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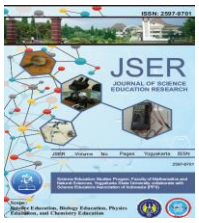

Development of Problems-Based Computer Assisted Instruction on Waste Material and Its Effect on Students Problem Solving Ability

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ABSTRACT

This study aimed to develop problems-based computer-assisted instruction in biology learning on waste material and its effectiveness on the ability of learners to solve the problem. This research was adapted from the model of development that includes ADDIE analyze, design, develop, implement, and evaluate. Test subjects in this study were the students of grade X at SMA Negeri 1 Magelang. Data were collected through questionnaires, observations, and test of problem-solving skills. The results showed that computer-assisted instruction effectively used to practice problem-solving. This was seen in the mode and the mean on experimental class higher than the control class. It was also seen at Anacova test followed by t-test at the 0.05 significance level result that media used in the experimental class were able to show better achievement than traditional learning in control class.

INTRODUCTION

Biology learning in secondary schools is a vehicle for students to learn about themselves and surroundings. In addition, biology learning emphasizes giving direct experience to develop competencies aiming the students can understand the natural phenomena and authentic problems of the environment. An authentic problem of the surrounding environment is waste. Waste is an interesting topic in biology learning in high school. This material discusses the problem of waste produced from factory activities, farm or agriculture, household, industrial, and other types of waste. The learning on the waste material can train students to develop their thinking skills at a higher level (higher order thinking skill). This is certainly in accordance with the competency standard 4, in the first semester of grade X high school, which analyzes the relationship between ecosystem components, material changes, and energy, as well as the role of humans in maintaining the balance of ecosystems. The basic competencies discussing waste are basic competencies 4.3; analyze the types of waste and waste recycling, and basic competencies 4.4; make waste recycling products (Ministry of National Education: 2006).

The operational verbs listed on the basic competencies are analyzing the cognitive abilities at the C4 level in the Bloom taxonomy which has been revised by Anderson & Krathwohl (2001: 79-84). The higher order thinking skill is more than just remembering and understanding. Thus, in studying the waste material needs to use innovative learning methods to train students' thinking skills. However, the preliminary studies through interviews indicated that educators tend to use learning methods that are not in accordance with the characteristics of the subject. Educators teach waste material by giving the task of summarizing the material to students without providing re-explanation due to limited time reason. Here, the competencies listed in the SK and KD is not achieved optimally.

One of the innovative learning methods and in accordance with the characteristics of waste material is problem-solving. Problem-solving is a process to find a combination of a number of rules that can be applied in an effort to solve a new situation. Problem-solving is not just a form of the ability to

apply rules but is a process to obtain a set of rules or strategies at a higher level (Made Wena, 2011: 52).

Problem-solving ability is the ability to make choices and solve various problems using logical reasoning (Muijs & Reynolds, 2008:186). Problem-solving is the ability to identify problems and find solutions which are accompanied by logical reasons (Brookhart, 2010; 98). Meanwhile, according to Gulo (2008: 113) problem solving is the process of thinking and finding a way out of a problem scientifically by using certain steps. Problem-solving is seen as a process to find a combination of a number of rules that can be applied in an effort to solve a new situation.

Problem-solving skills are very important for students and their future in facing real situations or real problems in life. Thus, to teach students the problem-solving skills need a series of strategies and learning programs in teaching and learning (Made Wena, 2011: 52-53).

The world of education always relates to the era of information and telecommunications. Technological advances have made it easier for humans to obtain, analyze and communicate information in more detail and faster than previous eras. The consequence, increasing the demands in the field of education in preparing students to have the ability at high-level skills that can make them better in analyzing, decisions making, and solve authentic problems around their environment which are increasingly going to be complex (Newby, et. al., 2000: 6).

Problem-solving learning can use computer technology as an innovation in the learning process. The use of computer technology in the learning process acts as a learning medium that helps educators in delivering learning material to students and facilitate the students to understand the material. Computer-based learning media is a new concept which recently has many types of design and implementation in the world of education (Dina Indriana, 2011: 107).

A type of computer-based learning media is Computer Assisted Instructions (CAI). Computer Assisted Instructions (CAI) is the use of computers as learning media where students interact with computers directly, students can access the programs presented in each segment, each segment contains subject material, and questions or problems require responses or answers to learners (Loca & Atkins, 1984: 249).

Computer Assisted Instructions (CAI) can also use collaboratively in the problem-solving process (Rusman, 2011: 240). Thus, Computer Assisted Instructions (CAI) not only makes the learning process more interactive but also can train and develop problem-solving ability.

Computer Assisted Instructions (CAI) contain authentic problems that are presented and designed with interesting concepts and displays accompanied by questions in each segment which lead students directly to the problem-solving process. So, CAI can help to develop the problems solving ability of students. In addition, the use of CAI can also help teachers in the lead the students in carrying out the phases of problem-solving learning to make the learning activities are more organized and effective. Thus, this adds the value in the use of computer-assisted on the biology learning process.

The importance of Problem-Based Computer Assisted Instructions (CAI) has not fully realized by the teachers. Based on the interview with biology teachers in grade X of SMA 1 Magelang, they still face the obstacle in implementing a problem-based learning model with computer assistance due to various reasons, such as the lack of understanding of educators on problem-based learning models and computer media use, limited preparation for teaching, limited on teaching hours and costs.

Based on the description, it needs to develop computer-assisted learning media in biology problem-based learning on the topic of waste and find out the effect on the problem-solving ability of the student. It hopes could help the students; especially grade X, to achieve competencies and learning objectives determined by the National Education Standards Agency (BSNP).

Problem formulations are: (1) How is the development of problem-based CAI on biology learning on waste topic?, (2) What type of CAI program will be developed in problem-based biology learning for waste topic?, (3) What is the technical use of computer-assisted media for problem-based biology learning at the level of the applied learning approach to the subject material of waste topic?, And (4) how are the results of the use of computer-based media on the problem solving ability of grade X students at SMA 1 Magelang in second semester II to solve problems on waste topics?

The developmental goals are: (1) to develop of problem-based CAI on biology learning on waste topic, (2) to know the type of CAI program in problem-based biology learning for waste topic, (3) to know the technical use of computer-assisted media for problem-based biology learning at the level of the applied learning approach to the subject material of waste topic, and (4) find out the results of the use of computer-based media on the problem solving ability of grade X students at SMA 1 Magelang in second semester II to solve problems on waste topics.

The product specifications in this research and development are (1) computer-assisted on biology learning media packaged into CDs (Compact disks)

using Adobe Flash Professional CS 4 program. This program uses to present the waste problems and steps to solve, as well as the learning materials. The presentation of videos and images accompanied by the animation on the media is expected to encourage students to solve problems. Then, it can develop students' ability to solve problems; (2) computer-assisted on biology learning media consists of the following components: (a) an introduction contains learning objectives and apperception, (b) core activities contain examples of problem solving and presentation of real cases on waste that demand solutions by students in groups, (c) a close contains questions on waste, and (d) other elements to attract students' attention in the learning process, such images, colors, videos, and animations.

The expected benefits of this research and development are (1) helping the students to understand the material and problems of waste on their surrounding environment; (2) train the students' problem-solving skills; (3) help the teacher in explaining the waste learning material; (4) motivating teachers to use innovative learning models that are not only oriented towards learning outcomes but also on students' high-level thinking abilities; and (5) motivating teachers to use computer media in schools.

In this study, computer-assisted learning media is defined as a learning media packaged into a Compact Disk (CD) which contains a Flash program on waste topic consisting the parts of opening, discussion activities, material presentation, and closing/evaluation. Problem-solving is learning methods consist of the stages of solving a problem systematically that can lead students in understanding and finding solutions to problems. So, students can improve their problem-solving ability. Waste material is the material listed in the basic competencies 4.3 and 4.4 which include the elaboration of types of waste, negative impacts of waste, waste management, and recycling of waste.

METHOD

Research Type

The research was research and development. This study developed computer-assisted learning media on problem-based biology learning models. The developed product is a computer-assisted learning media in a compact disk (CD) and operated through a computer. This media is certainly suitable for biology learning at senior high school level on the waste topic. This research was adapted from the model of development that includes the ADDIE model. The development stages are Analysis, design, development, implementation, and evaluation (Carr-Chellman, 2011: 3). The model of developing computer-assisted learning media for problem-based biology learning conducted until the development stage because the product was not disseminated to other schools other than the place of research, namely the SMA Negeri 1 Magelang.

Time and Place of the Research

The research conducted from February to June 2013 at UNY (Yogyakarta State University) and SMA N 1 Magelang.

Research Subject

Test subjects in this study were the students of grade X at SMA Negeri 1 Magelang. Test subject on limited trial was 30 students. And, test subject on field test was students of grade X6 at SMA N 5 Magelang.

Procedure

The research procedures were: analysis, design, and develop. (1) Analysis stage consists of literature studies, field studies, and instrument analysis; namely conducting a review of relevant literature. Literature studies was carried out by collecting and studying information on PBL models, computer-assisted learning media, problem-solving, and waste from various sources such as journals, research reports, and books. It conducted interviews with teachers and students of grade X in field studies. Interviews with the teacher of biology subject at grade X aimed to determine the feasibility of the problem-based learning model and media used for the learning, and the teacher efforts in developing thinking skills of students. Meanwhile, interviews with students aimed to find out the biological learning process experienced by students, as well as to find out the student’s interest in biology learning. Analysis of learning instrument used by teacher includes syllabus, lesson plans, learning media, and assessment, especially in KD 4.3 and 4.4, which aimed to find out the models and media used in the learning.

(2) Design stage begins with the design of computer-assisted learning media; the steps are: making outlines, flowcharts, and storyboards, scripts, considering the time to communicate the content/learning material, and making media specifications such as voice recordings, time, computer, programming, and budgeting.

(3) Develop stage; after the design stage, it continues to bring the design into a computer-assisted learning media. The steps are: (a) create a flowchart view; used as a media navigation of flow diagram, (b) create a storyboard; aims to make appropriate and interesting frames, (c) burning learning material into media programs of Compact Disks (CD), (d) validate products for material experts and learning experts, (e) product analysis and revision based on input and suggestions from

material and learning experts, (f) conducting peer reviews on 6 peers and 4 biology teacher, followed by product analysis and revision based on input and suggestions from peer reviews, and (g) test the product. Product testing aimed to collect data on the quality of computer-assisted learning media in problem-based biology learning from the aspects of the material, learning, and media display. The data is then analyzed and used to improve the developed product.

The product trial as media from the development stage carried out in two stages; limited and field trials. The limited trial aimed to determine the responses of students to problem-based computer-assisted learning media on waste. And, it continued to data analysis and product revisions. Meanwhile, field trial aimed to determine the effectiveness of the product and the responses of students to the media. The field trial used a quasi-experimental method with a nonequivalent control group design. This design used two classes; experimental class (using problem-based computer-assisted learning media) and control class (using a problem-based learning model without computer-assisted learning media). Two classes are considered as homogenous in all relevant aspects, but the only difference in treatment. The design of this study is presented in table 1 (Gall & Borg, 2003: 402):

Table 1
Nonequivalent control group design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_1	-	O_2

Where:
O_1 : Score of *Pre Test*
O_2 : Score of *Post Test*
X : Learning using computer-assisted problem-based learning media

Data, Instrument, and Data Collection Technique

The data consisted of qualitative and quantitative. Qualitative data is data from responses, inputs, and suggestions on the quality aspects of computer-assisted learning media in problem-based biology learning which obtained from the development of various sources such as material experts, media experts, teachers, peers, and students. Quantitative data is data on product assessment by the valuator (experts), data on the learning implementation from the observer, and data tests the ability of students to solve the problems. The instruments of data collection consisted of questionnaires, problem-solving ability tests, and observation sheets.

Data Analysis Techniques

a. The technique of analyzing questionnaire. Scores data of validator response in categories consist of three choice categories on the quality of learning media products; good (3), poor (2), and not (1). Meanwhile, responses from students on the quality of learning media consisted of two categories; good (1) and No (0).
b. The technique of data analyzing of observation sheet on the learning implementation by calculating the percentage.

Data analysis techniques on problem-solving ability begin with a normality test to find out the sample is normally distributed or not. After that, it continues to ANACOVA test and t-test by using the help of SPSS 16.0 program.

RESULT

A. Developing Result

1. Result of Material Expert Validation

Validation of learning media products by material experts aim to determine the feasibility of the products from the aspects of material quality. Material experts provide assessments, comments, and suggestions for learning media products from material aspects side on waste topics.

The score of validation by the material expert is 12, and on good categories (data is presented in appendix 14). Moreover, material experts evaluated the entire concepts on the waste topic on the summary page. The material is not systematic and tends to out of its guidance. So, the entire concepts in summary page are improved. Material improvements include the definition of waste, the distribution, and elaboration of the types of waste, waste management, the negative impact of waste toward the environment, and glossary. After improvements, the material in the media is presented systematically and clearly.

2. Validation Result of Learning Expert

Validation of learning media aims to determine the feasibility of the product from aspects of learning quality and media display. Learning experts provide assessments, inputs, and suggestions on the developed products on the aspect of learning and media display.

The score from learning expert is 33 from a maximum score of 36 for the learning aspect and 48 from a maximum score of 51 for the media display aspect. The scores are on good categories (data is presented in appendix 15). Meanwhile, the advice from an expert is:

a The title on the first page of media is placed separately with the body. The title on the first page does not unite. So, the expert gave the advice to unite the title with the body as a whole.

b The end of the program is on the left. The program cover or end of the program is on the left and not clearly visible. And, it must place and move to the right to be more clearly visible.

c The icon on the main menu is not suitable and less attractive in terms of color and shape. So, it needs to replace with an icon of leaves that could be more interesting and biologically nuanced.

d Question with problem-solving is presented with videos without text aiming to train the students to analyze real situations or problems occurring in the real field through the videos. Therefore, the problems are only presented in videos.

e The steps for problem-solving displayed on a single page with videos to facilitate the students to understand the process of problem-solving the problem.

f The layout on the page of group discussion activities can confuse the students. So, it must be made simpler.

3. Result of Peer Review and Biology Teacher

Products validation by peers and biology teacher aimed to improve the assessment of media quality on the aspects of the material, learning, and media display. There are 6 peers and 4 biology teacher at this stage.

The score of the peer and biology teacher for the material aspects are 11.5 from a maximum score of 12, for the learning aspect is 34.4 from a maximum score of 36 and for the aspect of media display is 48 from a maximum score of 51 (data is presented in appendix 16). Meanwhile, suggestions from peers and biology teacher toward the media are:

a. Icons need to add into the main menu page for the profile page and reference page.

b. Access to other menus is quite difficult. So, the menu on each slide needs to make scrolling.

c. Need to give an example of a summary page by providing pictures. Here, aiming to make the material can be clearly understood by students.

d. The videos and images need to add information and reference sources.

e. Television icons for videos must replace with more interesting.

f. Accompanying music sounds serene and makes sleepy. Music is given on the main menu page only as opening music but not for other pages.

g. Learning objectives should be on a sequence of numbers or letters.

h. The opening of the media must begin with an intro to creating better attract to students' attention.

i. Shorten the video of B3 waste on the summary page and use the important parts.

j. The next and back buttons should always live on each slide.

4. Result of Limited trial

Limited trials conducted after product revision based on suggestions or input from material experts, learning experts, peers, and biology teachers. Limited trials carried out in the multimedia room of SMAN 1 Magelang to 30 students as participants.

The student’s response to the quality of learning media products was collected using a questionnaire. The data from the questionnaire were student evaluations and responses to aspects of ease in media use.

The score of the students' responses to the quality of learning media is 6.1 from the maximum score 7. The score is on good categories (data is presented in appendix 17). The product revision after a limited trial is; the music opening on the main menu page is omitted because disturbs the concentration of students.

5. Result of Field Trial

Field trials conducted to students of SMA Negeri 1 Magelang on class X6 and X8. Class X6 plays an experimental class with 30 students and X8 plays as a control class with 27 students. Field trials aimed to determine the effectiveness of learning media. The subjects of the field trial were students of class X6 and X8 of SMA 1 Magelang. The data from the field trial consisted of observations on the implementation of problem-solving skills, the assessment of students on computer-assisted learning media, and the test results of problem-solving abilities (pretest and posttest) on experimental class and control class.

Before conducting a test for learning outcome both in experimental class and control class, the learning outcomes test is first empirically validated. Based on the result of item analysis of empirical validation, the results of in fit Mean Square (INFIT SQUARE) for the pretest questions were 1.05 for the estimate items and 0.88 for the case estimates. And, the results of the posttest question analysis obtained in fit Mean Square (INFIT SQUARE) were 1.01 (item estimates) and 0.94 (case estimates). These results showed that items or testimony/case/person are declared fit with the

model in the QUEST program. This finding is in line with the opinion of Bambang Subali & Pujiati Suyata (2012: 61), stated that in the QUEST program, it determined an item or test/case/ person is declared fit with the model with the MNSQ INFIT range from 0.77 to 1.30.

a. Descriptive Analysis

1) Result of Problem solving ability test

The posttest score of the experimental class was higher than the control class, seen from the comparison of the modes or values from the two classes. The comparison is presented in Table 2.

Table 2
Comparison of mode on posttest score of field trial

Interval of score	Experiment Class	Control Class
≤7	-	4
>7-8	6	**13**
>8-9	**18**	7
>9	6	3

Based on Table 2, the mode or score in the experimental class is at intervals > 8-9 which is 18 students. Meanwhile, the mode or score in the control class is at the interval > 7-8 which is 13 students.

In addition, the mean score of posttest in the experimental class was also higher than the control class. The comparison of the mean between the experimental and control class is presented in Table 3.

Table 3
Score Comparison of pretest and posttest

Component	Score of student (scale 0-10)			
	Control Class		Experiment Class	
	Pre-test	*Post test*	*Pre test*	*Post test*
Mean	2,8	7,8	3	8,5

Based on Table 3, in the control class, the mean of the pretest is 2.8 and the mean of the posttest is 7.8. Meanwhile, in the experimental class, the mean of the pretest is 3 and the mean of the posttest is 8.5. Based on the mean, both classes increased the problem-solving ability after the learning process.

2) Implementation of problem solving ability

Observations aimed to determine the implementation of the student activity in discussing problem-solving in groups. The student activities in solving problems in groups were observed by 1 observer due to maintaining the natural condition of learning activities.

Based on the observations, each group conducted a discussion of problem-solving. Almost all indicators of discussion activities for problem-solving are well conducted by each group. The results of the implementation group discussion activities in solving problems are presented in Table 4.

Table 4
Data of observation result on learning process

No.	Groups	Achieved of Descriptor (%)
1	Group 1	81,8
2	Group 2	72,7
3	Group 3	90,9
4	Group 4	90,9
5	Group 5	72,7
6	Group 6	90,9

(3) Evaluation of students on computer-assisted learning media. The score of students' responses to the quality of learning media was 5.8 from the maximum score 6. The score was in good category (data is presented in appendix 17). The inputs of students on learning media were; the material description on the summary page of the material needs to be simpler.

b. Hyphotesis Test

Covariance analysis (Anacova) was used in the hypothesis test. An analysis prerequisite test conducted before anacova test. Normality test and homogeneity test were used for analysis prerequisite test.

a. Covariance Analysis test (Anacova)

Covariance analysis (Anakova) conducted to compare the learning achievement between experimental class and control class.

Table 5
Anacova Test Result
Post test as dependent variable

Source	Df	F	Sig.
Corrected model	2	7,076	0,002
Intercept	1	622,170	0,000
Pretest	1	0,943	0,336
Class	1	11,935	0,001

Based on Table 7, the majority of students increased their score based on the significant role of the pre-treatment score on post-treatment ($F = 11.935$; $p < 0.05$). However, the pretest data is not significant in explaining the posttest indicated by $F = 0.943$; $p > 0.05$. Therefore, the posttest data must have t-test. Table 6 is the results of t-test analysis.

Table 6
T-test result for hypothesis

Component	t-test for Equality of Means		
	T	Df	Sig. (2-talled)
Equal variances assumed	3,636	55	0,01
equal variances not assumed	3,593	49,672	0,01

Based on Table 8, Sig. <0.05 means the learning media in the experimental class are able to show better achievement than the common learning strategy in the control class.

Thus, concluded that there is a significant difference between the score of problem-solving abilities of students using problem-based computer-assisted learning media as a result of the experiment class with students using problem-based learning models without using media (class control).

B. Discussion

The problem-based computer-assisted learning media is designed as teaching aids in the learning process, especially for problem-based learning (PBL) models in order to create effective learning and improve the students' problem-solving ability. Therefore, a field trial process carried out to determine the effectiveness compared to common learning. The results of field tests showed that CAI problem-based is effectively used in learning on the waste topic. The result is proven from the learning outcomes and the learning process.

Student learning outcomes in the experimental class are higher than the control class, seen from the modus or the most appearing scores obtained in each class. Modus in the experimental class found at intervals scores> 8-9; which are 18 people. Meanwhile, modus in the control class is at intervals score> 7-8; which is 13 people. In addition, the average score of posttest in the experimental class was higher than the control class. The average score of posttest in the experimental class was 8.5, and 7.8 in the control class.

Learning outcomes in the experimental class are higher than the control class because the use of CAI as a learning media in the experimental class provides advantages. The strengths are the program contains videos of real issues as well as images on waste; this clearly facilitates the students more easily analyze and solve the problems. In line with Dina Indriana (2011: 119) stated that interactive video tutorials are able to guide the students to understand a problem or material through visual aspects. Also, research by Srinivasan & Crooks (2005: 157) found out that the images on CAI have the power to stimulate and motivate learners in learning.

The advantages of the learning process using problem-based CAI also is in the steps of problem-solving. The problem-solving steps can guide students to identify problems, scientific facts, and analysis the situations. So, they can develop their thinking abilities, especially problem-solving abilities. Research by Chun Yen Chang (2002: 148) found out that problem-solving computer-assisted instruction (PSCAI) encourages students to have a better understanding of problems, identify scientific facts associated in problems, collect important data and information to elaborate solutions. Thus, through CAI, students not only acquire knowledge but also skills.

In addition, CAI might present various objects that are difficult to see and difficult to obtain in the learning environment; in this case, the objects are the situation of problems on waste in big cities. So, the students might have experience directly without having to leave the classroom. Thus, learning activities is more effective in terms of time and cost. Research by Jennifer (2006: 180) showed that CAI provides direct experience to students on events without having to bring students out of the class.

The excellences of the experimental class compared to the control class are also seen in the learning process, which is in the field trial process. During the learning process in the experimental class, problem-based computer-assisted learning media are proven able to train students in improving problem-solving ability. This fact is seen during the group discussion activities, students in each group seemed enthusiastic and tried to analyze the problems presented through CAI, then discuss to find a solution. Through discussion activities, students can express their opinions and exchange ideas with friends in groups. In line with Arief Sadiman et al. (2002: 187), stated that the advantage of using CAI learning media in groups is that student can discuss the material in a group.

As a product of development, CAI is used in the applied learning approach that places CAI as a learning media. Applied learning is pragmatic with the question "what can learners do?", so CAI is developed to present the problems on waste to sue the solution or solution offered by the students. In the learning process, the teacher prepares interesting and challenging learning activities for each student (Dettmer, 2006: 73).

The form of CAI is a problem solving that presents problems on waste. Problems presented on CAI are relevant to the learning objectives. Chee & Wong (2003: 145) stated that the problems

presented in CAI of problem-solving must be in accordance with the learning objectives. The media functions for learning purposes where the information or material presented must involve the students both in mind or mentally and in the form of tangible activities. Then, learning can occur and provide pleasant experiences, as well as meet the needs of individual students (Azhar Arsyad, 2005: 21).

Problem-based CAI encourages students to build their own knowledge. Students actively seek information and solve problems from their perspective. These activities facilitate students to construct their knowledge through meaningful learning (Chun Yen Chang, 2002: 148). The effectiveness of using problem-based CAI is determined by several factors, such as conformity with learning objectives, the suitability of student characteristics, conformity with the material, and compatibility with supporting facilities, environmental conditions, and time (Dina Inddriana, 2011: 28-29).

In this development research, the form of the developed learning media has been in accordance with the learning objectives. The learning objectives contained in the SK and KD are analyzing the types of waste and recycling waste. The analysis is one of the high-level thinking skills, so it takes the form of learning media that can train high-level thinking skills, for example, problem-solving. Therefore, the particular study chooses the problem solving as the form of media.

The developed product of CAI has also in accordance with the material. The material of teaching on waste is very relevant to current problems in the middle community. Therefore, at CAI, the waste topic is presented to the student, and they must solve it.

In addition, CAI in the form of audiovisual is in accordance with the characteristics of students. This result is proven with the increasing of learning outcomes.

Supporting facilities, environmental conditions, and time have also adjusted to the developed CAI. SMAN 1 Magelang has computer facilities equipped with handsets/earphones so that participants in the discussion between each group are not disturbed by the voices of other groups of media. The time allocation for media use has also been adjusted to the available time allocation on the learning plan implementation sheet.

Thus the problem-based computer-assisted learning media product in biology learning on waste is feasible to be used and disseminated to users.

CONCLUSION

Conclusions

Based on the results of research and development, concluded: (1) development carried out through three stages; analysis, design, and develop. The result of the analysis stage is the need for CAI which contains videos and issues of waste topics. Meanwhile, the results of the design stage are a storyboard, flowchart, and product on CD. The results of the development stage are a learning media in a CD that has been validated by material experts, learning experts, peers, biology teachers, limited trials, and field trials; (2) the form of CAI in the learning of biological waste material is problem-solving; (3) CAI in biology learning at the level of the applied learning approach is used as a learning media or learning process aids in group discussion activities, since the beginning of learning to group discussion activities; (4) The problem-solving ability on the experimental class are higher than the control class, seen from the comparison of modes and mean score between the experimental class and the control class. The experimental class mode is in the interval score > 8-9 while the control class> 7-8. And, the mean of the experimental class is 8.5 while the control class is 7.8. In addition, the anacova test and t-test at the 0.05 significance level obtained by the Sig. (2-tailed) <0.05; 0.01 <0.05. The result indicated that the learning media used in the experimental class are able to show better achievement than the common learning in the control class.

Suggestion

CDs of learning media developed only until the limited trial stage. Therefore, it needs to be revised and tested extensively through dissemination in order the product be used by teachers accompanied by instructions for use.

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