Improving Understanding of Students Digestive Concepts with PALED 3D Learning Media

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Article Info

Abstract

The 3-dimensional LED board of the digestive system (PALED 3D-SD) is a learning media that was developed on the basis of analyzing the problems and needs of students. Based on the results of observations in the field, students still have difficulty in learning, especially in understanding the concept of the human digestive system material so that it has an impact on learning outcomes that are not optimal. This is due to the character of the material of the digestive system that cannot be sensed directly by the five senses of students. The learning media used so far have not optimally facilitated students' understanding of concepts. The availability of visual media (torso) of the human digestive system in schools has not been able to display a wide range of material, namely showing the flow of human digestive bioprocesses. This study aims to analyze the validity of the PALED 3D-SD media developed according to media experts and material experts, analyze the practicality of the media according to teachers and students, and analyze the effectiveness of the media in improving students' conceptual understanding through indicators of N-gain test results, class classical completeness, and average difference test. This research is a type of R&D (*research & development*) research using the ADDIE model through the *analysis, design, development, implementation*, and *evaluation*. The validity test of PALED 3D-SD media was obtained from the assessment of 2 media experts and 2 material experts. The practicality test of the media used samples from class XI MIPA 9 and teachers at SMA N 5 Semarang, while the media effectiveness test through a *quasi-experimental design* used samples from class XI MIPA 5 (control class) and XI MIPA 6 (experimental class) at SMA N 12 Semarang. The results of the media validity test show that the PALED 3D-SD media is very valid according to media experts and material experts. The results of the media practicality test show that the PALED 3D-SD media is considered very practical according to students and teachers. The results of the media effectiveness test show that PALED 3D-SD is effective in improving students' conceptual understanding based on the results of the N-gain test which is in the medium category, the results of classical class completeness are obtained by the percentage of completeness that has met the effective criteria and is higher than the control class, and the test results average difference statistic which shows that there is a difference in learning outcomes (concept understanding) between the group that learns to use PALED 3D-SD and the group that learns to use video. The conclusion based on this research is that the PALED 3D-SD media developed is valid, practical, and effective in improving students' conceptual understanding.

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INTRODUCTION

Science in the 21st century continues to change and develop along with technological advances. 21st century education reflects how a teacher as a facilitator is able to integrate and take advantage of technological advances into learning, one of which is through learning media. The use of appropriate media in the learning process is very important to help achieve the goals of learning and achieve optimal learning quality.

Referring to the 2013 curriculum, digestive system material or commonly called the human digestive system for class XI SMA consists of two basic competencies KD.3.7. and KD 4.7. In cognitive 3.7, namely analyzing the relationship between the structure of the organ-composing tissue in the digestive system in relation to nutrition, bioprocess, and functional disorders that can occur in the human digestive system requires students to play an active role in learning so that they are able to analyze, relate, and solve problems that arise related to the human digestive system.

Based on an interview with one of the teachers at SMA N 12 Semarang, information was obtained that students were still experiencing difficulties in learning the human digestive system material. The digestive system which is composed of many organs with their respective structures and functions makes it very difficult for students to find and understand broad material concepts. The use of media to support learning material on the human digestive system has not been optimized properly. The availability of visual aids in schools in the form of the torso of the human digestive system has not been optimally applied by teachers in classroom learning. This is because the media has not been able to optimally build students' interest and motivation in learning and has not been able to display broad material concepts such as helping to display the flow of the digestive process in the human body.

Learning so far still uses the lecture method assisted by illustrated PPT media and videos that have not been able to optimally facilitate students' discovery and understanding of concepts in material on the human digestive system which is quite broad and complex in scope. PPT media, images, and videos have not been able to visualize the digestive system in real terms so that it has not been optimal in facilitating students to find and understand knowledge concepts. The impact of these conditions is that students in the learning process only memorize and students are not active in learning. While the indicators that must be achieved by students in analyzing the structure of the tissues that make up the digestive organs and linking them with nutrition, bioprocess, and functional disorders really require an understanding of material concepts and more activeness from students. This condition has an unfavorable effect on competency achievement and has an impact on student learning outcomes where in the daily test of the human digestive system it is found that more than 50% of students in one class have not reached the specified KKM. Learning outcomes that are not yet optimal are due to the abstract concept of the human digestive system material so that it is difficult for students to understand, to better understand it, we need an appropriate media to facilitate students' understanding of concepts.

Understanding of important concepts is owned by students because it will have an impact on the ability to analyze and solve various types of problems properly. This is in line with research from Ridia & Afriansyah (2019) dan Lisnani & Pranoto (2020) that students' ability to find and understand good concepts will be able to improve other fundamental abilities such as communication, analysis, problem solving, and reasoning abilities.

Problems faced by students in understanding the material concept of the human digestive system can be overcome with a learning media. The media in question is 3D visual media because the media is able to depict material concepts in real terms such as being able to describe the shape and structure of the organs making up the digestive system as real as the original, being able to display the composition of the digestive system, and being able to display the digestive process so that students will better understand and it is hoped that later students' understanding of concepts will be better.

The choice of 3D visual aids as a tool for material on the human digestive system cannot be separated from the advantages of the product, namely that it can be sensed by students both through sight and touch.

According to Sarjana *et al.* (2020), students in the learning process not only hear, but see and experience for themselves what they are learning. These conditions require learning to be able to make more use of the sense of sight or direct observation and experience of students in the learning process. The use of visual media in learning will affect the development of student learning by providing real experiences to students (Sulaeman, Novianti Yusuf, et al., 2022).

The visual aids that are developed certainly need to be adjusted to the competency standards and basic competencies to be achieved. It is important to innovate in the media, one of which is through the addition of technology in an effort to increase effectiveness in conveying information and reach material more broadly. For example, by integrating LED lighting technology. The human digestive system is a unit of organs that are connected to each other to form a system and there is a process or mechanism that runs in it, this is what the usual visual media (torso) cannot describe. The use of LEDs in this display media is used to display the digestive bioprocess flow that occurs in the human body. In addition to facilitating the discovery of concepts and understanding of broad material, the development of digestive system visual media that is integrated with LED technology aims to create meaningful, active, creative, and fun learning so as to generate student motivation and interest in studying human digestive system material which leads to increasing learning achievement. According to Emda (2011), the use of attractive visual media in learning will affect students' interest and motivation in learning. Students will focus more attention on the topics studied if they use media, so that it will have an impact on increasing student learning outcomes.Based on the description above, it is necessary to develop PALED 3D-SD media as a valid and effective learning media in order to increase students' conceptual understanding of the material on the human digestive system in class XI senior high school.

RESEARCH METHOD

This research is a type of *Research and Development* (R&D) using the ADDIE development model. This model consists of 5 stages, namely: 1)***Analysis***, interviews with class XI high school biology teachers to analyze the problems and needs that underlie product development. Data were obtained through interview sheets and analyzed qualitatively. 2)***Design,*** planning to create a design or media framework to be developed. 3)***Development,*** manufacture of PALED-3D SD products. Products that have been made are validated by 2 media expert lecturers and 2 material expert lecturers to determine validity. The instrument used is the validity sheet by media and material experts. Validity data were analyzed using descriptive percentage statistics. If the percentage is $\geq 82\%$ then the PALED 3D-SD media can be said to be valid. Suggestions and input from media and material experts are used as material for revising the media. 4)***Implementation,*** the small-scale test phase of PALED 3D-SD to students of class XI MIPA 9 (32 students) and 4 high school biology teachers. This stage aims to determine the level of validity of the media. The instrument used is the media validation sheet by teachers and students. Data were analyzed using descriptive percentage statistics. If the percentage is $\geq 82\%$. then the PALED 3D-SD media can be said to be valid. Suggestions and input from students and teachers on the PALED 3D-SD media were used as material for revising the media.

Finally, 5) ***Evaluation,*** stage to measure the effectiveness or impact of media in learning. The effectiveness test was carried out with a research design *like an experiment*. Sampling technique is done by technique *simple random sampling*. Test the effectiveness using two classes. One class as the experimental group and one class as the control group. In the experimental class, digestive system learning was carried out using PALED 3D-SD media, while in the control class, learning was carried out using digestive system learning videos. Media effectiveness data was collected through test instruments in the form of questions *pretest* and *posttest* as many as 25 multiple choice questions integrated aspects of understanding the concept. Indicators of media effectiveness in this study were determined from the results of increasing N-gain, class classical completeness, and differences in average student learning outcomes.

RESULTS AND DISCUSSION

This development research produced a product in the form of PALED 3D-SD display media (Digestive System 3D LED Board). This media is a learning medium that is able to display a real picture of the organs that make up the human digestive system. The media is also able to display the flow of the digestive process that occurs in the body and its disturbances through a simulation of LED lights. PALED 3D-SD media display can be seen in Figure 1.
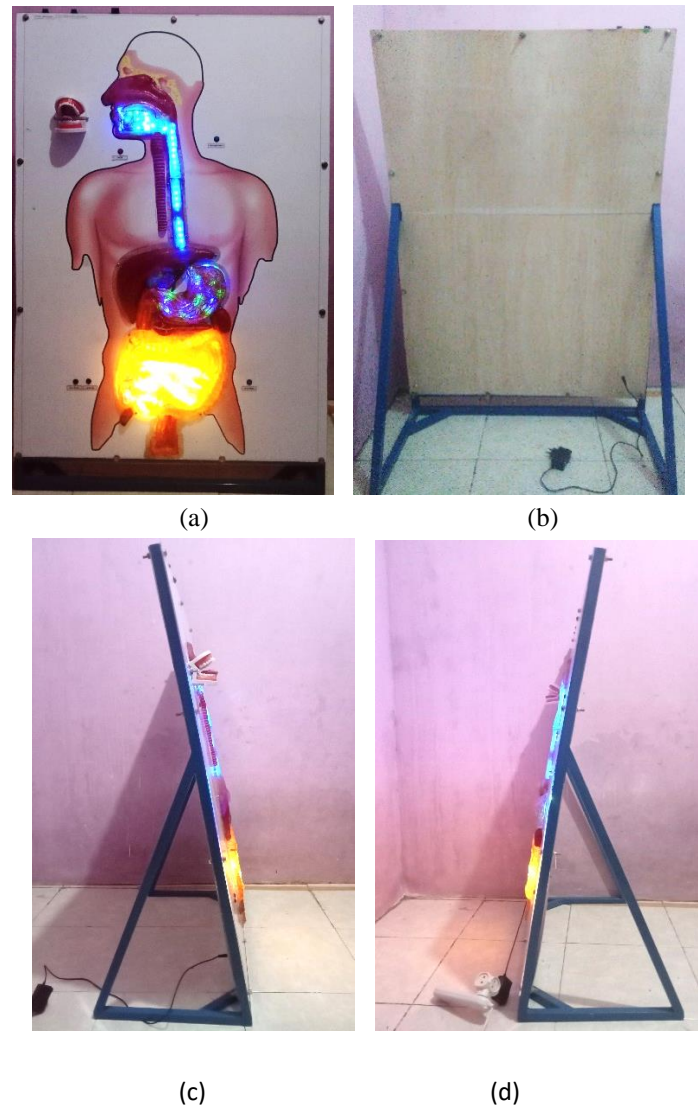

(a)   (b)

(c)   (d)

Figure 1. PALED 3D-SD Media Display a) Front View, b) Rear View, c) Right View, d) Left View

PALED 3D-SD media that has been developed is then tested for validity and revision before being applied to learning in schools. The validity test was carried out through a validity assessment sheet by media experts and material experts. The valid media then proceed to the practicality test and effectiveness testing stages through in-class learning activities using PALED 3D-SD media.

PALED 3D-SD Media Validity by Expert

PALED 3D-SD was validated by media design experts and material experts through media validity questionnaires to determine the level of validity of the media before it could be implemented in school learning. The PALED 3D-SD validity test includes several aspects, in terms of the media, namely: aspects of the shape and appearance of the media, media quality, and media functions. While testing the validity of the media in terms of material includes aspects of the relevance of the content to the material and aspects of the accuracy of the presentation of the material in the media. The results of the analysis of the validity test of the PALED 3D-SD media can be seen in Table 1.

Table 1. Media Validity Analysis Results

Media						Material					
Aspects	**A1**	**A2**	**X̄**	**%**	**Criteria**	**Aspects**	**A1**	**A2**	**X̄**	**%**	**Criteria**
Media Form and Appearance	16	15	15.5	96.88	Very Valid	Relevance of content to Material	22	18	20	83.33	Very Valid
Media Quality	27	25	26	92.86	Very Valid	Accuracy Material Presentation	14	12	13	81.25	Valid
Media Function	23	18	20.5	85.42	Very Valid						
Average Score				91.18	Very Valid	Average Score				82.5	Very Valid

Based on Table 1, it can be concluded that the PALED 3D-SD media is very valid according to media experts and material experts. Overall, the PALED 3-SD media has fulfilled all design aspects with a very valid category. Aspects of the form and appearance of the media get a very high percentage of validity compared to other aspects. This shows that the PALED 3D-SD media has a very attractive, simple shape and appearance, as well as the size and arrangement of the digestive organ systems that are proportional to the original. The appearance of a simple and attractive media will increase students' attention to the media (Nomleni et al., 2018). The aspect of media quality obtained a high percentage according to experts, indicating that the media is very good in terms of duration of use and safety of the type of material used. PALED 3D-SD media was developed using a resin base material to visualize organ shapes, this material is very safe to use and can last a relatively long time in use. The PALED 3D-SD media is also valid in terms of the availability of instructions for using the media, ease of use, ease of maintenance, suitability with the subject matter of the human digestive system, and has complied with the principles of learning innovation through the addition of LED lights. Instructions for using media are very important to make it easier for teachers or students to use learning media (Pramesty & Prabowo, 2013). The media care instructions contained in the user manual will also make it easier for users to maintain and repair media.

The assessment of the media function aspect is lower than other aspects but is still in the very valid category. Giving an assessment that is not maximal in this aspect is because the media needs to be tested first to find out more about its impact. However, from the expert assessment of these functional aspects, it can be seen that PALED 3D-SD has the potential to be used in mastering material concepts while training thinking, building an active and fun learning process, being able to explain material concepts properly and clearly, being able to visualize the digestive system in real terms, has the potential to increase student enthusiasm and motivation in the learning process, as well as being able to add to the richness of learning resources for students. The results of the 3D-SD PALED design validity assessment have shown very high criteria valid, but requires revision by researchers according to suggestions and input from media expert lecturers. It is necessary to make some improvements/revisions to the media to increase credibility (Nurdyansyah et al., 2021).

Based on Table 1, PALED 3D-SD is also said to be valid according to material experts. The percentage of all aspects of product assessment from material experts is said to be feasible if they obtain a percentage score of 80% (Anggraini, 2016). The aspect of content relevance to the material is included in the

very valid criteria. This shows that PALED 3D-SD has the potential to be effective in achieving KD.3.7 of the human digestive system, the media contains information about the material of the human digestive system and media according to the characteristics of the material that cannot be sensed directly by the five senses. Adjustment of the model or form of PALED 3D-SD media with the character of the digestive system material that is difficult to sense aims to describe the digestive system directly through 3D visualization so that it helps teachers convey content/information about the material. The model or form of media must be adapted to the objectives and learning materials to be achieved (Arifudin, 2021). PALED 3D-SD media is able to provide extensive and complete information related to material to support the achievement of KD 3.7, namely in displaying the structure and arrangement of digestive organs and the bioprocess of human digestion. The media is also able to provide a clear picture of the concept of organ structure and shape, organ function, and the concept of digestive bioprocess flow clearly through three-dimensional visualization that can be seen and touched.

The aspect of accuracy in presenting material in PALED 3D-SD obtains a percentage with valid criteria. There is a suitability of the media in displaying the concept with the existing material concept theory. PALED 3D-SD media presents material on the components of the digestive organs in full according to the material concept. These organs include: mouth, esophagus, ventricle, small intestine, large intestine, rectum, anus, liver, and pancreas gland. The media presents the shape and structure of the digestive organs and the arrangement/location of the organs correctly according to the material concept. Display the shape of the props by way of 3 dimensions that resemble the original besides being able to help students understand, can also attract their attention to actively observe (Nurindah et al., 2022). The media is able to display the order of the organs of the human digestive system according to the actual concept. The media is also able to display a simulated picture of the digestive bioprocess flow correctly according to the material concept through the display of LED lights that travel through the human digestive tract starting from the mouth organs to the anus. Accuracy or suitability of the contents in the media with the concept existing theory aims to avoid misconceptions about the material (Permadani et al., 2012).

Broadly speaking, PALED 3D-SD media is valid in terms of design and materials so that the media is feasible to be applied to learning in schools. Media validity or feasibility is the first step that determines the effectiveness of a media.

PALED 3D-SD Media Validity by Users

Display media that are valid and have been revised are then carried out small-scale trials on students and teachers to determine the practicality level of the media. Practicality indicators can be viewed from the aspects of content relevance, presentation of material, form and appearance of media, media quality, and media functions. These indicators were compiled by modifying the indicators of the practicality of learning media (Pramesty & Prabowo, 2013), namely in the form of ease of use, ease of maintenance, and media quality with various aspects of media attractiveness, media clarity in conveying information, simplicity, and size. The number of students used in the practicality test was one class (32 students) and biology teachers (4 teachers) at SMA N 5 Semarang. The results of the practicality test analysis of PALED 3D-SD media according to the teacher can be seen in Table 2.
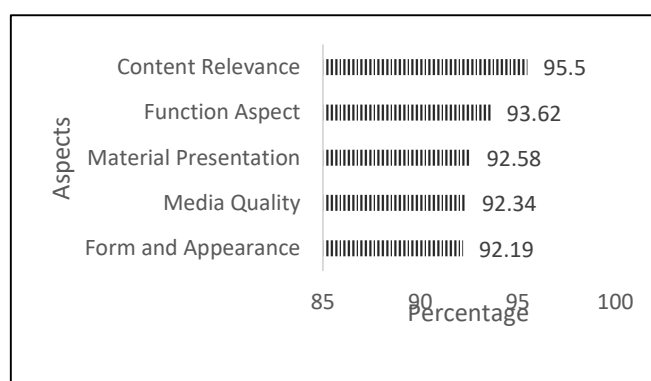
Table 2. Results of Media Practicality Analysis According to the Teacher

Aspects	G1	G2	G3	G4	X̄	%	Criteria
Form and Appearance	13	14	12	15	13.5	84.38	Very Practical
Media Quality	23	25	21	26	23.75	84.82	Very Practical
Media Function	21	24	18	24	21.75	90.63	Very Practical
Content Relevance	22	23	22	22	22.25	92.71	Very Practical
Material Accuracy	12	15	12	16	13.75	85.94	Very Practical
Average Score						**87.96**	Very Practical

Based on Table 2, it can be concluded that PALED 3D-SD is very valid according to the teacher. Overall, the PALED 3-SD media has fulfilled all practical aspects with a very valid category. The aspect of content relevance to the material gets the highest percentage score followed by the aspect of media function, the aspect of presenting the material in the media, the aspect of media quality, and the form and appearance of the media. In general, teachers gave a positive response to the PALED 3D-SD media that was developed from several aspects. Teacher's assessment of the media from the aspect of quality as well as aspects of form and appearance to be the lowest. These results can be seen in the items on the media care indicator and media size that get less than the maximum score. The low score on this item is because the teacher feels that the media is difficult to maintain. The teacher is of the opinion that although it is equipped with a manual for use and maintenance, the media uses technology related to electrical installations so it is complicated and requires special handling. The media is also too big in the teacher's view, this hinders the transfer and storage of media at school. However, after the researchers discussed further with the teacher regarding the size of the media, the consideration was that the media was made in a size that almost resembled the original size so that the media was able to clearly display the digestive system. Especially if it is applied to learning with a large number of students in the class, the media will still be visible to students who sit at the very back when the media display simulation takes place so that all students' senses can be reached.

Based on the teacher's assessment, PALED 3D-SD media can be said to be very valid. Some of the inputs submitted by the teacher for PALED 3D-SD media include: 1) The need to pay attention to the size and security of electronic-based media. 2) The use of media is carried out in an interesting way and connected to the reality that students encounter. 3) Make operating instructions in book form.

The results of the analysis of the validity test data of PALED 3D-SD media according to students can be seen in Figure 2.

Figure 2. Results of Media Practicality Analysis According to Students

Based on Figure 2, it can be concluded that PALED 3D-SD media is very valid according to students. The high percentage of scores is almost evenly distributed in all aspects. Overall, students' assessment of the items in several aspects showed positive results. In general, student responses to PALED 3D-SD showed that PALED media was simple and interesting. This simple media will make it easier for

students in the learning process using media simulations. This is in line with the opinion of Alali *et al.*(2018) that simple 3D teaching aids will help students to interpret and understand information in the learning process well.

Students think that PALED 3D-SD media is very interesting in terms of color and innovation in adding LED lights.The use of attractive display media colors will focus the attention of students (Nomleni et al., 2018). This opinion is in line with that expressed by Zubaidi & Lidyawati (2013) where the use of three-dimensional visual media with attractive colors has an impact on students in terms of being active and enthusiastic in paying attention to the material from the teacher. The teaching aids that use interesting innovations can have a positive influence on enthusiasm, activity, and student achievement(Sulaeman, Yusuf, et al., 2022). According to Dwipayanti *et al.*(2013), innovative visual media and in accordance with the character of the material will affect the effectiveness of student learning.

Media Effectiveness PALED 3D-SD

Students' understanding of concepts was measured using a test instrument. Test the effectiveness of using the experimental class (XI MIPA 6) which is applied PALED 3D-SD in learning while the control class (XI MIPA 5) uses video-assisted learning of the human digestive system. The achievement of the effectiveness of PALED 3D-SD is determined by 3 indicators, namely: the average N-gain value in the medium category, the percentage of classical completeness $\geq 60\%$, and the difference in average learning outcomes between groups using PALED 3D-SD and groups using videos.

Based on the N-gain analysis, the N-gain results for the group of students who studied using PALED 3D-SD were 0.35 (moderate category) better than the group of students who studied using videos of 0.06 (low category). The application of PALED 3D-SD in learning provides students with a better understanding of material concepts. PALED 3D-SD able to display the concrete form of the material presented. Props are able to provide a form of depiction of an object which includes characteristics, shape or appearance, and the mechanisms that occur in a material concretely (Saleh et al., 2015). PALED 3D-SD's ability to visualize digestive system material concretely is what will make it easier for students to find abstract material concepts (cannot be captured by the five senses directly) so they are easy to understand.

Students in learning to use PALED 3D-SD are given the concept in real terms and then given attention through an LED light that will support the concept or information stored in long-term memory so that when tested it will get good results. This is supported by information processing theory by Robert M.Gagne that incoming new concepts will be accepted *sensory memory* then when you get attention it will be processed in short term memory, and if it is repeated it will be stored in long term memory. This is in accordance with Kusaeri (2018) which states that with new concepts that are given attention and repeated, they will be processed and entered into students' long-term memory. Through the help of PALED 3D-SD, students can better understand the basic ideas or messages that underlie a concept and can integrate students' previous knowledge or concepts. This affected the level of students' understanding of concepts in the group that studied using PALED 3D-SD which increased significantly compared to the group that used video media of the human digestive system. This is in line with Dahniar *et al.*(2016) and Setyowati *et al.*(2016) research where 3D visual media in learning can improve understanding of material concepts and student learning outcomes more significantly.

The results of the classical mastery analysis between classes using PALED 3D-SD and those using video can be seen in Figure 3.
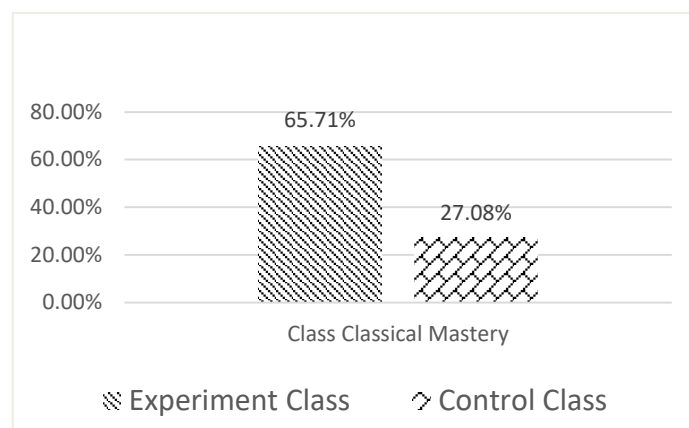
Figure 3. Comparison of Classical Completeness of Experimental and Control Classes

Based on Figure 3, it can be concluded that the classical completeness of the group of students who studied using PALED 3D-SD was higher than the group of students who studied using videos of the human digestive system. These results are strengthened by a statistical test of the average difference in which the Asymp.Sig value is obtained. < 0.05, namely 0.00 which indicates that there is a significant difference in learning outcomes between the two groups.

PALED 3D-SD media provides information effectively through the provision of learning experiences as conveyed by Edgar Dale in Dale's cone of experience. Visual media simulations provide 90% of concrete learning experiences while videos only provide 30%, so that the impact on classical completeness in the PALED 3D-SD class is higher than in the video class. PALED 3D-SD-based learning means that there is an optimization of the functions of all the students' five senses in an effort to increase the effectiveness of the learning process through sight, touch, and the use of logical and realistic thinking. The more senses used in the learning process, the greater the information obtained and understood. Widiyatmoko & Nurmasitah (2014) stated that the use teaching aids in learning can provide learning experiences for students so that learning will be more memorable and last longer in their memories.

Based on the results of the analysis of indicators of the effectiveness of increasing conceptual understanding through the N-gain test, classical completeness test, and the average difference test above, the PALED 3D-SD media can be declared effective in increasing students' conceptual understanding abilities.

CONCLUSION

Based on the results of this development research, it can be concluded that the 3D-SD PALED media meets the very valid criteria according to experts (media and materials), and users (teachers and students). PALED 3D-SD media is also effective in increasing students' understanding of concepts.

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