53-68	Enough
37-52	Inadequate
20-36	Very Poor

The effectiveness of the product developed can be seen from tests of concept understanding and problem-solving abilities. The results obtained in the form of pretest and posttest values, which are then calculated the value of N-Gain to see an increase in the achievement of the concept understanding and problem-solving ability. To see the improvement of students' creativity and problem-solving ability, the N-Gain formula is used as follows:

$$N\text{-Gain} = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{max}} - S_{\text{pre}}} \times 100\% \quad (2)$$

The table of N-Gain score criteria can be seen in the following Table 3:

**Table 3.** Gain score criteria [18]

Gain score classification.	Category
$0.7 < g \leq 1$	High
$0.3 < g \leq 0.7$	Medium
$g \leq 0.3$	Low

### 3. RESULT AND DISCUSSION

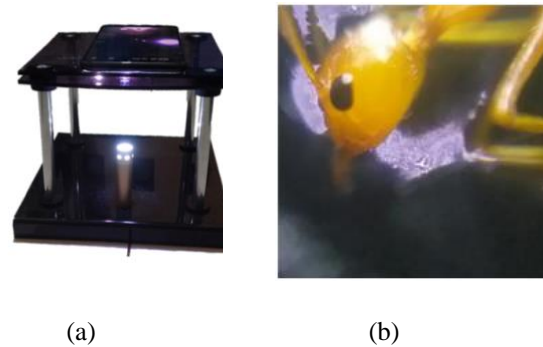
#### 3.1. Validation Results of Learning Media Digital Portable Auto Microscope Design

The media validation developed was carried out by three media and material expert validators. Validation is based on 3 main components, namely general appearance, special appearance, and media presentation. In general, comments from the validator are that there needs to be a change in the colour of the microscope, the microscope box, the light holes, the number of lenses from 1 lens to 2 lenses, and the rotator to adjust the focus. The results of the final validation from the validator can be seen in Table 4 below:

**Table 4.** Recording of portable auto design microscope validation results

Assessment Aspect	Score (%)
General Display	98.09
Custom Views	97.78
Presentation of Media	97.33
Average	97.78
Criteria	Very Eligible

Table 4. shows that the average result of the validation of learning media in the form of a portable auto design microscope is 97.78% with very feasible criteria. This shows that this learning media is suitable for use in learning. The following is an image of the portable auto design microscope learning media that has been developed (Figure 1a) and an example of the resulting Ant image (Figure 1b).

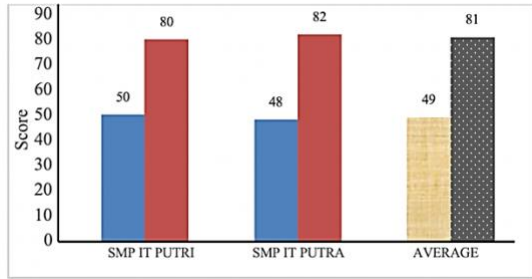


**Figure 1** (a) Digital microscope portable auto design developed, (b) Ant image.

The picture above is a portable auto design digital microscope image that was developed as a science learning medium on Light material and Optical Devices in class VIII. This media is a simple media designed using a laser lens. This digital microscope has the same function as light microscopy in general, which is to see objects or small objects. The fundamental difference with a light microscope is that this microscope uses a smartphone application to see the anatomy of the object being observed, so its use is simple, and can be displayed on an LCD screen. Another advantage is that the object being observed can be taken pictures or videos, so that students can easily study the anatomy of the observed animals and plants because they can be seen repeatedly.

#### 3.2. The results of the effectiveness test of the Portable Auto Design Digital Microscope learning media

To see the effectiveness of the media and tools developed, it was carried out through tests of students' abilities on the variables to be measured, namely understanding of concepts and problem-solving abilities. The results of the concept mastery test can be seen in Figure 2 below.



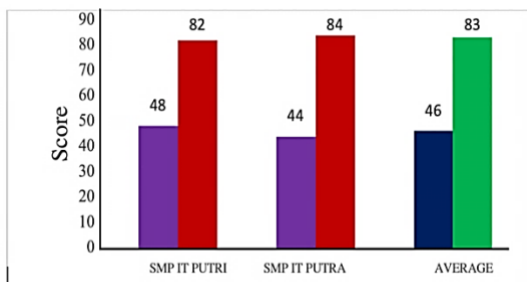
**Figure 2** Value of the pretest and posttest mastery of the concept.

The picture above is the result of the pretest and posttest in two schools, namely SMP IT Putra and SMP IT Putri Mataram. The graph shows that there is a significant difference between the pretest and posttest scores. This shows that the learning media developed are effective in increasing students' understanding of concepts and at the same time being able to attract students' interest.

Interest is the first capital to form learning motivation. Students who have an interest in learning will definitely be sincere so that they can achieve achievements [19]. Likewise, on the contrary, students who do not have a request to learn tend not to pay attention to the lesson [20].

The results showed that the learning motivation of students had an effect of 48 % on the learning achievement of students [21]. The results also show that students who have higher learning motivation will find it easier to follow the learning process [22]. Conversely, students with low learning motivation have difficulty understanding the concept and cause a learning process that is less conducive. The results also show that to overcome this, a fun learning process is needed and students can be actively involved in the learning process [23].

This has influenced student learning outcomes to increase because learning is presented using modern media so that students' interest in learning and curiosity are high. The results of the problem-solving ability test can be seen in Figure 3 below.



**Figure 3** The value of pre-test and post-test of problem-solving abilities.

Figure 3 above shows the average pre-test and post-test scores tested at the schools that were the research subjects, namely SMP IT Putra and SMP IT Putri Mataram. This graph shows that there is a very significant increase between the pre-test and post-test scores. This shows that the portable auto design digital microscope is effective for improving the problem-solving abilities of students in schools that are the research subjects.

Students who are taught using instructional media tend to have good problem-solving skills [24, 25]. This is because the use of instructional media is able to attract students' learning interest so they are focused and have high curiosity. There is a significant difference between students who learn to use learning media and do not use learning media [26, 27, 28]. This is because students are facilitated by the media making it easier to understand the material and tend to be able to improve problem solving well.

#### 4. CONCLUSION

The portable auto design digital microscope learning media developed is very suitable for use based on the validation results. The portable auto design digital microscope learning media developed effectively improves students' understanding of concepts and problem-solving abilities. This can be seen from the difference in the results of the pre-test and post-test.

#### AUTHORS' CONTRIBUTIONS

Aris Doyan has contributed to making articles and data analysis. Susilawati contributed to the data analysis. Adi Hardiyansyah has contributed to data collection and data processing for making complete articles.

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