Digital flipbook immunopedia (DFI): A learning media to improve conceptual of immune system

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Abstract. The research purpose is to analyze digital flipbook immunopedia (DFI) learning media implementation for immune system concept mastery improvement. The research method used quasi-experimental method with one group pretest-posttest design. The research carried out at SMAN 1 Cibinong, Indonesia in Grade XI of MIPA. Samples consisted of 62 students. Instruments used in the research were in the form of multiple-choice questions of 40 questions. The instrument grid refered to a revised Bloom’s Taxonomy levels with indicators of C1 to C6. The instruments were valid and had a significantly high reliability. The Wilcoxon test result of 0.000 indicated the effect of DFI on learning. Average total result of Normalized Gain was 0.81, which was high and the Effect Size test result was 2.37 indicating a strong effect. It proved that DFI could improve the immune system concept mastery. The immune system learning should utilize digital learning media, such as flipbook that could assist in the achievement of concept mastery.

Keywords: Conceptual mastery, DFI, effectiveness, immune system.

1. Introduction
Biology as one of branches in science contains structures, processes, and interactions of organism [1,2]. It comprises various contents from simple to abstract concepts [3,4]. Concept mastery of biology is a necessity in achieving the pre-determined learning objectives [5,6]. According to the 2013 Curriculum, students who learn biology are expected to be able to apply a concept resulted from the learning. Concept mastery influences by various factors, such as students’ interest to learn, learning activeness, and literacy skills [7,8]. Interest to learn contributes to learning success achievement. Students’ low interest to learn prompts them for not learning and in turn, it complicates them in mastering a concept [9]. Students’ learning activeness, such as activities of asking and observing contents affect concept mastery achieved [8,10]. The more of the five senses used in learning activities, the higher the concept mastery achievement obtained [3,11]. The five senses involvement in learning process could be activated by presenting an appropriate learning medium [12,13]. Students who learn biology are stated as mastering a concept if they are capable of re-elaborating information in their own sentences without changing the essence of the biology concept being studied [14]. In addition, they could name examples from the biology concept and apply the instruction of implementation in solving daily life-related problems [5,15,16].

Immune system as one of biology branches studies about a series of physiological mechanism in the body to protect the body from various foreign substances attack [17,18]. Immune system learning in Indonesia stated in the basic competence is intended for students to be able to apply the immune system
concept in daily life. The purpose of students to learn immune system is to increase their quality of life so that they could maintain their body endurance and become a healthy person [19–21]. Students are expected to have good immune system concept mastery that is required to achieve the goals. The concept mastery of biology is an ability to understand the essences and combine various concepts as well as apply them in daily life [22–24]. The immune system concept mastery is an ability in understanding, combining, and applying the immune system concept in life. In learning process at school, however, the immune system content includes in content with high incompleteness percentage [21]. It is due to a variety of factors, among others the content is an abstract content with extensive coverage [18,19]. The factors often trigger a misconception of immune system among students [25]. Selection of appropriate learning media has proven to have contribution to the enhancement of biology learning concept mastery achievement [3,26,27].

Biology learning media have a main function as a tool to assist teachers in organizing learning activities and improving students’ learning motivation [28]. They could clarify information provided and reduce verbalistic [12,29]. Moreover, they are not limited by one’s space, time and sensory power [30,31]. Learning media effectiveness also influences by teacher skill in apply them [32,33]. Learning media could help visualizing the abstract immune system concepts thus facilitate students in mastering the concepts [34,35]. One of learning media that has various features of image, animation, and video is flipbook [32,36,37].

Biology content learning using flipbook media is numerously developed and affects the learning process and outcome. One of the media is flipbook in bacteria content that produces media suitable for learning and is capable of improving students’ learning outcome [36]. Flipbook application in moss (bryophytes) sub-content could enhance students’ learning outcome [38]. Flipbook has been utilized in learning of anti-bacteria content of medicinal plants [39]. There are no studies, however, on flipbook effectiveness for immune system mastery. Digital Flipbook Immunopedia (DFI) is an electronic book in OPF flipbook format that contains immune system content in the form of components, mechanisms, abnormalities, and technologies on body immune system. DFI potential includes assisting in visualization and it is considered as appropriate and effective as a learning medium for the content. It is supported by various features of the flipbook such as images, animations, and videos. Therefore, the research aims to find out the DFI effectiveness in improving immune system concept mastery.

2. Method
2.1 Research Design
The research used a quasi experimental design with one group pretest-posttest design, namely experimental class as a self-control and observation on results (Table 1). The research independent variable was DFI learning media, whereas the dependent variable was immune system concept mastery.

| Group          | Pretest | Treatment | Posttest |
|----------------|---------|-----------|----------|
| Experimental class | O₁      | X         | O₂       |

Note: O₁: Pretest, X: DFI Learning Media, O₂: Posttest

2.2 Population and Sample
The research carried out in Grade XI of MIA of SMAN 1 Cibinong, Indonesia. The research population included all students of Grade XI of MIA that consisted of 7 classes. The research sample comprised two classes, Class XI MIA 2 and 3. The number of sample involved in the research was 62 students. Sampling was done using a random sampling technique.
2.3 Instrument
The research instruments used 32 items of multiple choice questions that had been validated of the 50 question items. The concept mastery instruments were utilized during pretest before learning and posttest after learning. The research instruments were based on revised Bloom’s taxonomy dimensions and immune system learning indicators. The instruments had met the valid criteria based on Pearson Product Moment formula and were reliable based on Cronbach’s Alpha formula. The instruments also had good discrimination. The instrument grid is summarized in Table 2.

| No | Indicators | Question No. | Total |
|----|------------|--------------|-------|
| 1. | Explain the basic concepts and components of the immune system (the immune system general concept and anatomy) | 1, 2*, 3, 4*, 5*, 6, 7*, 8*, 9, 10*, 11*, 12 | 12 |
| 2. | Describe the immune system mechanism stages (the immune system physiology) | 13, 14, 15, 16, 17*, 18*, 19*, 20*, 21*, 22*, 23, 24*, 25* | 13 |
| 3. | Analyze the immune system and its components (the immune system abnormalities) | 26, 27*, 28*, 29*, 30*, 31*, 32, 33, 34*, 35, 36*, 37*, 38*, 39*, 40* | 13 |
| 4. | Apply the immune system concepts in the surrounding life and developed technologies (the immune system technologies) | 41*, 42*, 43*, 44, 45*, 46, 47*, 48, 49*, 50 | 12 |

Table 2. Grid of Pretest and Posttest of Conceptual of Immune System

Note: * no of invalid question item

2.4 Data Analysis
Data of pretest and posttest results were grouped based on indicators of each topic and each cognitive domain, namely C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), C6 (create). The grouping aimed to identify the effect of DFI on concept mastery improvement. The research data analysis consisted of descriptive test of the immune system concept mastery data, analysis prerequisite tests, and hypothesis testing. The data descriptive test used average values, standard deviation, and percentage of improvement. The prerequisite test carried out on data collected using normality test (Kolmogorov-Smirnov test) and homogeneity test (Levene’s test) with p>0.05. The hypothesis testing used Wilcoxon Signed Rank Test to find out the effect of DFI on learning with significance level of 0.05. The effectiveness test used N-Gain test to identify the amount of DFI effect in improving the immune system concept mastery. The improvement was calculated using normalized gain (N) value using Hake’s formula (Meltzer, 2002) and the categories were as presented in Table 3.

$$n - gain = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

Table 3. Normalized Gain Score Categories

| Normalized Gain | Interpretation |
|-----------------|----------------|
| N≥ 0.70         | High           |
| 0.30< N< 0.70   | Medium         |
| N< 0.30         | Low            |
The effectiveness test also carried out using Effect Size test to find out the DFI effect level in learning (Cohen, et al., 2007). The Effect Size test used was One group with the following formula and the result criteria are described in Table 4.

\[
\text{Effect Size} = \frac{\text{posttest score} - \text{pretest score}}{\text{Standard Deviation}}
\]

Table 4. Effect Size One Group Score Criteria

| Size          | Interpretation |
|---------------|----------------|
| 0-0.20        | Weak effect    |
| 0.21-0.50     | Simple effect  |
| 0.51-1.00     | Medium effect  |
| >1.00         | Strong effect  |

3. Result and Discussion
The research aimed to analyze the effectiveness of DFI learning media for immune system concept mastery. The research pretest and posttest results are illustrated in Figure 1.

Based on Figure 1, it could be seen that the results indicated an improvement between pretest and posttest scores of 85.36%. It suggested that there was an improvement of the immune system concept mastery before and after learning using DFI. The research results also presented according to the immune system topics, namely: anatomy, physiology, immune system abnormalities, and immune system technologies. The calculation results of average score per immune system topic could be seen in Table 5.

Table 5. Average Score Results of Immune System

| Topic of Immune System | Pretest | Posttest | N-Gain | Category | Effect Size | Category |
|------------------------|---------|----------|--------|----------|-------------|----------|
|                        | Average | SD       | Average| SD       |             |          |
| Anatomy                | 58.75   | 19.55    | 95.39  | 8.09     | 0.89        | High     | 1.72     | Strong effect |
| Physiology             | 45.34   | 20.65    | 91.22  | 11.56    | 0.84        | High     | 1.88     | Strong effect |
| Topic of Immune System | Pretest Average | Pretest SD | Posttest Average | Posttest SD | N-Gain | Category | Effect Size | Category |
|------------------------|----------------|------------|-----------------|------------|--------|----------|------------|----------|
| Abnormalities          | 41.22          | 21.33      | 86.02           | 13.49      | 0.76   | High     | 1.79       | Strong effect |
| Technologies           | 56.45          | 19.43      | 96.08           | 7.39       | 0.91   | High     | 1.91       | Strong effect |
| Average                | 50.44          | 20.24      | 92.18           | 10.13      | 0.85   | High     | 1.83       | Strong effect |

Table 5 indicates that the average of each topic in the immune system content experienced an improvement. The average result of the N-Gain test in each topic was high, which was 0.85. The average result of the Effect Size test was 1.83 and it considered as strong effect. The average improvement of each immune system topic is depicted in Figure 2.

Figure 2. Graph of Average Improvement of Each Immune System Topic

Figure 2 implies that there was an improvement in the concept mastery for each immune system topic. The highest improvement average was in Immune System Abnormalities topic with a percentage of 108.74%. The DFI contains a feature that indicates several websites on immune system abnormalities as literacy for students. Good literacy could help improving students’ mastery of a topic (Windyariani, 2017). The results of average pretest and posttest scores of immune system concept mastery were grouped according to the cognitive domains, namely: C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (create). The grouping aimed to find out the effect of DFI on concept mastery improvement based on cognitive domains. The calculation of average pretest and posttest scores for each cognitive domain is indicated in Table 6.

Table 6. Calculation Results of Average Score for Each Cognitive Domain

| Dimension | Pretest Average | Pretest SD | Posttest Average | Posttest SD | N-Gain | Category | Effect Size | Category |
|-----------|----------------|------------|-----------------|------------|--------|----------|------------|----------|
| C1        | 58.46          | 24.77      | 92.33           | 12.47      | 0.81   | High     | 1.19       | Very Strong |
| C2        | 52.15          | 20.35      | 94.35           | 10.42      | 0.88   | High     | 1.84       | Very Strong |
The calculation results implied that there was an improvement between the average pretest score and posttest score. The average N-gain test result was considered as high with a score of 0.83. The Effect Size test results were also categorized as strong effect with a score of 1.52. The average improvement for each cognitive domain is displayed in Figure 3.

### Table 7. Results of Normality and Homogeneity Tests

| Type of Test        | Test Result | α    | Significance | Description   |
|---------------------|-------------|------|--------------|---------------|
| Normality Test      | Pretest     | 0.05 | 0.021        | Abnormal      |
|                     | Posttest    | 0.05 | 0.000        | Abnormal      |
| Homogeneity Test    | Concept mastery | 0.05 | 0.000        | Not homogeneous |
The normality and homogeneity test results are summarized in Table 7. The normality test results using Kolmogorov-Smirnov test in a significance level of 0.05 indicated that the data was abnormal in pretest and posttest data. The homogeneity test results using Levene’s test in a significance level of 0.05 suggested that the results were not homogeneous. Based on the results, hypothesis testing carried out using Wilcoxon Signed Rank Test. Summary of the hypothesis testing results is presented in Table 8.

Table 8. Overall Results of Immune System Concept Mastery

| Data          | Average | Wilcoxon Test (α = 0.05) | N-Gain Test | Effect Size Test |
|---------------|---------|--------------------------|-------------|------------------|
|               |         | Negative Rank Value | Ties Value | Positive Rank Value |               |
| Pretest (SD = 15.35) | 49.54   | 0                        | 0           | 62               | 0.81         | 2.37         |
| Posttest (SD = 7.32)  | 91.83   | (High)                   |             | (Strong effect)  |             |

Table 8 indicates that the Wilcoxon test result had a score of 0.000, which was smaller than the significance level of 0.05. It suggested that there was an effect of DFI utilization on immune system mastery. It was supported by the result of N-Gain test of 0.81 that was considered as high and the Effect Size test result of 2.37 or had a strong effect.

The DFI implementation aimed to find out the DFI effectiveness in the learning process. Learning using the DFI learning media was conducted in two classes of Grade XI of IPA with number of students of 69 students. Prior to the learning, students worked on the pretest of immune system concept mastery. Learning during the Covid-19 pandemic carried out in a long distance by referring to the syllabus and learning plan prepared. WhatsApp group was preferred since all students had the application. The application is easy to use that does not require strong internet network. Moreover, learning via WhatsApp group could facilitate discussion among students and between students and teachers. The learning process conducted in two sessions each for 45 minutes or one learning hour. The first and second session took place in different day.

In the first session, the learning used the DFI. Students were enthusiast with the media. It was indicated by numerous questions asked during discussion session. Questions could help students to better master the concept being studied [42–44]. There were obstacles during the discussion session as questions asked were incomparable to the students who answered the questions. Therefore, the first session in the learning took longer than it planned. It suggested the need for better planning for long distance learning. Good learning plan will facilitate the learning objective achievement process [45,46].

The second session of the learning was better than the first one due to limitation set in the number of question and answer during the discussion. Additionally, there were more students who had learned the DFI thoroughly. It indicated by questions asked that were not related to the basic concept of immune system contained in the Flipbook Imunopedia. Students’ questions tended to be related to various diseases or immune system abnormalities that did not explain in detail in the DFI. Once the learning completed, students worked on the immune system posttest. The pretest and posttest instruments consisted of 32 items of multiple choice questions that had passed the validity and reliability tests. Sample taken for the media effectiveness test consisted of 62 students. The pretest and posttest data collection carried out online through quizizz website. The quizizz was selected in the data collection as it is interested and fun for students [47–49]. Quizizz also has timer feature for each question thus it prevents cheating when working on the questions.

The results of average pretest and posttest of the sample were 49.54 and 91.83, respectively (Figure 1). Statistical processing using normality and homogeneity tests implied that data were abnormal and not homogeneous; thus, a non-parametric test carried out using Wilcoxon test. The Wilcoxon test suggested that the score of 62 samples tested experienced an improvement with a significance value of 0.000. It indicated that there was an effect of the DFI learning media on the learning process (Table 8).
The Normalized Gain test and Effect Size test aimed to identify the level of the DFI effect on the immune system concept mastery. The learning media were effective if once the implementation completed it could improve students’ concept mastery indicated by the results of N-gain score \([50]\). The Normalized Gain test result was 0.81, which was high, whereas the Effect Size test result was 2.37 or it categorized as a strong effect. The results indicated that the DFI resulted in high average difference and had a strong effect in improving the immune system concept mastery. It was in line with the strengths of flipbook that is equipped with various colors, images, and word forms that attracts students thus it helps to improve learning outcome \([32,36,37,51]\). Moreover, it various features trigger more than one of the five senses in the learning process; hence, greater concept mastery achieved \([3,26,28]\).

The pretest and posttest data of the immune system concept mastery also processed according to the average score of each content topic and cognitive domain of C1-C6. The average score of all immune system content topic showed an improvement. The highest improvement in the average score found in immune system abnormalities topic with a percentage of 108.74%. In terms of cognitive domains, the highest improvement found in C3 (apply) with average pretest of 47.58 and average posttest of 92.20. The result, however, different to the research results of \([52]\) that indicated the highest improvement in the cognitive domain of C1 (remember). It was due to the DFI features that include exercises and journal websites in addition to the images, audio, and video that trigger students to be capable of analyzing the link between concept and its implementation in life. The improvement in all cognitive domains suggested that the DFI learning media could help the mastery of immune system concept. Flipbook influences the improvement of students’ concept mastery \([53]\). In addition, other studies also proved that biology learning media had a significant effect in higher quality learning process \([43,54]\).

The developed DFI had weaknesses and strengths as learning media. Based on the media development and trial, the DFI weaknesses included it requires strong internet connection so that each feature could run optimally; the application has no license thus the DFI website must be updated continuously; and the watermark of the built-in application in the DFI display disturbs each flipbook page. The strength was related to various features such as images, audio, and videos that could visualize the abstract immune system concepts. The video feature of the media could be downloaded thus students could learn the video again without an internet connection. The media was also easy to operate and it could be used anytime and anywhere; thus, students could easily learn the immune system. The DFI was also very feasible to be used in the immune system learning. It was based on the assessment conversion from the series of development process and trial conducted. The strengths and weaknesses can be used as a reference for further research; hence, more quality flipbook learning media could be developed that could help the achievement of learning objectives.

4. Conclusion
The results of implementation as well as analysis tests indicated that the DFI learning media had effect on immune system learning. The DFI had high effectiveness and strong effect in improving students’ immune system concept mastery. It was indicated by the pretest and posttest results. The highest improvement percentage of the DFI learning media found in the C3 level and immune system abnormalities in human. The effectiveness test was expected to be carried out in more than two meetings to maximize various features of the DFI. Shorter meeting made the students were less optimum in exploring the DFI features.

References
[1] Zubaidah S, Fuad N M, Mahanal S and Suarsini E 2017 Improving creative thinking skills of students through Differentiated Science Inquiry integrated with mind map J. Turkish Sci. Educ. 14 77–91
[2] Djamahar R, Ristanto R H, Sartono N and Darmawan E 2020 Approaches to Respiratory and Excretion Systems Teaching: An Innovative Learning through Cirsa Univers. J. Educ. Res. 8 2204–10
[3] Rosamsi S, Miarsyah M and Ristanto R H 2019 Interactive multimedia effectiveness in improving
cell concept mastery \textit{J. Biol. Educ.} \textbf{8} 56–61

[4] Dewiayanti S and Kommers P 2005 Virtual reality for spatial topics in biology \textit{Int. J. Contin. Eng. Educ. Lifelong Learn.}

[5] Lancor R A 2014 Using student-generated analogies to investigate conceptions of energy: a multidisciplinary study \textit{Int. J. Sci. Educ.} \textbf{36} 1–23

[6] Lestari P, Ristanto R and Miarsyah M 2019 Analysis of conceptual understanding of botany and metacognitive skill in pre-service biology teacher in Jakarta, Indonesia \textit{J. Educ. Gift. Young Sci.} \textbf{7} 199–214

[7] Yangin S 2019 The effect of ethnobotanic activities on learning performance of pre-service teachers about plants’ classification \textit{Cypriot J. Educ. Sci.} \textbf{14} 401–21

[8] Casanoves M, Salvadó Z, González Á, Valls C and Novo M T 2017 Learning genetics through a scientific inquiry game \textit{J. Biol. Educ.} \textbf{51} 99–106

[9] Sapitri Y, Utami C and Mariyam M 2019 Analysis of conceptual understanding of botany and metacognitive skill in pre-service biology teacher in Jakarta, Indonesia \textit{J. Educ. Gift. Young Sci.} \textbf{7} 199–214

[10] Klymkowsky M W, Garvin-Doxas K and Zeilik M 2003 Bioliteracy and Teaching Efficacy: What Biologists Can Learn from Physicists \textit{Cell Biol. Educ.}

[11] Rusdi R, Evriyani D and Praharisih D K 2018 Pengaruh model pembelajaran peer instruction flip dan flipped classroom terhadap hasil belajar kognitif siswa pada materi sistem ekskresi \textit{Biosf. J. Pendidik. Biol.} \textbf{9} 15–9

[12] Qumillaila Q, Susanti B H and Zulfiani Z 2017 Pengembangan augmented reality versi android sebagai media pembelajaran sistem ekskresi manusia \textit{J. Cakrawala Pendidik.} \textbf{36} 57–69

[13] Jenkinson J and McGill G 2012 Visualizing protein interactions and dynamics: evolving a visual language for molecular animation \textit{CBE Life Sci. Educ.} \textbf{11} 103–10

[14] Ristanto R H, Zubaidah S, Amin M and Rohman F 2018 From a reader to a scientist: developing cirgi learning to empower scientific literacy and mastery of biology concept \textit{Biosf. J. Pendidik. Biol.} \textbf{11} 90–100

[15] Hadjichambis A C, Georgiou Y, Paraskeva-Hadjichambi D, Kyza E A and Mappouras D 2016 Investigating the effectiveness of an inquiry-based intervention on human reproduction in relation to students’ gender, prior knowledge and motivation for learning in biology \textit{J. Biol. Educ.} \textbf{50} 261–74

[16] Kurt H, Eklıçel G, Aksu Ö and Aktaş M 2013 The most important concept of transport and circulatory systems: Turkish biology student teachers’ cognitive structure \textit{Educ. Res. Rev.} \textbf{8} 1574–93

[17] Fink A L and Klein S L 2015 Sex and gender impact immune responses to vaccines among the elderly \textit{Physiology} \textbf{30} 408–16

[18] Sartono N, Rusdi R and Handayani R 2018 Pengaruh pembelajaran process oriented guided inquiry learning (pogil) dan discovery learning terhadap kemampuan berpikir analisis siswa sman 27 Jakarta pada materi sistem imun \textit{Biosf. J. Pendidik. Biol.} \textbf{10} 58–64

[19] Azka S H M, Indriyanti D R and Widiyantoro 2016 Keefektifan media pembelajaran “si imut” berbasis masalah materi sistem imun terhadap sikap paka dan peduli keselamatan diri dan lingkungan siswa \textit{J. Biol. Educ.} \textbf{5} 3–4

[20] Septiyana K, Prasetyo A P and Chrisjanti W 2013 Jurnal belajar sebagai strategi berpikir metakognitif pada pembelajaran sistem imunitas \textit{Unnes J. Biol. Educ.} \textbf{2} 1–9

[21] Puspita A, Kurniawan A D and Rahayu H M 2017 Pengembangan media pembelajaran booklet pada materi sistem imun terhadap hasil belajar siswa kelas XI sman 8 Pontianak \textit{J. Bioeducation} \textbf{4} 64–73

[22] Kristiani E, Ristanto R H and Lisanti E 2020 Exploring gender-based biological concepts: an analysis of bilingual secondary school students \textit{Biosf. J. Pendidik. Biol.} \textbf{13} 1–13

[23] Großmann N and Wilde M 2019 Experimentation in biology lessons: guided discovery through incremental scaffolds \textit{Int. J. Sci. Educ.} \textbf{41} 759–81
[24] Artun H and Özsevgeç T 2018 Influence of environmental education modular curriculum on academic achievement and conceptual understanding Int. Electron. J. Environ. Educ. 8 150–71

[25] Kholifah A N, Rinanto Y and Ramli M 2015 Kajian penerapan model guided discovery learning disertai concept map terhadap pemahaman konsep siswa sma kelas xi pada materi sistem imun Bio-Pedagogi 4 12–8

[26] Farisi M I 2016 Developing the 21st-Century Social Studies Skills Through Technology Integration Turkish Online J. Distance Educ. 17

[27] Miarsyah M, Ristanto R H, Nurhayati, Mufida S N, Suparini and Zharroh A E 2020 Development of adobe flash media integrated into HOTS on circulation system (AF-HOTS bicycle media) Int. J. Adv. Trends Comput. Sci. Eng. 9 896–903

[28] Ningsih L R, Rusdi R and Miarsyah M 2019 Exploring respiratory system to improve biological learning motivation: resysmart media application Biosf. J. Pendidik. Biol. 12 211–22

[29] Ristanto R H, Miarsyah M, Muhamromah D R, Astuti T A, Ainil S and Prihatin A I 2020 Light-board: Simple media to learn photosynthesis concepts Int. J. Adv. Trends Comput. Sci. Eng. 9 299–303

[30] Surahman E and Surjono H D 2017 Pengembangan adaptive mobile learning pada mata pelajaran biologi SMA sebagai upaya mendukung proses blended learning J. Inov. Teknol. Pendidik. 4 26–37

[31] Hidayati F and Pribadi T A 2014 Pengembangan Media Audio Characteristics of Organism Song Education (Chosen) Pada Pembelajaran Ipa Biologi Di Smplb-a (Tunanetra) J. Biol. Educ. 3 156–63

[32] Mulyadi D, Wahyuni S and Handayani R 2016 Pengembangan media flash Flipbook Untuk Meningkatkan Keterampilan Berfikir Kreatif Siswa Dalam Pembelajaran Ipa Di Smp J. Pembelajaran Fis. 4 296–301

[33] Lin C S and Wu R Y W 2016 Effects of web-based creative thinking teaching on students’ creativity and learning outcome Eurasia J. Math. Sci. Technol. Educ. 12 1675–84

[34] Nuridak A and Partaya 2019 The effectiveness of role playing method in learning immune system material on the creativity and learning outcomes of high school students J. Biol. Educ. 8 358–66

[35] Jirmi R and Goshen I 2011 Immune modulation of learning, memory, neural plasticity and neurogenesis Brain. Behav. Immun. 25 181–213

[36] Amiyanti R, Ningsih K and Yokhebed 2018 Pengaruh model kooperatif berbantuan media flipbook terhadap hasil belajar siswa kelas x SMAN 3 materi bakteri J. Pendidik. dan Pembelajaran Khatulistiwa 7 9

[37] Istitifar A M, Wijaya M and Nurmila N 2018 Pengaruh Multimedia Ncesoft Flipbook Maker Pada Materi Pembelajaran Pengendalian Gulma Terhadap Motivasi Dan Hasil Belajar Siswa Kelas X Atpb Smk Negeri I Bone-Bone J. Pendidik. Teknol. Pertan. 6 66

[38] Yunita A R, Ningsih K and Wahyuni E S 2009 Pengaruh model word square disertai media flipbook terhadap hasil belajar siswa pada submateri bryophyta SMA J. Pendidik. dan Pembelajaran Khatulistiwa 6 1–14

[39] Maf'ula A, Hastuti U S and Rohman F 2017 Pengembangan media flipbook pada materi daya antibakteria tanaman berksamtkat obat J. Teor. Penelitian, dan Pengemb. 2 1450–5

[40] Arifiadi N, Djudin T and Haratua 2013 Penggunaan Metode Demonstrasi Berbantuan Flip Chart untuk Meremediase Miskonsepsi Siswa tentang Getaran di SMP J. Pendidik. dan Pembelajaran 2 1–11

[41] Kohar S, Jatmiko B and Raharjo 2017 Pengembangan perangkat pembelajaran berbasis inkuiri terbimbing menggunakan simulasi pht untuk mereduksi miskonsepsi siswa Pendidik. Sains Pascasarj. Univ. Negeri Surabaya 6 1289–301

[42] Olander C 2013 Why am I learning evolution? pointers towards enacted scientific literacy J. Biol. Educ. 47 175–81
[43] Astuti L, Wihardi Y and Rochintaniawati D 2020 The development of web-based learning using interactive media for science learning on levers in human body topic J. Sci. Learn. 3 89–98
[44] Harahap L J, Ristanto R H and Komala R 2020 Getting critical thinking about ecosystem: How impact and responses of students about the CirGi learning model? Biosf. J. Pendidik. Biol. 13 86–100
[45] Djamahar R, Ristanto R H, Sartono N, Ichsan I Z and Muhlisin A 2018 Cirsa: designing instructional kits to empower 21st century skill Educ. Process Int. J. 7 200–8
[46] Bustami Y, Riyati Y and Julung H 2019 Think talk write with pictured cards on human digestive system: impact of critical thinking skills Biosf. J. Pendidik. Biol. 12 13–23
[47] Chaiyo Y and Nokham R 2017 The effect of Kahoot, Quizizz and Google Forms on the student’s perception in the classrooms response system 2nd Joint International Conference on Digital Arts, Media and Technology 2017: Digital Economy for Sustainable Growth, ICDAMT 2017 pp 178–82
[48] Orhan Göksün D and Gürsoy G 2019 Comparing success and engagement in gamified learning experiences via Kahoot and Quizizz Comput. Educ. 135 15–29
[49] Zhao F 2019 Using quizizz to integrate fun multiplayer activity in the accounting classroom Int. J. High. Educ. 8 37–43
[50] Azrai E P, Ristanto R H and Mulyaningsih 2020 Problem-based learning with concept map: is it effective to improve metacognitive skills? Int. Journal of Adv. Sci. Technol. 29 11047–61
[51] Diani R, Hartati N S and Email C A 2018 Flipbook berbasis literasi Islam: Pengembangan media pembelajaran fisika dengan 3D pageflip professional Flip. Berbas. literasi Islam Pengemb. media pembelajaran Fis. dengan 3D pageflip Prof. 4 234–44
[52] Susilawati S, Pramusinta P and Saptaningrum E 2020 Penguasaan konsep siswa melalui sumber belajar e-modul gerak lurus dengan software flipbook maker Unnes Phys. Educ. J. 9 36–43
[53] Darmawan M and Surya M 2017 Efektivitas pemanfaatan media buku digital dalam meningkatkan penguasaan konsep dan keterampilan berpikir kritis peserta didik melalui pembelajaran kontekstual J. Teknol. Pembelajaran 2 296–313
[54] Ristanto R H, Djamahar R, Heryanti E and Ichsan I Z 2020 Enhancing students’ biology-critical thinking skill through CIRC-Based scientific approach (Cirsa) Univers. J. Educ. Res. 8 1–8