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The Effectiveness of Web-based Comic Media to Train Creative Thinking Skills in Learning Immune System Materials	
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Article Info	Abstract
Article History: <i>Received : June 2023</i> <i>Accepted : June 2023</i> <i>Published : November 2023</i> Keywords: <i>Web-based comic media, Immune system, Creative thinking</i>	<p>The purpose of this study is to determine the effectiveness of web-based immune system comic media that has been previously developed through a development research process. This research is a pre-experimental study with typesone group pretest-posttest design. The sample of this research was students of class XI MIPA 1, XI MIPA 5, and XI MIPA 6 in one of the high schools in Purworejo. The sampling technique that was adopted in this research was cluster random sampling, involving 107 students as the total sample. In this study the learning process of the immune system material held by using web-based immune system comic media. The research data is in the form of students' creative thinking skills, types of activities in comics and their benefits for practicing creative thinking skills, and data on the implementation of teaching and learning processes. The data collection method was carried out by giving students formative tests (comic gap questions and description questions), observation sheets, and student response questionnaires. Descriptive qualitative method was used to analyze to obtained data. The research results show that creative thinking skills (could be known from the N-gain score). Student those who achieved moderate and high N-gain categories were 83% and 14% respectively (3% of students achieved low N-gain categories). The classical completeness level is 87.8%. This shows > 75% of students have achieved KKM (with good category). Based on the results of observing the learning process using comics, the information showed that the learning process that was carried out was useful to train creative thinking skills on students and the teaching and learning process can be carried out according to the RPP. The conclusion of this research is that web-based immune system comic media is effective for training students' creative thinking skills.</p>
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INTRODUCTION

Biology is one of the subjects in the field of science whose material is so complex and contains foreign terms that make students bored and have difficulty in understanding the materials (Hidayat *et al.*, 2019). Biology material in class XI even semester discusses a lot about human body systems and their physiological processes. One of the materials in Biology class XI even semester is the immune system material.

Based on interviews conducted with a biology teacher at a high school in Purworejo, this immune system material was included in the final chapter in the even semester so that it became an obstacle because the time for teaching and learning activities was cut short for the final semester exams preparation. Therefore we need a media that can help teachers overcome time constraints. Apart from that, the material for the immune system is one of the materials that is quite difficult because the process occurs in the body so that the work of the immune system cannot be seen directly by the eye. To make it easier for students to understand immune system material, aids are needed in the form of visual aids or learning media that are able to assist students in visualizing this fairly abstract material so that it can become concrete.

As a solution to these constraints, the researchers created a medium in the form of webbased immune system comic media. Making web-based immune system comic media is expected to help overcome limited time constraints. In addition, the media is expected to help students think creatively in constructing abstract and conceptual immune system material. Creative thinking according to Ernawati *et al.*(2019) is an activity to build new ideas that provide benefits in dealing with problems that occur. By increasing students' ability to think creatively, it is hoped that students will be assisted in understanding the material on the immune system.

The process of forming ideas from the results of creative thinking emphasizes fluency, flexibility, novelty, and details (Mahfud, 2017). This is in line with what Aryana (2007) said in Febriantiet al.(2016) which states that indicators of creative thinking are: a) fluency, namely being able to produce many ideas b) flexibility, namely being able to produce various ideas c) originality being able to produce new, original ideas d) detailing, the ability to develop or add ideas. Creative thinking can emerge and develop, it just depends on how students try to practice and the support of the people around them in developing these abilities. In this case, the teacher also plays a role in facilitating students to think creatively and increase their creativity. According to Arsyad (2004) in Nomarita (2015) stated that the media also contributes to support teaching and learning activities, which are needed as a facility to explore students' knowledge abilities. Good media will help and facilitate students in learning. Hence it can be said that creativity can be influenced by oneself, other people or the environment, as well as appropriate supporting media.

From the results of a questionnaire given to several students at one of the high schools in Purworejo, information was obtained that many students liked reading comics, one of which was comics on the webtoon portal. From some of the questions asked, students also agreed and supported if in learning the immune system material using comics as a learning medium. Comics can function as learning media. Novitasary (2014) states that comic storylines are easy to read and understand, so that some experts make it as a medium used for expedite the flow of communication in learning. Kurniawan (2017) stated that comics are a medium that is quite popular in Indonesia, according to his research comics can be used as a medium of speech to convey a story or information to readers. Regarding this, comics can also contribute as an alternative to student reading which can be used independently to increase understanding of the material. According to Pribadi (2011) in Novitasary (2014) comics have the advantage of making the information or material displayed very real so that students can be assisted in understanding. Based on this background, it is necessary to study the effectiveness of web-based immune system comic media developed to train students' creative thinking skills.

Based on this background, this research is conducted with the aim to determine the effectiveness of web-based immune system comic media that has been previously developed through a development research process.

RESEARCH METHODS

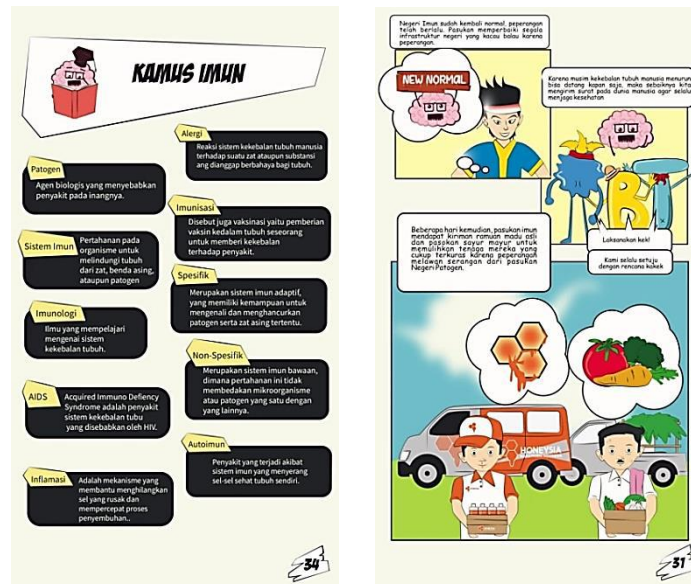
This research is a pre-experimental study with one group pretest-posttest design types. The research was carried out by applying biology learning material on the immune system using web-based immune

system comic media which had previously been developed by Aziz (not yet published). Web based immune system comic media are specially composed containing the prologue, episode 1 (2 series) and episode 2 (4 series), as well as an epilogue. Comics media are also equipped with a table of contents, bibliography additional information containing information regarding the specific and non-specific immune system in brief and also ways to increase the body's immunity, as well as a glossary containing a list of terms in comics and their more general meanings. The comic media consists of 38 pages accompanied by a package of comic gap questions and open questions to practice creative thinking skills. Comics are uploaded on the web with the domain address www.sistemimun-bioedu.my.id which students can then access online. Comics can be read online or offline, to be able to read offline students can download them from the web in pdf format.

The research was conducted in February 2021 in the 2021/2022 academic year at a public high school in Purworejo. Sampling was done by cluster random sampling technique, with a total sample of 107 students. Prior to conducting the effectiveness test research, web-based immune system comics that had been made had been developed and tested for feasibility through a development research process. From previous research, web-based immune system comic media has been declared valid by experts media, material experts, and high school biology teachers, and has been read by students. The following shows the menu display comic media on the web (Picture 1) and content snippets of web-based immune system comic media developed (Picture 2)



Picture 1. Comic media menu display on the web



Picture 2. Display of web-based immune system comic media content

The implementation of the teaching and learning process is done by giving assignments to students to read immune comics independently. Then students grouped and worked on assignments in the form of activities aimed at training students' creative thinking skills by utilizing the immune system comic media. These activities include group discussions and questions and answers based on student discussion sheets (LDS) by utilizing web-based immune system comic media.

The data collection is done by giving formative tests (comic gap questions and questions description) to the students. Formative tests are used to measure improvement of students' creative thinking skills. Observation sheets are used to observe the types of activities in comics and their benefits in training creative thinking skills and to observe data on the implementation of the teaching and learning process. The research data is in the form of data showing the level of students creative thinking skills, types of activities in comics and its benefits to train creative thinking skills performance and the data teaching and learning process. The data obtained were then analyzed descriptive qualitatively.

RESULTS AND DISCUSSION

In this section, the results of the research are presented in the form of: a) students' creative thinking skills, b) types of activities in comics and their benefits for training creative thinking skills, c) the implementation of the teaching and learning process. The following is a description of each of the results of the research data.

Students' Creative Thinking Skills

The improvement of students' creative thinking skills can be known by comparing students' score before using web-based immune system comic media (pretest) and after students using web-based immune system comic media (posttest). Measuring students' skills in creative thinking is done by giving evaluation questions in the form of formative tests (comic gap questions and essay questions).

After carrying out the pretest and posttest, the next step is to calculate the classical completeness and also the gain (gain) of students' creative thinking skills. The classical completeness of this study is defines as the learning outcomes achieved by all students while participating in learning using web-based immune system comic media. The results of the classical completeness percentage have been analyzed and obtained 87.8% with the number of students who have completed, namely 94 students > students who have not completed, namely 13 students. The results of the percentage of classical completeness of these students showed > 75% who had achieved a score of 70 (minimum completeness criteria) so that the results of classical completeness were in the good category. The higher number of students who complete than those who do not is the one of the indicators showing that the developed web-based immune system comic media is effective for training students' creative thinking skills.

N-gain is calculated using a certain formula by processing the results of the pretest and posttest score that has been previously enumerated. The N-gain percentage results obtained in this study were 97% with medium to high criteria (Archambault, 2008). This percentage shows an increase (gain) in creative thinking skills obtained by students which is very good and fulfills an effective indicator for improving students' creative thinking skills even though it is not perfect by obtaining an N-gain score of 100%. As the data presented in Table 1, students who get medium and high N-gains showed that these students are able to think more creatively so that they can understand the concept of material after using comic media. The percentage of students who get an N-gain of more than 0.3 is as much as 97%, so it can be said that the improvement in students' creative thinking skills is very good and web-based comic media is effective.

Table 1. Percentage of N-gain Test Results

Information	∑ Students	Percentage
Students with high N-gain score (N-gain > 0.7)	15	14%
Students with medium N-gain score ($0.3 \leq \text{N-gain} \leq 0.7$)	83	83%
Students with low N-gain score (N-gain < 0.3)	3	3%

According to Patmawati *et al.* (2019) every student has the ability to be creative with each of the characters they have. Riyadi *et al.* (2017) states that the ability to think creatively does not grow in a vacuum, that is, in other words, it requires the means to grow it. From the results of the study, comic media that has been created can be used as an effective means to grow and train students' creative thinking skills. Creative thinking is one of the 4 skills needed in the 21st century (ACTE&P21, 2013). The role of creative thinking skills, especially in this immune system material, is that it can help students visualize material so that they can better understand the immune system which is difficult because it is abstract. Creative thinking skills in students are also one of the most important things as a provision for students in the future where students who are trained to think creatively will be able to find solutions to various problems faced in life.


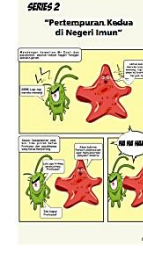

This study measures students' creative thinking skills by using questions in the form of comic gaps and open questions. The questions made are enough to measure students' creative thinking skills, however, they still need to be improved. It is expected that indicators of creative thinking can appear in each student, as a sign that these students are able to think creatively. The indicators of creative thinking in question are students who are able to produce many ideas or fluency, generate varied ideas or flexibility, generate original new ideas or originality, and able to develop and add ideas or elaboration (Febrianti *et al.*, 2016).

Based on the results of students' answers in working on the immune system material questions, indicators of creative thinking skills mastered by students are fluency, in this case students are able to smoothly provide various ideas in answering a problem properly and relevant to the question and are able to convey answers clearly. Then students are enough on the category originality or purity, flexibility, and elaboration or detailing. On the originality indicator, students have provided answers that are relevant to the question, not copy and paste from the internet, but the answers are still less varied from one student to another, tending to be similar or not new or unique. Meanwhile, for the flexibility indicator, many students gave answers that were less relevant, even when filling out comic questions, they still went back and forth between giving narration and filling in speech bubbles. For the elaboration indicator, students are sufficient in providing elaboration and detailing answers, but it needs to be improved to make it better. It can be concluded that students still need to be trained again so they can produce varied ideas, generate new original ideas and be able to add or develop and detail the ideas they have. The low achievement of students in several indicators is probably because students feel troubled and confused and need to get used to answering open ended questions and comic gap questions (Jumi, 2018). Therefore it is necessary to practice working on similar questions so that students can get used to it so as to better achieve all indicators of creative thinking skills. Based on the description above, it can be stated that web-based comic media is effective for improve creative thinking skills.

Types of Activities in Comics and Their Benefits for Practicing Creative Thinking Skills

Before the pretest and posttest were carried out to measure the increase in students' creative thinking abilities, students were given the task of carrying out activities aimed at training their creative thinking skills by utilizing the immune system's comic media, see Table 2.

Table 2. Activities to Train Creative Thinking Skills Based on Comics

Comic screenshot	Description of Student Activities
<p>Page 10 to page 26 (body's mechanism against pathogens)</p> 	<p>Students are in groups to play roles regarding the body's mechanisms against pathogens with their own design. For the mechanism students can choose to practice one of:</p> <ul style="list-style-type: none"> • Do roleplay regarding dust that enters the body • Do roleplay about malaria caused by <i>Plasmodium sp</i> and mechanisms of the immune response against <i>Plasmodium sp</i>. • Do roleplay of diarrheal diseases caused by bacteria <i>Eschericia colli</i> and mechanisms of the immune response against <i>Eschericia colli</i>. <p>Note: This learning activity can be done offline.</p>
<p>Pages 14 to 21 (malarial disease)</p> 	<p>Students answer questions from the teacher in the form of questions originating from immune system comics (episode 2 series 2 regarding malaria caused by <i>Plasmodium sp</i> and mechanisms of the immune response against <i>Plasmodium sp</i>).The question is as follows:</p> <ul style="list-style-type: none"> • What kind of pathogen that causes malaria? • How does <i>Plasmodium sp</i> cause malaria? • Explain the things that cause someone to be infected <i>Plasmodium sp</i>! • How can you prevent contracting malaria?
<p>Pages 22 to 26 (diarrheal diseases)</p> 	<ol style="list-style-type: none"> 1. Students read immune system comics episode 2 series 3 about diarrheal diseases caused by bacteria <i>Eschericia colli</i> and mechanisms of the immune response against <i>Eschericia colli</i>. 2. Students answer the following questions: <ul style="list-style-type: none"> • Explain the things that cause a person to be infected with bacteria that cause diarrhea! • How to prevent from getting diarrhea? 3. Students look for supporting answers that come from scientific articles/ journals and write down the bibliography of the articles/journals used as a reference.

Many of carried out activities train students to analyze and evaluate facts through literacy activities (reading and listening to videos), discussions, questions and answers, and presentations. This means that students are trained to think analytically which is a high-level thinking skill, a skill that is important for training students to understand information in depth, detail, and be able to connect between components (Astriani *et al.*,2017). This is of course in line with creative thinking skills which are also high-order thinking skills. Anuuru *et al.* (2017) stated that higher-level thinking is thinking that trains students' cognitive abilities at a higher level, that is, students can combine facts and ideas in the process of analyzing, evaluating to the stage of making, namely in the form of providing an assessment of a fact learned.

At the time of learning, students were given the task of discussing in groups and answering questions according to LDS related to comic content. According to Isnaeni *et al.*(2021) every activity carried out during the discussion process makes a positive contribution to a scientific attitude, which then encourages students to think analytically in solving a problem. According to Thaleb *et al.*,(2016) in Astriani *et al.*,(2017) analytical skills are abilities that are active when students are faced with unusual problems, uncertainties, questions or dilemmas. One important aspect of a job is knowing how to think analytically and use it to solve problems. Chidoz *et al.*,(2014) in Isnaeni *et al.*,(2020) practicing higher-order thinking skills for students can be done by exposing students to a problem that is not yet known, so that in this condition students are challenged to use their thinking skills to find a way out of the problem they are facing. By giving students various problems in the form of issues to be discussed, it can help trained students to think creatively. So, it is clear that this web-based immune system comic media is able to encourage students to do various activities that can train creative thinking skills.

Implementation of Teaching and Learning Process

In the teaching and learning process students carry out activities so that they are trained to think creatively according to the learning plan that has been prepared. Table 3 exhibits the performed data teaching

and learning process using the immune system comic media according to the RPP in designed learning activities to train students' creative thinking skills.

Table 3. PBM Implementation Data Using Immune System Comic Media

No	Learning Activities Based on RPP	Execution
1	Group discussions and questions and answers based on student discussion sheets (LDS) using web-based immune system comic media	Done. Students discussed with groups and conducted questions and answered based on student discussion sheets (LDS) by utilizing web-based immune system comic media
2	Students search for answers to several contextual questions based on the content of web-based immune system comic media. Students are directed so that the answers given are supported by scientific articles/journals and write a bibliography of articles/journals used as a reference.	Done. Students answered correctly and according to directions. Even so, there were some students who still used references from sources that were less valid (have not used references from scientific articles/journals)
3	Students form groups for the roleplay body's mechanism of resistance pathogen student's own design based on comic content. For the mechanism, students can choose to practice one of the following themes: dust entering the body, malaria caused by Plasmodium spand mechanisms of the immune response against Plasmodium spabout diarrheal disease caused by bacteria Eschericia coli and	Because learning activities must be carried out offline, it couldn't yet be done maximumly. Even so, as a substitute, in PBM, students in groups then choose one of the themes provided. Students carry out searching activities while listening to the videoroleplay related to the body's defense system from YouTube according to the theme of each group. Then discussed to analyze then the mechanism of the immune present it to other groups.

From the results of observations it can be seen that the design of learning activities to train creative thinking skills can be implemented, even though there are activities that are not optimal. Activities have not been carried out optimally because these learning activities must be carried out offline. It is planned that comics will be used as a reference for roleplay activities regarding the mechanism of the defense system in the human body against pathogens or foreign objects that enter the body. However, because the learning that is being carried out is still in the network (online) then the roleplay activities regarding immune system that was on comic media couldn't yet be carried out. The solution to this problem is that the use of comic media can still be used to train students' creative thinking skills, then a number of discussion and question and answer activities are added which can be seen in Table 3.

Based on the description above, it can be stated that the learning process using immune system web-based comic media are well implemented. When students learn to use comics, students can participate in any activity that can train creative thinking skills. Therefore, this activity can encourage students to think creatively.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the comic media system web-based immunity immune system material is effectively used as a tool to train creative thinking skills on immune system material.

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