Development of 3d Animation Interactive Media to Improve Cognitive Learning Outcomes and Student Self-Efficacy

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Abstract

Biology learners at SMAN 1 Rantau Pulung, SMAN 1 Sangatta Utara, and SMAN 1 Sangatta Selatan are very much liked by students, but there are student scores that have not reached the KKM standard, one of the difficult materials is microscopic. This is because students' cognitive abilities and self-efficacy are different and the learning media used have largely not been developed less interactive and do not vary by teachers. Teachers need a variety of interesting learning media to be applied. The purpose of this study is to examine the design, validity, practicality, and effectiveness of 3D animation interactive media in improving cognitive learning outcomes and self-efficacy of class X students. The research was conducted at SMAN 1 Rantau Pulung, SMAN 1 Sangatta Utara, and SMAN 1 Sangatta Selatan. The results showed media design in the form of animated images, materials, sounds, and virtual laboratories. Media belongs to the valid category with media validity of 81.46%, Language 98.21%, and material 77.15%. Practicality results by Biology teachers were 96.67% and students 82.85%. Media belongs to the very practical category with a value of 89.76%. Students' cognitive scores increased with an N-gain score of 0.57 and the results of the t-test there was a noticeable difference between *the pre-test* and *the post-test*. The level of self-efficacy of students increased by 32% after using 3D animation media Based on the results of the study, it can be concluded that 3D animation interactive media on virus material in Biology learning is effectively used as a learning medium.

Keywords: Interactive media; 3D Animation; Viruses; Cognitive learning outcomes; Self-efficacy.

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1. Introduction

Based on the results of class X tests observed in 3 schools, namely SMAN 1 Sangatta Utara, SMAN 1 Sangatta Selatan, and SMAN 1 Rantau Pulung, there are still students whose scores have not reached the KKM graduate in Biology subjects. From the results of teacher interviews, one of the difficult materials is to give students an understanding of the structure of viruses, reproduction, and classification of viruses. The main problem is that they have not implemented viral material into interesting media because of the lack of knowledge about developing learning technologies. Teachers have used electronic-based learning media such as smart phones, computers, laptops and LCD but have not used interactive media-based learning media so that the subjects taught are less attractive, especially material that requires practicum, so that cognitive learning outcomes have not achieved the expected results. From the results of observations at SMAN 1 Sangatta Utara, SMAN 1 Sangatta Selatan, and SMAN 1 Rantau Pulung it was also found that students were accustomed to following media developments in the form of computers or Android phones. Students are more interested and confident in using media that includes theory, pictures, animation, evaluation, and games. Therefore, so that classroom learning is effective and students are able to master the subject matter optimally, teachers must use a variety of learning media, so that students do not feel bored in following the lesson. The use of varied learning media can also make students' self-efficacy more active to achieve success in understanding the material. The use of 3D media in the learning process is considered more effective because it looks more real, interactive 3D animation media is similar to AR media but is easier because it is directly on the screen and does not require special barcodes or camera scans. 3D animation interactive media is the incorporation of objects in the virtual world (virtual) into the real world in the form of 2D or 3D that can be touched, seen and heard in real time. Learning will be very effective if it fulfills the essential components in learning, namely discursive, adaptive, interactive and reflective with elements that will be very good if integrated with the learning environment so that it can become online learning that is integrated with the environment or fulfill the digital learning ecosystem component because it can accommodate the learning styles, flexibility and learning experiences of students so that they can create positive feelings [1]. Therefore, 3D animation media is media that fulfills these components as the right solution to overcome the problem of developing existing media to become more attractive. Based on the description above, it is necessary to develop 3D interactive learning media on virus material for class X SMA. 3D animated interactive media is expected to help explain the real virus concept and increase students' self-efficacy and cognitive learning outcomes. The interactive media that are arranged can visualize the material using a combination of various teaching component media, namely in the form of images, text, videos, simulations, evaluation questions that are packaged in an attractive way so that they can support the learning process and variations in understanding virus material.

2. Method

The method used in this research is research and development. This method was used to adapt to the research objective, namely to develop interactive learning media 3D animation on virus material to improve cognitive learning outcomes and self-efficacy of high school students in class X. The research and development design used was the 4D model of Thiagarajan [10]**.**

2.1. Research Subjects and Objects

The population of this development research is the entire population of class X students from SMAN 1 Rantau Pulung, SMAN 1 Sangatta Utara, and SMAN 1 Sangatta Selatan. The subjects of this study were Biology teachers and students of class X SMA. Small scale research subjects consist of 6-10 students and for large scale use 25-40 students for large scale. The object of the research is the feasibility of 3D animation interactive media on virus material for class X SMA

2.2. Learning Media Validity Analysis

The purpose of this study was to determine the media design based on three three criteria, namely validity, practicality, and effectiveness. This data analysis is carried out in the following stages [7]

Table 1: Expert Assessment Item Score Weighting Rules

Score	Criterion	Information
5	Excellent	Excellent quality, easy to understand, according to the context of understanding
4	Good	Good quality, easy to understand, necessary refined context of his understanding
3	Enough	The quality is good enough, quite understood, it needs to be refined the context of the understanding
2	Not Good Enough	Poor quality, difficult to understand, needs to be refined context understanding
1	Bad	The quality is not good, difficult to understand, it is necessary enhanced context understanding

Table 2: Criteria for the 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

2.3. Data Analysis of the Practicality of Learning Media

Convert the score obtained into qualitative criteria of tools practicality from student responses with a table references adapted from [7] as presented in table 3, table 4, and table 5

Table 3: Criteria for Assessing the Practicality of Learning Media

Value Code	Information
A	Can be used without revision
B	Can be used with minor revisions
C	Can be used with multiple revisions
D	Unusable

Table 4: Assessment Scale of Student Response Questionnaire Statement

Score	Category
5	(SS) Strongly Agree
4	(S) Agree
3	(KS) Disagree
2	(TS) Disagree
1	(STS) Strongly Disagree

Table 5: Criteria for the Practicality of Learning Media from Student Response Questionnaires

No.	Percentage(%)	Criterion
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	Impractical

2.4. Data Analysis of the Effectiveness of Learning Media

Data analysis of the effectiveness of learning media, table 6 and table 7 references adapted from Ministry of Education and Culture [5]

Table 6 : Percentage of Effectiveness of Learning Media

Presntase (%)	Category
90-100	Excellent
80-90	Good
65-79	Enough
55-64	Less
0-54	Not Good Enough

$$tstat = \frac{X1 - X2}{SD/\sqrt{n}}$$

Information:

n = Lots of data

D = Difference between Pre-test and Post-test

n= Number of Samples

$\bar{X}1$ = Sample average of 1

$\bar{X}2$ = Sample average of 2

SD = Standard deviation from D

Table 7: Grade Intervals and Descriptions of Learning Outcomes

Value Interval	Capability Description
93-100	Excellent Ability
84-92	Good Ability
75-83	Enough Ability
< 75	Less Ability

2.5. Data Analysis of Cognitive Learning Outcomes

To find out the N-gain, table 8 and table 9 the following formula from Arikunto is used [2] :

N-Gain = Posttest Score – Pretest Score

Ideal Score – Pretest Score

Table 8: N-Gain Score Section

N-Gain Value	Category
g > 0.7	Tall
$0.3 \leq g \leq 0.7$	Keep
g < 0.3	Low

Table 9: Categories of interpretation of the effectiveness of N-Gain

Percentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Quite Effective
>76	Effective

2.6. Self-Efficacy Data Analysis

Table 10: Norms of Katogorization of self-efficacy

Score	Categorization
$\mu + 1.5 < \sigma X$	Very high
$\mu + 0.5 \sigma < X \leq \mu + 1.5 \sigma$	Tall
$\mu - 0.5 \sigma < X \leq \mu + 0.5 \sigma$	Keep
$\mu - 1.5 \sigma < X \leq \mu - 0.5 \sigma$	Low
$X \mu - 1.5 \sigma$	Very low

3. Result

The design that has been developed is in the form of computer-based interactive learning media containing virus material for class X SMA, 3D animated virus images, virtual laboratories, and evaluations. Interactive learning media of 3D animation of viral viruses that have been developed in accordance with the 4D stages. The first stage is defining, the second stage is design, the third stage is development and the stage of dissemination.

Table 11: Assessment Results Medal Interactive Animasi 3D By Expert Materi

Assessment Aspects	Validators	Criterion
Material / Contents	89.29	Very Valid
Learning	65.00	Less Valid
Average	77.15	Valid

The validation results on the aspect materi / content of 82.29% (very valid) and the learningaspectof 65.00% (less valid) on average 77.15% mshowed that the materi media was valid . The advice given by materi experts for revision is to penmmaterial materi on the structure and shape of the virus to make it more, detailed, and complete.

Table 12: Results of the Assessment of validity Media Interactive Animasi 3D By Expert Media

Assessment Aspects	Validators	Criterion
Display	95.83	Very Valid
Navigation	80.00	Valid
Application Presentation	75.00	Valid
Benefits	75.00	Valid
Average	81.46	Valid

The table above mstates that media termasuk aktegory is valid. The advice given by the expert media are; first point; improvements in the sound of materi, second point; improvements to the evaluation of false, and correct, third; it is better to use it channeled with the internet so that it can be more interactive

Table 13: Results of Language Validity Assessment Media learning Interactive Animasi 3D By Linguists

Assessment Aspects	Validators	Criterion
Readability Aspects	96.43	Very Valid
Instructions for use of the application	100.00	Very Valid
Average	98.21	Very Valid

The aspects assessed are the readability and usage aspects of the application. Semua aspect mgot an average value of 98.21 (very valid). The suggestion given by the language validator before to make revisions is that there needs to be an improvement in the latin word / scientific, the writing should be in theory.

Table 14: Teacher Response Questionnaire Results

NO	Group	Teacher Response Results%
1.	High School 1 Rantau Pulung	99
2.	SMAN 1 Sangatta Utara	97
3.	SMAN 1 Sangatta Selatan	84
	Average Value	96,67
	Category	Very Practical

The results of the teacher response questionnaire at SMAN 1 Rantau Pulung, SMAN 1 Sangatta Utara, and SMAN 1 Sangatta Selatan, on average,showed that theinteractive provision of 3d asi ani masi was very practical (96.67%). The response given by the teacher when musing this media is very practical, malready used, and menarik. The advice given is penmmaterial materi and more questions.

Table 15: Student Response Questionnaire Results

NO	Group	Student Response Results%
1.	SMAN 1 Rantau Pulung	82,86
2.	SMAN 1 Sangatta Utara	80,08
3.	SMAN 1 Sangatta Selatan	85,61
	Average Value	82,85
	Category	Practical

The response of students to the media used is very good. The table above shows that theinteractive availability of3D m asi masuk in the practical category with a percentage of 82.85%. The validation results by the validators, the results of the limited class test, and the student's response questionnaire showed that the interactive provision of 3D asi is very feasible so that it can be continued in large classes.

Table 16: Cognitive learning outcomes of students

No.	Kelompok	Value (%)	
		Pre-test	*Post-test*
1.	SMAN 1 Rantau Pulung (small class)	40,00	80,50
2.	SMAN 1 Sangatta North	52,00	84,41
3.	SMAN 1 Sangatta South	40,00	80,29
	Average value	44,00	81,73
	Category		Effective

Cognitive aspects measured from student learning outcomes inm mm worked on *pre-test and post-test* questions consisting of 20 multiple-choice questions about viruses getting an average pre-test score of 44% and an average post-test score of 81.73% which means that there is an increase in the value of learning outcomes that are assimilated in the effective category, the results of the t-test there is a real difference between the *pre-test* and *post-test*.

Table 17: Small Class N-Gain Analysis Calculation Results

No.	Class	N-Gain	Criterion
1.	Treatment Class	0,65	Keep
2.	Control Class	0,32	Keep

Table 18: Large Class N-Gain Analysis Calculation Results

No.	School	Class	N-Gain	Criterion
1.	High School 1 Sangatta Selatan	Control Class	0,29	Low
		Experientialclass men	0,65	Keep
2.	SMAN 1 Sangatta Utara	Control Class	0,28	Low
		Experientialclass men	0,50	Keep
Average N-Gain		Experimental Class	0,57	Keep
		Control Class	0,28	Low

Based on the calculation results of the N-Gain score test above, it shows that the average N-Gain value for the experimental class is 0.57 or 57% which is included in the category of quite effective. In the control class, an average of 0.28% or 28% is included in the category of ineffective. Thus, it can be concluded that the use of 3D animation interactive media is quite effective in improving student cognitive learning outcomes because there is an increase of 57%.

Graph 1 shows that students who fall into the self-efficacy category are very high 31%, high 40%, medium 24%, and low 5%. Graph 2 shows students who fall into the very high category of 46%, high 29%, and medium 25% The very high category has increased by 15%, the high is reduced by 11%, is being reduced by 1%, and the low

is reduced by 5%. From the table and graph above, it can be seen that the school in East Kutai, which was piloted by several students, experienced an increase in self-efficacy after using 3D animation interactive media with an increase of 32%.
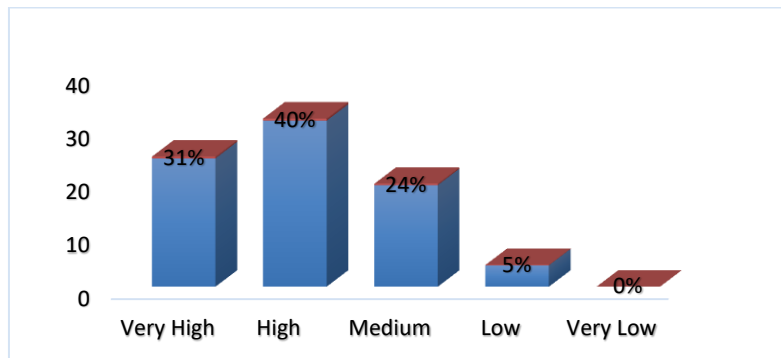

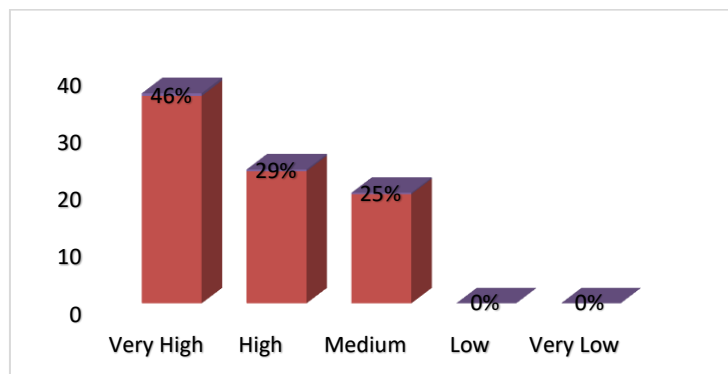**Figure 1:** Average Category of Self-Efficacy Level of Class X Students (Pre-test)

Figure 2: Average Category of Self-Efficacy Level of Class X Students (Post-test)

4. Discussion

Based on the results of the study, it is known that the development design is in accordance with the steps of the 4D model, this is evidenced by the creation of a medium that is in accordance with the design and can be applied well in schools. Animation media has been widely developed, what distinguishes this media from other media is the existence of 2D and 3D animations on virus materials and is equipped with a virtual laboratory. Usually the media is only 2D or 3D only but this media combines the two. So the development specification is on virus 3D animation and a virtual movable laboratory. This research is in line with the research carried out by Krisna (2021), namely the development of android-based interactive learning media using SAC for 2D and 3D animation subjects concluding that 2D and 3D animation interactive media are suitable and feasible to be applied as student learning media. The average validation results of material experts, media experts, and linguists are 85.60 which belong to the valid category so it can be concluded that this media is of good quality and is worthy of being developed and used in schools. This is in line with Syahroni's research [8] The results showed that the media developed was suitable and qualified to be used as a learning medium for 3D cartoons. The teacher's response commented that the 3D animation interactive learning media used is very interesting and

easy to use, students become more active and focused in studying the structure and shape of the virus displayed, so it is very effectively used in the learning process. Meanwhile, the student's response stated that learning using interactive media 3D animation is fun the learning process becomes exciting, not boring, and the use of media so that the lessons discussed are easier to remember as if seeing and practicing directly the virus material discussed. The analysis of average teacher responses based on statements in the questionnaire was very practical 96.67% and student responses averaged 82.85%. In line with the results of the development of Juanda [3] 3D media provides convenience for teachers in delivering material. The practicality of learning is one of the quality criteria in terms of research results. Based on the results of the N-Gain trials the small class of the experiential classmen and the control class sama-sama masuk dalam medium criteria but the experiential classmen mendapat the N-Gain value is higher which is 0.65 so that it is a significant increase. In large classes the average value of the N-Gain of the experimental class is 0.57 or 57% belonging to the category of moderately effective. In the control class, an average of 0.28 is included in the category of ineffective. Thus, it can be concluded that the use of 3D animation interactive media is quite effective for improving student cognitive learning outcomes because there is a significant increase of 57%. The level of self-efficacy in students varies in SMAN 1 Rantau Pulung SMAN 1, Sangatta Selatan, and SMAN 1 Sangatta Utara, thelevel of self-efficacy in students can increase because there is an aspect of the level of difficulty of alesson that is considered a task by students, where students must always do it. Aspec of this difficulty level is influenced by the medium used. Students who use 3D interactive media after the experiment tend to increase compared to students who do not use media in the research process, students consider the material discussed to be easier and more interesting. In accordance with the opinion of Bandura [4] which states that the magnitude aspect is the aspect that has the greatest influence on the self-efficacy variable compared to the other two aspects related to the degree of difficulty of individual tasks, the easier a material in the learning process, the higher its self-efficacy. So 3D animation interactive media as a medium that facilitates learning material in the aspect of magnitude has an influence in increasing self-efficacy. Schools in East Kutai that were piloted by students experienced an increase in self-efficacy by 32% after using interactive media 3D animation. In line with the concept of self-efficacy in the theory of hope related to motivation where a person will get high achievement if they see a high probability in their efforts will produce high achievements, high probability leads to profitable results and these results felt effective [1].

5. Conclusion

The design that has been developed is in the form of computer-based interactive learning media containing virus material for class X high school, 3D animated virus images, virtual laboratories, and evaluations. The 3d animation interactive learning media developed is in the valid category and has met the very feasible criteria with an average percentage of validators from media experts, material experts, and language experts, which is 85.60 Practical results by Biology teachers and students are an average of 89, 76%. The cognitive scores of students at SMAN 1 Rantau Pulung, SMAN 1 Sangatta Utara, and SMAN 1 Sangatta Selatan increased with an N-gain score of 0.57 and the T test results showed a significant difference between the pre-test and post-test scores. The level of student self-efficacy increased by 32% after using 3D animation media.

References

[1] Affandi, Usman Channy. Development of 3 (Three) Dimensional Interactive Animation Media as a Tool for Teaching Science Subjects Class VII Using the Blender Game Engine. 2015. *https://doi.org/10.1371/journal.pone.0155895.* [6 April 2021]

[2] Arikunto, Prosedur Penelitian Suatu Pendekatan Praktek. Jakarta . PT Rineka Cipta. 2006

[3] Juanda, nanda Development of interactive learning media application for 3D animation Solar system using augmented reality technology using android. 2018 Internet: *httpsjurnal.umj.ac.idinde x.phpsemnastekarticleview34392588.* [March 30, 2022]

[4] Nismalasari, Penerapan Pembelajaran Learning Cycle Terhadap Keterampilan Proses Sains dan Hasil Belajar Siswa pada Pokok Bahasan Getaran Harmonis." Jurnal EduSains. Vol 4 pp 83. 2016

[5] Ministry of Education and Culture. Curriculum Implementation Teacher Training Materials. Jakarta: Debdikbud. 2017

[6] Riskey O, Riantina F. A. The Effectiveness of Integrated Online Learning in the Era of Education 4.0. Didactic: Journal of Education and Science. Vol.20 No.2. 2020. *http://103.114.35.30/index.php/didaktis/ article/view/4763/2824.* [April. 6. 2021]

[7] G. Rosginasari "Pengembangan media pembelajaran Berbasis Audiovisual pada Pembelajaran Ekstraksi di SMKN 2 Indramayu. Internet: " http//respository.upi.edu//11647.Oct. 15. 2014 [Feb. 05. 2022]

[8] Syahroni. The development ofcomputer-based interactive media in mathematics learning, number material in grade 3 elementary schools. Formative journal 7 (3): 262-271,2017 ISSN: 2088-351x. 2017 *httpsjournal.lppmunindra.ac.idindex. phpFormatifarticlev iew22371697.* [Feb. 20. 2022]

[9] Tarigan, Darmawaty, dan Sahat Pengembangan Media Pembelajaran Interaktif Pada Pembelajaran Ekonomi. *Jurnal Teknologi Informasi & Komunikasi dalam Pendidikan, Vol. 2, No. 2, , p-ISSn: 2355-4983; e-ISSN: 2407-7488.* 2015.

[10] Thiagarajan, Sivasailam, dkk. (1974). Instructional Development for Training Teachers of Exceptional Children. Washinton DC: National Center for Improvement Educational System