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# THE EFFECTIVENESS OF THE VIRTUAL LEARNING MEDIA GRAPH COLORING LABORATORY

**Irmayasari[1] , Makrina Tindangen[2], Evie Palenewen[3]**
Mulawarman University Samarinda
maya.sari9633@yahoo.com[1]
makrin_tundangen@yahoo.co.id[2]
eviepalenewen@yahoo.com[3]

## Abstract

*The purpose of this study was to determine the effectiveness of virtual laboratory learning media on gram staining material in improving student learning outcomes and retention. The method used in this study is an experiment with a Pretest-Post Nonequivalent Control Group Design . The results showed that the validity of the learning media was 95.6%, the language was 96.4% and the material was 95.5%. The practicality of the media based on teacher questionnaire data is 91.6% and 82.9% of student questionnaires, and the average student learning outcomes increase by 81.9% and the results of student retention power of 87%. Based on the results of the validity, practicality and effectiveness of Biology students and teachers at SMAN 8, SMAN 17 and SMA Wahidiyah Samarinda, it can be concluded that the effectiveness of virtual laboratory media on gram staining material in Biology learning is appropriate to be used as a learning medium.*

*Keywords: Effectiveness, Virtual Laboratory, Gram Staining, Learning Outcomes and Retention*

Currently the whole world is facing the era of the industrial revolution 4.0, and Indonesia is no exception. The era of revolution has affected all aspects of human life, from transportation, trade, health, to education. Educational activities that are influenced by the 4.0 revolution are called *education 4.0* (education 4.0), namely education characterized by the use of digital technology in the learning process ( *cyber system* ). Teachers are challenged to be able to master the development of science and technology, so that they can optimize the use of technology in learning and are no less competitive with the ability of students in mastering digital technology.

Sudjana in (Prasetya, 2012) states that in the national education system, both curricular and instructional objectives, use the classification of learning outcomes from Benjamin Bloom which broadly divides into three domains, namely the cognitive domain, affective domain and psychomotor domain. The cognitive domain is a domain related to intellectual learning outcomes which includes six aspects, namely: knowledge or memory, understanding, application, analysis, synthesis and evaluation. The first two aspects are called low-level cognitive and the next four aspects include high-level cognitive.

One indicator of the achievement of learning outcomes is the ability of students to remember (retention) a material that has been studied. Retention is the ability of students to recall what has been previously learned during a certain time interval. The use of media and supportive learning models will greatly affect student retention, because memorable learning experiences will be stored longer in children's memory. The information received can be stored for only a few moments, some time, or an unlimited period of time (Lubis & Simatupang, 2014). Winarno in (Widayati, 2016), suggests that the benefits of learning media include: 1) The delivery of learning becomes more standard, meaning that each student can get the same message from a material, 2) The learning process becomes more interesting, can increase curiosity

and motivation and student interest, 3) Learning becomes more interactive, 4) Efficient learning time, 5) Improving the quality of learning, 6) Learning can be done anytime and anywhere, especially if the media is designed for individual use, 7) The teacher's role can be more positive, because it uses learning media. So, it can be concluded that the use of media in the learning process can be useful for stimulating student learning activities, facilitating interactions between educators and students, and facilitating the delivery of messages or learning materials.

Flowers in (Widodo, Maria, & Fitriani, 2016) and (Dewi & Prasetiyo, 2015) virtual practicum is a computer simulation that contains a number of instructions and procedures, data analysis and presentations where all laboratory tools and materials are in the form of computer-based *software* . interactive multimedia, which can be operated with a computer and can simulate practical activities as if the user was in a real laboratory. The results of research on the benefits of practicum on improving student learning outcomes in the cognitive domain, indicate that practicum improves student learning outcomes in cognitive aspects. Virtual practicum has a number of advantages, including: 1), providing opportunities for students to repeat demonstrations on material that is not understood, 2) reducing the risk of dangerous experiments, 3) shortening the time for carrying out activities in *real* laboratories , 4) reducing the budget for costs. practical materials and tools. In addition to having advantages, virtual practicums have disadvantages, such as: 1) Lack of experience to train students' laboratory skills, such as making incisions, 2) Lack of experience in handling living organism specimens, 3) Lack of direct contact and supervision from the teacher, 4) Sometimes you can experience technological problems, such as having to update the *server* on the virtual practicum *software* .

The results of the study (Habibbulloh, Jatmiko, & Widodo, 2017) the use of a virtual laboratory-based learning model can reduce the misconceptions of SMK students on the topic of Photoelectric Effects. In addition, the results of the study (Dewi & Prasetiyo, 2015) show that with the use of virtual laboratory media the results of the posttest scores of students have increased compared to the pretest, but the N-gain analysis is still quite low, namely 0.2. So that virtual laboratory-based learning can be used as an alternative to eliminate the limitations of laboratory equipment. The results of the study (Maryuningsih, Benefit, & Riandi, 2019) data on practicum values for students who are able to take genetics and practicum courses using a virtual gel electrophoresis laboratory and real practicum do not experience significant differences, which shows that virtual laboratories can be used as a substitute for real electrophoresis material practicums. gel. (Seifan, Robertson, & Berenjian, 2020). Virtual laboratory experiments allow students to investigate a phenomenon and make it possible to conduct experiments that are cost-effective, affordable and timely.

Based on the results of initial observations and interviews with class X students of SMA 17 Samarinda, SMA 8 Samarinda and SMA Wahidiah, it was found that the teacher had never carried out Gram staining practicum on *archaebacteria* and *eubacteria* material . So far, teachers only use videos that are available on the internet as an alternative to learning, due to the lack of availability of tools and practicum materials. Based on these constraints, it causes students to be passive and less interested in learning, because they only watch videos without doing practical activities. In addition, due to restrictions on teaching and learning activities in schools during the COVID-19 pandemic, all schools conduct distance learning, so that practicum activities that should be carried out in the laboratory cannot be carried out. Therefore, researchers chose a virtual laboratory learning media to facilitate practical activities in distance learning, and it is hoped that it will be able to improve learning outcomes and retention of class X students on Gram staining material.

**METHOD**

This research approach uses quantitative experimental research methods using a quasi-experimental design *Pretest Posttest Nonequivalent Control Group Design* . The research was carried out at SMAN 8, SMAN 17 and SMA Wahidiyah Samarinda, which was carried out from November 2020 - March 2021.

**Table 1.1 Experimental Research Design Pretest Posttest Nonequivalent Control Group Design**

| Group | Pretest | Treatment | Posttest | Retention |
|-------|---------|-----------|----------|-----------|
| **Experiment** | 01 | X1 | 02 | 03 |
| **Control** | 03 | X2 | 04 | 06 |

Source: Research Design (Source: Sugiono in Susilowati 2017)

Description :

O1, O4  : Pretest

O2, O5  : Posttest

03, and 06 : Retention test

X1  : Control class

X2  : Experiment class

The purpose of this study was to determine the validity, practicality and effectiveness of the Gram staining laboratory virtual learning media to improve learning outcomes and retention of class X students at SMAN 8, SMAN 17 and SMA Wahidiyah Samarinda. Data collection techniques used in this research are questionnaire sheets from teachers and students, validation sheets, and questions for pre-test, post-test and retention-test.

1.  **Learning Media Validity Analysis**

The data on the validity of the learning media in this study were obtained based on the results of expert research (validators), namely media experts and biology learning media experts. The expert assessment is based on a Likert scale (interval 1-4) which has the rules for weighting the score of the expert assessment items in table 1 as follows:

**Table 1. Rules for Weighting Expert Assessment Points**

| Score | Criteria | Description |
|-------|----------|-------------|
| 4 | Very good | Very good quality, easy to understand, according to the context of understanding |
| 3 | Good | Good quality, easy to understand, need to improve the context of understanding |
| 2 | Not good | Poor quality, difficult to understand, need to improve understanding context |
| 1 | Not good | Quality is not good, difficult to understand, need to improve the context of understanding |

Calculating the validity score from the results of the expert validation questionnaire using the formula:

P =                   x 100%

The results of the validity of the known percentage can be matched with the validity criteria as presented in table 2 below.

**Table 2. Criteria for Validity of Learning Media**

| No | Percentage (%) | Validity Criteria |
|---|---|---|
| 1 | 85.01 - 100.00 | Very Valid |
| 2 | 70.01 - 85.00 | Valid |
| 3 | 50.01 - 70.00 | Less Valid |
| 4 | 01, 00 - 50.00 | Invalid |

(Source: Akbar, 2013)

## 2. Data Analysis of the Practicality of Learning Media

The practicality data of this learning media was obtained from the practical validation of the use of learning media by students and the teacher's response (practitioners). The practicality of learning media from the assessment of educational practitioners uses 4 general assessment criteria as presented in table 3 below.

**Table 3.** Criteria for Assessment of Practicality of Learning Media

| Value Code | Description |
|---|---|
| A | Can be used without revision |
| B | Usable with minor revisions |
| C | Can be used with multiple revisions |
| D | Can not be used |

The student response questionnaire aims to determine student responses that can be used as a benchmark for the quality of learning media that have been developed from the practical aspect. In this response questionnaire, there are four answer choices with assessment criteria based on table 4 below.

**Table 4 Assessment Scale of Student Response Questionnaire Statements**

| Score | Category |
|---|---|
| 4 | (SS) Strongly Agree |
| 3 | (S) Agree |
| 2 | (TS) Disagree |
| 1 | (STS) Strongly Disagree |

(Source : Arini & Lovisia, 2019)

Calculating the practicality score from the results of the teacher and student response questionnaires using the formula:

$$P = \qquad \times 100\%$$

**Table 5 . Practical Criteria for Learning Media From Student Response Questionnaires**

| No | Percentage (%) | Criteria |
|---|---|---|
| 1 | 85.01 - 100.00 | Very Practical |
| 2 | 70.01 - 85.00 | Practical |
| 3 | 50.01 - 70.00 | Less Practical |
| 4 | 01, 00 - 50.00 | Not Practical |

Source : (Akbar, 2013)

### 3. Analysis of Learning Media Effectiveness

The value of the students' *pre-test* and *post-test results was* calculated using the t-test with the statistical formula (tcount) as follows:

Description:

n   = Lots of data

D = Difference between *Pre-test* and *Post-test*

n   = Number of Samples

   = Sample mean 1

   = Sample mean 2

   = Standard deviation of D

**Table 6. Percentage of Effectiveness of Learning Media**

| Presentation (%) | Category |
|---|---|
| 90-100 | Very good |
| 80-90 | Good |
| 65-79 | Enough |
| 55-64 | Not enough |
| 0-54 | Not good |

### 4. Student Retention

The data obtained in this study will analyze student learning outcomes by determining student retention. In the study, student retention power was determined using the formula:

Retention Power =

**Table 7. Percentage of Retention Categories**

| Retention (R)% | Category |
|---|---|
| R 70 | Tall |
| 60 < R < 70 | Currently |
| R 60 | Low |

(Source: Setiawan, in Lubis & Simatupang, 2014)

The subjects in this study were grade X students at SMAN 8, SMAN 17 and SMA Wahidiyah Samarinda. The object of this research is the virtual learning media of the Gram staining laboratory to improve learning outcomes and retention of class X students.

### RESULTS

The research data obtained through the results of the assessment of the validity, effectiveness and feasibility of the media. Small class trials were conducted at SMAN 8 Samarinda for 10 students, then large class trials were conducted at 36 students in SMAN 8, 36 students in SMAN 17 and 24 students in Wahidiyah High School Samarinda.

**Table 4.6 Results of Assessment of the Validity of Virtual Materials in Gram Staining Laboratory**

| No. | Assessment Aspect | Eligibility Percentage | Qualitative Value |
|---|---|---|---|
| 1. | Material / Content | 96.4% | Very worth it |
| 2. | Learning | 95% | Very worth it |
| | Average | 95.7% | |

(Source: Primary Data in 2021)

The table above shows the results of the virtual laboratory media validity assessment from material experts, which is 95.7%, with a very feasible / valid category for use in learning. Learning media is designed in an attractive and simple way so that students can easily use the virtual gram staining laboratory as a learning medium.

**Table 4.8 Results of Virtual Language Validity Assessment Gram Staining Laboratory**

| No. | Judging Aspect | Eligibility Percentage | Qualitative Value |
|---|---|---|---|
| 1. | Legibility | 92.8% | Very Worthy |
| 2. | Application usage instructions | 100% | Very Worthy |
| Average | | 96.4% | |

(Source: Primary Data in 2021)

The table above shows the results of the assessment of the validity of the virtual laboratory media from linguists, namely 96.4%, with a very feasible / valid category for use in learning. The virtual laboratory learning media uses simple language and sentences, as well as instructions for using the media to make it easy for high school students to understand and understand.

**Table 4.10 Results of Assessment of the Validity of Virtual Media for Gram Staining Laboratory**

| No. | Judging Aspect | Eligibility Percentage | Qualitative Value |
|---|---|---|---|
| 1. | Appearance | 100% | Very Worthy |
| 2. | Navigation | 95% | Very Worthy |
| 3. | Presentation | 87.5% | Very Worthy |
| 4. | Benefits | 100% | Very Worthy |
| Average | | 95, 6% | |

(Source: Primary Data in 2021)

The table above shows the results of the virtual laboratory media validity assessment from media experts, namely 95.6%, with a very feasible / valid category for use after undergoing one revision from a media expert. Comments and suggestions from the validator are used as considerations in developing the media, in order to improve the quality of the media being developed.

The practicality of the virtual learning media of the Gram staining laboratory was obtained from questionnaire data on student responses and teacher responses, then analyzed to find out how practical the

media was developed. The results of the analysis of teacher and student responses are listed in table 9 and table 10 below.

**Table 9. Analysis of Average Teacher Responses**

| No. | Group | Teacher Response Results (%) |
|---|---|---|
| 1 | SMA Negeri 8 Samarinda | 82% |
| 2 | SMA Negeri 17 Samarinda | 96% |
| 3 | Wahidiyah High School Samarinda | 97% |
| **Average value** | | **91.6%** |
| **Category** | | **Very Practical** |

(Source: Primary Data in 2021)

**Table 10. Analysis of Average Student Responses**

| No. | Group | Student Response Results (%) |
|---|---|---|
| 1 | Small Class (SMA Negeri 8 Samarinda) | 88.44% |
| 2 | SMA Negeri 8 Samarinda | 83.77% |
| 3 | SMA Negeri 17 Samarinda | 82.03% |
| 4 | Wahidiyah High School Samarinda | 76.65% |
| **Average value** | | **82.72%** |
| **Category** | | **Very Practical** |

(Source: Primary Data in 2021)

The results of the practicality analysis based on the teacher and student response questionnaires proved that the media developed was included in the appropriate category to be used as a medium in learning Gram staining.

The achievement of effectiveness is measured based on the cognitive aspect by looking at the minimum completeness criteria (KKM) in biology lessons at school. The KKM score in schools in this study was 80. The evaluation was carried out through the results of student work related to *pre-test, post-test* and *re-test questions* in the form of 10 essay questions.

**Table 11. Analysis of the Average Student Learning Outcomes**

| No. | Group | Mark |
|---|---|---|
| **1.** | Small Class (SMAN 8 Samarinda) | 80,40 |
| **2.** | SMAN 8 Samarinda | 80.14 |
| **3.** | SMAN 17 Samarinda | 84.28 |
| **4.** | Wahidiyah High School Samarinda | 82.92 |
| **Average value** | | **81.93** |
| **Category** | | **Effective** |

(Source: Primary Data in 2021)

Learning by using the right media will make it easier for students to accept and understand the material presented. Based on the data obtained, it was found that the percentage of students' scores had increased by 81.93%. This shows that the virtual laboratory media can help students in the learning process.

Analysis of student retention was carried out by giving *re-test questions* to students within 7 days after taking the *post-test* scores . Data analysis of student retention using virtual laboratory learning media is presented in the following table.

**Table 12. Analysis of Average Student Learning Retention**

| No. | Group | Mark (%) | | |
|---|---|---|---|---|
| | | **Post-test** | **re-test** | **Retention Power** |
| **1.** | Small Class (SMAN 8 Samarinda) | 80,40 | 69.60 | 86.61 |
| **2.** | SMAN 8 Samarinda | 80.14 | 69.41 | 85.91 |
| **3.** | SMAN 17 Samarinda | 84.28 | 74.13 | 87.72 |
| **4.** | Wahidiyah High School Samarinda | 82.92 | 73.5 | 87.88 |
| **Average value** | | 81.93 | 71.66 | 87.03 |
| **Category** | | | | **Tall** |

(Source: Primary Data in 2021)

The results of data analysis show that students who learn to use virtual laboratories have a greater retention power of 87.03% which is included in the category of high retention power, compared to students who are taught only by video.

## DISCUSSION

Based on the questionnaire given, students experience difficulties in understanding abstract biological material and students have never done laboratory practicum activities during the current pandemic, from the results of student responses it can be concluded that students prefer creative, innovative and more varied learning.

The virtual laboratory learning media developed based on interactive multimedia that can provide direct feedback to students, this media contains text, images and audio that are packaged in order to provide an attractive appearance for students and support the learning process.

From the results of the research method, it is known that the virtual learning media of the Gram staining laboratory which has gone through the validation stage by the validator and field trials, it can be concluded that the virtual learning media of the Gram staining laboratory has good quality and is feasible to be used as learning media in the classroom. The students' cognitive learning outcomes were obtained from the results of the students' *pretest* and *posttest* which consisted of 10 validated essay questions. The average learning outcomes of students from the three schools based on table 11, obtained a percentage increase of 81.93% which is included in the effective category. This shows that the virtual laboratory media that has been developed can help students in the learning process. An attractive and interactive media design is able to stimulate the work of the students' senses, attracting students' interest and attention in the learning process.

The learning media used is effective if the learning objectives that have been set can be achieved compared to certain criteria. The achievement of competence or mastery of learning is defined as the

achievement of the minimum mastery standards set for each unit of learning material both individually and in groups. A student is said to be complete if student learning outcomes at a certain competency standard have reached the minimum completeness criteria (KKM) that have been set by the school. In this study, a student is said to have completed individual learning if the student's test score is 80, and a class is said to have completed classical learning if 80% or more of the students have completed individual learning. The average learning outcomes of students who learn to use virtual laboratory applications are listed in the following table.

**Table 4. 18 Analysis of Average Student Learning Outcomes**

| No. | Group | Mark |
|---|---|---|
| 1. | Small Class (SMAN 8 Samarinda) | 80,40 |
| 2. | SMAN 8 Samarinda | 80.14 |
| 3. | SMAN 17 Samarinda | 84.28 |
| 4. | Wahidiyah High School Samarinda | 82.92 |
| **Average value** | | **81.93** |
| **Category** | | **Effective** |

Students work on pretest and posttest questions which consist of 10 essay questions to see the increase in student scores before and after using virtual gram staining laboratory media. Based on the data obtained, it was found that the percentage of students' scores had increased by 81.93%. This shows that the virtual laboratory media can help students in the learning process. This attractive and interactive media design is able to stimulate the work of the students' senses, attracting students' interest and attention in the learning process.

Data retention analysis shows that students who learn to use virtual laboratories have a large retention power of 87.03% which is included in the category of high retention power, compared to students who are taught only by video. Although not all students experienced an increase or equal to the value of the previous *posttest* results . The increase in student retention power can occur because the students being taught have never used virtual laboratory media so that they become interested in trying and experiencing firsthand virtual practicum activities, so that the experience is more imprinted on students' memories and students are also more active in learning. This proves that the virtual laboratory media can be used to support the student learning process.

In line with Sukiman's opinion in (Lisawani, 2013), students learn 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they hear. said, as well as 90% of what he said and did. This shows that if the teacher teaches with the lecture method, students will remember and master the lesson only 20% because he only listens. On the other hand, if the teacher asks students to do something and practice it, the students will remember and master the lesson as much as 90%. Teachers can streamline classroom learning by using virtual gram staining laboratory media as an alternative to practicum in the school laboratory or as a demonstration medium for students before doing practicum in the real laboratory. Second, further research needs to be done that has the potential to develop other virtual laboratory learning media to assist student learning activities in schools, especially to deal with school constraints in procuring laboratory tools and materials.

## CONCLUSION

Based on the research results that have been described, the following conclusions can be drawn. *First* , the virtual laboratory learning media that has been developed based on the results of media, language and material validation has an average percentage of 95.8% with a very valid category. *Second* , the practicality of the media based on the teacher's questionnaire data was 91.6% and 82.9% of the student questionnaires were categorized as very valid . *Third* , the effectiveness of the media from student learning outcomes is 81.9% and student retention results are 87% included in the effective category. Based on the results of the validity, practicality, and effectiveness of Biology students and teachers at SMAN 8, SMAN 17 and SMA Wahidiyah Samarinda, it can be concluded that the virtual laboratory media on gram staining material in Biology learning is suitable for use as a learning medium.

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