INTERACTIVE DIGITAL CONCEPT MAPS OF IMMUNE SYSTEM TO INCREASE STUDENT INTEREST AND CONCEPTS UNDERSTANDING

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Abstract

This development research aims to produce a biology learning media in the form of interactive digital concept maps based on Adobe Flash topic immune system, to find out the feasibility of the development results media, and to know relationship between learning media developed by the students interest and concepts understanding. The purpose of this research based on the observations result which show that the immune system is difficult topic to understand because it contains various mechanisms in the human body, likes phagocytosis and NK-Cell mechanism to destroying target cells, and it cannot be directly observed. In addition, the large number of scientific words that need to be understood and the limitations of the learning media used results in low student interest and concepts understanding. This development research refers to the 4-D Model developed by Thiagarajan, Semmel, & Semmel. The development procedure includes four stages, namely definition, design, development, and dissemination. Product trials developed used Alpha and Beta tests. Alpha test includes assessments by media experts, material experts, and biology teachers. Beta testing includes limited trials involving 15 students, and field trials involving 64 students. The data analysis technique used in the Alpha test and limited trials was descriptive statistics, while in the field trials using the t-test (SPSS version 21). The results of this research indicate that the interactive digital concept maps of the immune system are suitable for use as a learning resource and can increase students interest and concepts understanding.

Keywords*: concept map, digital interactive, immune system, interest, concepts understanding*

1. INTRODUCTION

The immune system is an example of a biological study that studies how the body defends itself from infectious pathogens such as viruses, bacteria, fungi, protozoa, and various other infectious agents, including toxins or toxins that can cause tissue damage, cause disease, and even cause death.

Based on the Annex to Permendiknas Number 69 of 2013 concerning the Basic Framework and Structure of the Senior High School / Madrasah Aliyah Curriculum, the immune system is one of the subjects in biology subjects studied at grade XI MIA semester 2, with the scope of material referring to basic competencies of 3.14, namely applying the understanding of the principles of the immune system to improve the quality of human life with immunity through immunization programs so that physiological processes can be maintained in the body.

The results of observations show that the immune system is the most difficult topic for students to understand in grade XI MIA because it includes bioprocesses or mechanisms that occur in the body, such as phagocytosis mechanisms and NK cells in destroying target cells that cannot be visualized directly in front of participants students. Furthermore, based on the results of interviews with class XII MIA students, information was obtained that the subject of the immune system is the most difficult subject to understand. Students complain of difficulties in learning the immune system because it contains a lot of memorization, scientific terms in Latin, and various complicated mechanisms that cannot be observed directly. In addition, the limited variety of learning media used causes students' low interest in learning in studying the immune system.

The broad material coverage on the subject of the immune system often makes it difficult for students to identify and understand important concepts. One way to solve this problem is to use a concept map.

The concept map is a form of brief presentation of several concepts, where there are conjunctions that act as a liaison between concepts to form a map of relationships that can make it easier for users to understand these concepts. The use of concept maps is highly recommended in learning activities because it can have various positive impacts. Concept maps can improve understanding and relationships of various concepts in the field of science education (Novak & Canas, 2008), increase the achievement of student learning outcomes and stimulate biology learning activities so that they become more meaningful (Chiou, 2008; Akay, Kaya, & Kilic, 2012; Sakiyo & Waziri, 2015).

A digital concept map is a form of presenting a concept map with the help of an electronic device or computer. Concept maps in digital format allow the addition of supporting components, such as images, sound, video, and animation, so that the concept map becomes rich in information and knowledge. The digital concept map acts as a technology that bridges the presentation of material, knowledge and information (Tergan, Keller, & Burkhard, 2006). The use of technology-based concept maps in science learning can lead to positive attitudes of students during learning activities (Hwang, Wu, & Kuo, 2013).

Interest in learning is one important factor that plays a role in supporting successful learning. Learning interest is a form of interest between students and certain objects or situations in learning activities. Interests can improve learning outcomes (Schraw, Flowerdy, & Lehman, 2001). In other words, students who have a high interest in learning in learning a learning material can also produce high learning outcomes compared to students who are not interested in the learning material.

One of the efforts to increase interest in learning is by presenting subject matter in the form of interactive learning media that provides opportunities for students to interact with these media. The use of interactive learning media requires electronic or computer devices to operate. The use of computer assisted learning media can increase student interest and achievement of learning outcomes (Jauhari, 2015; Chinna & Dada, 2013). In addition, the use of concept maps can also increase students' interest in learning (Chiou, 2008).

Ideal biology learning prioritizes the interaction between students and the object being studied. It is intended that students can observe directly and understand how the mechanisms and interactions that occur in the object being studied are. The learning process of students in the field of biology will be more successful if the objects studied are real objects that children encounter in life, especially the surrounding environment. (Suryadharma & Suyanto, 1993). However, the problem is that not all biological objects can be observed directly, especially with regard to bioprocesses that occur in the body, so they require special media to help visualize them, for example by using learning media equipped with animation and video.

Adobe Flash is a computer software that can be used to create animation. In addition to creating animation, Adobe Flash is also known to be able to combine several types of media elements, such as text, sound, images, animation and video to produce an interactive multimedia form, which allows users to interact directly (input device) with various media elements and control their use.

Based on the description above, the researcher intends to develop biology learning media for immune system material in the form of interactive digital concept maps. The concept map was chosen because it plays a role in building relationships between concepts so that they are easier to understand. The digital format was chosen because it allows the addition of supporting elements to the concept map, for example animation that can provide an overview or visualize various mechanisms that cannot be seen in real life. The interactive format was chosen to give students the opportunity to interact with digital concept maps, where students can freely choose which material to display first, and have the opportunity to repeat the material they want. Adobe Flash was chosen because it provides content that supports the creation and addition of components, such as video and animation. The use of interactive digital concept maps based on Adobe Flash is expected to increase interest in learning and conceptual

understanding of class XI MIA SMA students.

2. MATERIALS AND METHODS

Types of research

The type of research used in this research is research development or Research and Development (R&D). The development model refers to the 4-D model developed by Thiagarajan, Semmel, & Semmel (1974, p.5), which consists of four stages, namely define, design, develop, and disseminate.

Time and Place of Research

This research was conducted from March to June 2016. The research site is Class XI MIA SMA.

Research Target / Subject

The test subjects in this study were high school students in semester 2 of the 2015/2016 academic year, which consisted of 79 students of class XI MIA.

Procedure

This research and development procedure consists of four stages, namely define, design, develop, and disseminate.

The define stage is the initial stage in development research. The definition stage aims so that researchers can get an overview of the types of learning media to be developed. This definition stage consists of two steps of activity, namely the analysis of learning components and the characteristics of students.

The design stage is the second stage in development research. This stage consists of two activity steps, namely the preparation of the initial format for the development media and the test and non-test research instruments. The results of the design stage are prototypes or initial development media products that will be validated at a later stage.

The development stage (develop) is the third stage in this research. The steps of the activities carried out at this stage include validation of the prototype (initial product) by internal & external validators, limited trials (small groups), and field trials (large groups).

The dissemination stage is the final stage in this development research. At this stage the developer disseminates the final product of the development results through distribution in limited quantities to teachers and students to get responses and feedback on development media.

Data, Instruments, and Data Collection Techniques

Data collection techniques used in this development research can be seen in table 1.

Table 1. Data Collection Techniques and Instruments

No	Data Collection Technique	Data Collection Instruments
1	Interview	Teacher Interview Guidelines
		Student Interview Guidelines
2	Observation	Observation Sheet
3	Questionnaire	Needs Analysis Questionnaire Sheet
		Validation Questionnaire Sheet for Media Experts, Material Experts, Biology Teachers
		Student Response Questionnaire Sheet
		Learning Interest Questionnaire Sheet
4	Test	Items of Pretest and Posttest

The data collection technique used the interview method freely / unstructured, in

which the researcher was free to ask any questions related to biology learning in class XI. Interviews were conducted with biology subject teachers and students of class XII MIA using an interview sheet containing several specific points related to the things the researcher wanted to know.

The data collection technique used the observation method by observing biology learning activities in class XI MIA 3 for 3 meetings to observe the characteristics of students during biology learning activities. In addition, observations were also made on the completeness of the facilities provided by the school to support biology learning activities.

The needs analysis questionnaire is used as an initial reference in developing instructional media. This questionnaire sheet contains a number of statements related to biology learning activities.

The media validation questionnaire sheet aims to measure the quality of the development media. The material aspect validation questionnaire sheet aims to measure the validity of the material presented in the development media. The biology subject teacher assessment questionnaire sheet is in the form of an assessment questionnaire sheet which aims to determine the evaluation of the biology subject teacher for class XI MIA related to the learning media of development results. While the student assessment response questionnaire sheet is used to find out students' responses to the feasibility of development media. The fourth questionnaire uses a Likert scale with 4 alternative choices, namely Very Good (SB), Good (B), Less (K) and Very Less (SK).

The interest in learning questionnaire sheet is used to determine the interest in learning biology of control and treatment class students before and after using the media of development results. This study interest questionnaire uses a Likert scale with 4 alternative choices, namely Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS).

The technique of collecting data using the test method was carried out by providing pretest and posttest question sheets. Pretest questions are used to determine the initial ability of students before being given treatment. While the posttest questions are used to determine the final ability of students after learning activities are completed. The types of test questions used were short form (10 items) and T / S choice (10 items) with cognitive domains including memory (C1), comprehension (C2) and application (C3).

Teknik Analisis Data

Data yang diperoleh dari instrumen penelitian berupa data kuantitatif dan kualitatif. Data kuantitatif berupa skor penilaian dari lembar angket validasi oleh ahli media, ahli materi dan guru mata pelajaran biologi, angket respon peserta didik dan angket minat belajar peserta didik. Sedangkan data kualitatif berupa saran dan masukan dari validator dan peserta didik setelah menilai produk/media pengembangan.

Media Feasibility Data Analysis Techniques

The data analysis technique for the feasibility of developing media refers to the Mardapi assessment procedure (2008, p.123), with the following conditions:

- Obtaining quantitative data by changing the score data on the questionnaire into qualitative data with the guidelines in table 2.

Table 2. Guidelines for Assessment of Feasibility Questionnaire for Development Media

Assessment Criteria	**Score**
Very good	4
Good	3
Less	2
Very less	1

- Calculate the average score of the total filling out of the questionnaire sheet using the following formula:

$$\bar{X} = \frac{\sum X}{n}$$

Information:

$\bar{X}$ = Average score
$\sum X$ = Total score
N = Number of Appraisers

- Converting the average score into a qualitative value with the assessment criteria as listed in table 3.

Table 3. Conversion of the Ideal Assessment Score of Development Media Feasibility

Score Range	Score	Category
$x \geq \bar{x} + 1$ SBi	4	Very worthy
$\bar{x} + 1$ SBi $> x \geq \bar{x}$	3	Worthy
$\bar{x} > x \geq \bar{x} - 1$ SBi	2	Unworthy
$x < \bar{x} - 1$ SBi	1	Very Unworthy

Information:

X = Score obtained

$\bar{x}$ = Ideal average
= 1/2 (ideal maximum score + ideal minimum score)
1/2 (4 + 1) = 2,5

SBi = 1/5 (ideal maximum score - ideal minimum score)
1/5 (4 – 1) = 0,6

Learning Interest Data Analysis Techniques

The data analysis technique for students' interest in learning is carried out in the following steps:

- Obtaining quantitative data by changing the score data on the questionnaire into qualitative data using the guidelines in table 4.

Table 4. Learning Interest Questionnaire Assessment Guidelines

Assessment criteria	Score
Strongly agree	4
Agree	3
Disagree	2
Strongly Disagree	1

- Calculate the average score of the total filling out of the questionnaire sheet using the following formula:

$$\bar{X} = \frac{\sum X}{n}$$

Information:

$\bar{X}$ = Average score

$\sum X$ = Total score

N = Number of Appraisers

- Converting the average score into a qualitative value using the assessment criteria in table 5.

Table 5. Convert Learning Interest Score

Score Range	Score	Category
$x \geq \bar{x} + 1$ SBi	4	Very high
$\bar{x} + 1$ SBi $> x \geq \bar{x}$	3	High
$\bar{x} > x \geq \bar{x} - 1$ SBi	2	Low
$x < \bar{x} - 1$ SBi	1	Very low

Information:

X = Score obtained

$\bar{x}$ = Ideal average
= 1/2 (ideal maximum score + ideal minimum score)
1/2 (4 + 1) = 2,5

SBi = 1/5 (ideal maximum score - ideal minimum score)
1/5 (4 – 1) = 0,6

Analyzing data on the results of student interest in the control class and treatment with the t test (independent sample t-test) using the SPSS version 21 for windows program. The requirements that must be met before carrying out the t test include the normality test (Kolmogrov-Smirnof) and the homogeneity test (Levene's test). The data obtained can be said to be normally distributed if it has a probability value greater than 0.05 (p> 0.05) and the research sample is said to be homogeneous if it has a probability value greater than 0.05 (p> 0.05) at a significance level of 5%.

The hypothesis proposed in the t test is as follows:

Ho = There is no significant difference between the learning interests of students who take part in learning activities using development results media and those who do not use development learning media.

Ha = There is a significant difference between the learning interest of students who take part in learning activities using development results media and those who do not use development learning media.

The decision making criteria in the t test, namely:

(a) If the significance value> 0.05, then Ho is accepted
(b) If the significance value <0.05, then Ho is rejected

Concept Understanding Data Analysis Techniques

The data analysis technique for understanding students' conceptual understanding was carried out in the following steps:

- Tabulation of the pretest and posttest scores of each class, namely treatment and control, with the following scoring guidelines: True = score 1, False = score 0.
- Calculating the average pretest and posttest score of each class, namely treatment and control, using the following formula:

$$\bar{X} = \frac{\sum X}{n}$$

Information:

$\bar{X}$ = Average score
$\sum X$ = Total score
N = Number of Appraisers

- Conducting an effectiveness test based on the acquisition of the average pretest and posttest scores of the two classes.
- The effectiveness test on students' conceptual understanding was carried out by using the t test (independent sample t-test) using the SPSS version 21 for windows program. The data used in the effectiveness test is the gain value of the two classes. The standard gain calculation used refers to the Hake equation (Jauhari, 2015). The formula for determining the standard gain value is as follows:

Standard gain =
Posttest score - Pretest score
Maximum score - Minimum score

Index criteria <g> according to Hake (Jauhari, 2015) can be seen in table 6.

Table 6. Gain Index Criteria

Index <g>	Criteria
(<g>) > 0,70	High
0,30 < (<g>) < 0,70	Moderate
(<g>) ≤ 0,30	Low

The prerequisites that must be met before carrying out the t test include normality test (Kolmogrov-Smirnof) and homogeneity test (Levene's test). The data obtained can be said to be normally distributed if it has a probability value greater than 0.05 (p> 0.05) and the research sample is said to be homogeneous if it has a probability value greater than 0.05 (p> 0.05) at a significance level of 5%. The hypothesis proposed in the t test is as follows:

Ho = There is no significant difference between the conceptual understanding of students who take part in learning activities using development results media and those who do not use development results media.

Ha = There is a significant difference between the conceptual understanding of students who take part in learning activities using development results media and those that do not use development results media.

The decision making criteria in the t test, namely:

(a) If the significance value> 0.05, then Ho is accepted
(b) If the significance value <0.05, then Ho is rejected

3. RESULTS AND DISCUSSION

Product Development Results

The results of the analysis of the learning components show that biology learning for class XI MIA uses the 2013 curriculum. The syllabus and implementation plan for biology learning are well structured and complete and refer to the 2013 curriculum. The data from the interview results show that the material most difficult for students to understand is in biology learning activities. in class XI MIA is the material of the immune system, because it has a wide range of material and contains a variety of complex mechanisms that cannot be seen in real time. The available learning

resources are biology textbooks and biology student activity sheets (LKS) for class XI MIA. In terms of the availability of supporting facilities, it is known that all classrooms XI MIA are equipped with LCD / projectors, screens, audio devices, whiteboards, and cable rolls, so they can support biology learning activities when using computer-assisted learning media. Furthermore, the results of the analysis of the characteristics of students show that the learning interest of students in class XI MIA during biology learning activities tends to be low, which is indicated by many students who do not pay attention to the delivery of biology material both by the teacher and the material presenter group. Only a few students actively participate in these learning activities.

The results of the design stage are in the form of an initial development media design format and research instruments, as listed in Table 1.

The result of the development stage is biology learning media, immune system material in the form of interactive digital concept maps based on Adobe Flash to increase interest in learning and conceptual understanding of students in class XI MIA SMA. The resulting media has several advantages, including the main page in the form of an interactive digital concept map that can be connected with material text and other supporting information, such as image, animation, and video content that can help students understand the mechanisms of the immune system.

In addition to providing interactive digital concept maps, some of the advantages possessed by the developed media include the material presented that has been adjusted to the level of development of students, uses language that is easy to understand, is equipped with evaluation questions, has a good combination of background colors, text, pictures, harmonious, and not too flashy, equipped with instructions for use, accompaniment music, as well as sound and screen size adjustment buttons.

Product Trial Results

The results of the product trial results of the development can be seen in table 7-12.

Table 7. Results of the Media Expert's Assessment

No	Indicator	Average Score of Acquisition	Category
1	Display quality	3.0	Worthy
2	Application selection	2.6	Worthy
3	Ease of operation	3.0	Worthy
4	Reliability	3.0	Worthy
Average total score		2.9	Worthy

Based on the data in the table 7, It is known that the average total score of the four assessment indicators is 2.9 (feasible category), which means that the quality of the learning media developed in terms of the results of the media expert's assessment is in the feasible category and is ready to be tested at a later stage.

Table 8. Result of Material Expert Assessment

No	Indicator	Average Score of Acquisition	Category
1	Kelayakan dan keakuratan materi	3.6	Very Worthy
2	Kebahasaan	3.0	Worthy
3	Penyajian materi	3.0	Worthy
4	Kesesuaian alat evaluasi	3.0	Worthy
Rerata skor total		3.1	Very Worthy

Based on the data in table 8, it can be seen that the total mean score of the four assessment indicators is 3.1 (very feasible category), meaning that the quality of the material presented in the learning media developed is in the very feasible category and is ready to be tested at a later stage.

Table 9. Subject Teacher Assessment Results

No	Question Points	Score		Average Score	Category
		Teacher I	Teacher II		
1	Display quality	3.8	3.3	3.6	Very Worthy
2	Application selection	3.3	3.6	3.5	Very Worthy
3	Ease of operation	3.5	3.5	3.5	Very Worthy
4	Reliability	3.0	3.0	3.0	Worthy
5	The feasibility and accuracy of the material	3.6	3.4	3.5	Very Worthy
6	Language	3.5	3.0	3.2	Very Worthy
7	Presentation of material	3.3	3.0	3.1	Very Worthy
8	Appropriateness of evaluation tools	3.0	3.0	3.0	Worthy
Rerata Skor Total				3.3	Very Worthy

Based on the data in table 9, it is known that the total mean score of the eight assessment indicators is 3.3 (very feasible category), meaning that the quality of the learning media developed is in the very feasible category in terms of the results of the biology subject teacher assessment and is ready to be tested at a later stage.

Table 10. Results of Student Response Assessment

No	Indicator	Average Score of Acquisition	Category
1	Display quality	3.2	Very Worthy
2	Application selection	2.3	Very Worthy
3	Ease of operation	3.3	Very Worthy
4	Reliability	3.2	Very Worthy
Average total score		3.2	Worthy

Based on the data in table 10, it is known that the mean total score of the five assessment indicators is 3.2 (very feasible category), meaning that the quality of the learning media developed is in the very feasible category in terms of the results of the assessment of student responses and is ready to be tested at a later stage.

Table 11. Concept Understanding t Test Results

	Description	Df	*Sig (2-tailed)*	Information
Gain score	*Equal variance assumed*	62	0.000	Significant
	Equal variance not assumed	57.832	0.000	Significant

The data in table 11 shows that the significance value (sig 2-tailed) is 0.000 (p <0.000), which means that there is a significant difference between the conceptual understanding of students who use developed learning media and those that do not use development learning media.

The increase in students' conceptual understanding was significantly increased while using biology learning media in the form of interactive digital concept maps based on Adobe Flash because the learning media provided opportunities for students to control the use of the concept map, select and repeat the desired material. The use of interactive digital concept maps can also make it easier for students to understand the concepts that are being studied, because it is equipped with elements of supporting media such as images, videos, and animations so that it can help students understand the mechanisms of the immune system. The results of this study are in accordance with the results of research by Udeani & Okafor (2012) which states that the use of concept maps in biology learning is effective in improving student learning outcomes. Concept maps can improve understanding and relationships of various concepts in the field of science education (Novak & Canas, 2008), increase the achievement of student learning outcomes and stimulate biology learning activities so that they become more meaningful (Chiou, 2008; Akay, Kaya, & Kilic, 2012; Sakiyo & Waziri, 2015). The use of digital concept maps is effective in improving the learning abilities of students (Anderson & Horney, 1997). The use of technology-based concept maps in science

learning can lead to positive attitudes of students during learning activities (Hwang, Wu, & Kuo, 2013). Flash-based learning media can improve students' conceptual understanding (Jauhari, 2015). The use of multimedia learning can facilitate the acquisition of information for students and train the ability to organize, synthesize, and evaluate learning messages (Mawarni, 2016, pp.53-54) and improve the academic abilities of students (Ilhan & Oruc, 2016).

Table 12. Learning Interest t Test Results

	Description	**Df**	***Sig (2-tailed)***	**Information**
After learning	*Equal variance assumed*	62	0.000	Significant
	Equal variance not assumed	56.127	0.000	Significant

The data in table 12 shows that the significance value (sig 2-tailed) of students' interest in learning is 0.000 (p <0.000), which means that there is a significant difference between the learning interests of students who use the media of development results and those who do not use the learning media of development results.

The increase in students' interest in learning significantly while using biology learning media, immune system material in the form of interactive digital concept maps based on Adobe Flash, is because the learning media can provide opportunities for students to control the use of concept maps, select and repeat the desired material, in other words students can freely interact with the digital concept map. In addition, an interactive digital concept map is presented with an attractive color composition and is equipped with media elements such as back sound, pictures, videos, and animations so that it can attract students' interest in studying immune system material. The results of this study are also in accordance with the results of previous studies, namely Chiou (2008), Akay, Kaya, & Kilic (2012), Sakiyo & Waziri (2015), which states that concept maps can increase interest and achievement of student learning outcomes and stimulate activity. learning biology so that it becomes more meaningful. The use of technology-based concept maps in science learning can lead to positive attitudes of students during learning activities (Hwang, Wu, & Kuo, 2013). The use of Flash-based learning media can increase students' interest in learning (Jauhari, 2015).

4. CONCLUSION

Biology learning media, immune system material in the form of interactive digital concept maps based on Adobe Flash, is in the appropriate category to be used as a learning resource for biology in class XI MIA SMA. Biology learning media, immune system material in the form of interactive digital concept maps based on Adobe Flash, can increase learning interest and conceptual understanding of class XI MIA SMA students..

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