Bio-repropedia website based on reading, mapping, and sharing (RMS): A way to improve biological literacy

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Abstract. This research aims to determine the effect of the Bio-Repropedia website based on reading, mind mapping, and sharing (RMS) learning model of reproductive system materials to improve student biological literacy. The method used is a quasi-experimental with one group pretest-posttest design. Sample of 61 students were taken random sampling from the class XI IPA SMAN 16 Jakarta, Indonesia student population. The instrument used is biological literacy oriented tests amounted to 30 items. Data were analyzed using descriptive methods, t test and normalized gain. The results showed an increase in biological literacy due to the application of the Bio-Repropedia website based RMS to reproductive system learning. The normalized gain score of 0.69 indicated that the Bio-Repropedia website is effective at improving biological literacy. The Bio-repropedia Website based on RMS is best at improving the multidimensional aspects of biological literacy and the concept of menstruation of the reproductive system.

Keywords: Literacy, media, reproductive system.

1. Introduction
Learning media utilization provides myriad positive impacts on classroom learning process, among others, it creates effective and efficient learning atmosphere [1–3]. Rapid technology development brings positive effect to the learning media development that offers technology alternatives or electronic as a learning medium [4,5]. E-learning (electronic learning) is one of technology implementation as a learning medium in information era [6,7]. Several researchers indicate that technology-based learning environment, such as website, gives positive influences in the form of student attraction to use it [7–9]. Learning using website media in e-learning activities is able to enhance students’ literacy [10].

Literacy is closely related to reading and writing activities in any contexts. Literacy skills could be implemented in various scientific aspects. One of them is science literacy that can be utilized in understanding and solving daily life problems [11,12]. One of science literacy branches is Biological literacy that could assist students in understanding content, especially Biology; for example, reproductive system content that is categorized as difficult content [13,14]. Some Biology contents, such as reproductive system is unlikely for direct learning as students have a hard time to understand it [15]. Reproductive system content is among difficult content as it contains abstract concepts and students are required to have sufficiently high concept understanding [16]. The abstract concepts could be resolved with good Biological literacy [12–19].

Indonesian reading performance, however, is still low. Indonesia is in the last rank of several countries in the world [20,21]. Students prefer to listen without active involvement during learning; hence, students haven’t been able to display their existence yet to think and find independently and
elaborate their understanding directly in class [22–24]. One of learning models that contains reading activity in its syntax is Reading-Mind mapping-Sharing (RMS) model [25–27]. The RMS model will be implemented in a website learning medium known as Bio-Repropedia. Bio-Repropedia is an RMS-based reproductive system content website. The utilization of a website-based reproductive system learning medium is one of e-learning implementation and it could be accessed with internet network [28,29].

Learning media utilization as a learning support is not new. As regards reproductive system content, it has been applied with a wide variety of media, such as interactive multimedia to enhance learning outcome and train critical thinking skills [30], Bio-Magz[31], learning modules [32], and interactive and character education-based multimedia [33]. The website learning media utilization, however, is a new thing in reproductive system learning.

The RMS model utilization could also enhance concept mapping skills [25]. Moreover, critical reading will establish a comprehensive understanding; thus it will store in the brain longer and not only memorizing facts [34,35]. Constructivist activities in the RMS model facilitate students in finding main concept in the content using understanding produced [36]. Based on the aforementioned studies, the research aims to find out the effectiveness of RMS-based Bio-Repropedia media against students’ Biological literacy in reproductive system content.

2. Method
2.1 Research Design
The research used a quasi-experimental method. The research design was a one group pretest-posttest design as presented in Table 1.

Table 1. One Group Pretest-Posttest Research Design

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

2.2 Population and Sample
The research population consisted of Grade XI of MIPA students of SMAN 16 Jakarta, Indonesia in even semester of 2019/2020 academic year. Sample was taken using random sampling method that resulted in 2 classes of Grade XI of MIPA. Both classes assigned as experimental class. Sampling included 61 students of 72 students using simple random sampling technique from calculation results using Slavin’s formula.

2.3 Instrument
Instruments used to measure students’ Biological literacy were multiple choice test of 30 questions and the score range used was 0 and 1. The instruments had been previously tested to 32 students. Validity using Pearson Product Moment indicated that the 30 question items were valid. Regarding the instrument reliability, it was calculated using Kuder Richardson 20 (KR-20) formula that indicated a reliability value of 0.86 or in high criteria. The instrument grid of Biological literacy could be seen in Table 2.

Table 2. Biological literacy Test Instrument Grid

| Indicators                                      | Dimension | No of question |
|------------------------------------------------|-----------|----------------|
| Compare male and female reproductive organs     | Nominal   | 2              |
| Explain the functions of male and female reproductive organs | Functional | 1              |
| Categorize male and female reproductive hormones | Functional | 1              |
| | Structural | 1              |
| Indicators                                                                 | Dimension | No of question |
|---------------------------------------------------------------------------|-----------|----------------|
| Compile gametogenesis process stages in male and female using mind map    | Multidimensional | 1               |
| Create a chart of woman menstrual cycle                                   | Structural | 2               |
| Conclude the fertilization processes, gestation, and labor                | Structural | 1               |
| Summarize examples of technology in reproductive system                   | Nominal   | 1               |
| Analyze the relationship of contraceptive methods and population and KB (family planning) programs | Functional | 1               |
| Analyze lactation factors                                                 | Functional | 1               |
| Analyze reproductive system abnormalities and disturbances                | Functional | 2               |

2.4 Procedure
The research comprised three stages, namely: preparation, implementation, and data processing. The preparation stage included a development stage of valid and reliable Biological literacy test instruments, preparation of learning plan, learning syllabus, and preparation of RMS-based Bio-Repropedia media and student worksheets via Google Classroom. Sample taken from the population of Grade XI of SMAN 16 Jakarta used Slovin’s formula.

The implementation stage started with pretest for students using Biological literacy instruments. The pretest aimed to measure the students’ prior Biological literacy in reproductive system as a comparison to the posttest results. Students’ learning using RMS-based Bio-Repropedia media was carried out online due to the pandemic situation during the research. The long-distance learning was assisted by Google Meet application as a face-to-face meeting platform between teachers and students. The learning carried out according to the RMS syntax that was integrated into the Bio-Repropedia media. The RMS learning stages are illustrated in Figure 1.
Figure 1 shows the three syntaxes in the RMS model, namely: reading, mind mapping, and sharing phases. In the reading phase students conducted critical reading activity on reproductive system content that had been integrated into the RMS-based Bio-Repropedia media. The critical reading activity was intended for students to learn the content main concept and form initial understanding [27,37]. In the mind mapping phase, students created a mind map in group based on information generated from the critical reading activity. In the sharing phase, students would perform a social interaction by presenting their group mind mapping results in front of the class. After the RMS-based Bio-Repropedia media learning, students were provided with Biological literacy posttest. The final stage of the research was data processing described in the data analysis section.

2.5 Data Analysis
Data analysis used in the research consisted of descriptive analysis technique that included the calculation of average score, maximum score, minimum score, and standard deviation for pretest as well as posttest scores. The pretest and posttest results were analyzed to identify the effectiveness of the RMS-based Bio-Repropedia media in the reproductive system content from various aspects, among others Biological literacy dimensions and question topics. Data obtained were analyzed using prerequisite tests that consisted of normality and homogeneity tests. The normality test results using Kolmogorov-Smirnov test and homogeneity test using F-test indicated that data were normally distributed and homogeneous. Summary of the normality and homogeneity tests is presented in Table 3. Additionally, normalized gain test carried out to find out the enhancement of students’ Biological literacy and hypothesis testing using statistical analysis of paired t test.

| Test results | Type of test      | α     | Sig.   | Test results | Description            |
|--------------|-------------------|-------|--------|--------------|------------------------|
| Pretest      | Normality test    | 0.05  | 0.20   | 0.20 > 0.05  | Normal                 |
|              | Homogeneity test  | 0.05  | 0.21   | 0.21 > 0.05  | Homogeneous            |
| Posttest     | Normality test    | 0.05  | 0.17   | 0.17 > 0.05  | Normal                 |
|              | Homogeneity test  | 0.05  | 0.21   | 0.21 > 0.05  | Homogeneous            |

3. Results and Discussion
3.1 Results
The results of students’ Biological literacy test in reproductive system content indicated a difference between pretest and posttest results. It was implied by the average score of the pretest and posttest. Summary of the descriptive test results is presented in Table 4 that includes the highest and lowest scores, standard deviation, and average score. The pretest average score obtained was 57, whereas the posttest average score was 86 with maximum score of 100.

| Data           | Pretest | Posttest |
|----------------|---------|----------|
| The lowest score | 40.00   | 73.00    |
| The highest score | 73.00   | 100.00   |
| Average score   | 57.00   | 86.00    |
| Standard deviation | 8.37    | 7.04     |

The improvement of Biological literacy skill could also be seen from the pretest and posttest results in each dimension as well as the percentage of the number of respondents in each dimension. Table 5 indicates the pretest and posttest scores based on Biological literacy dimensions.
Table 5. Descriptive Data of Pretest and Posttest Scores based on Dimension of Biological literacy

| Dimension       | Pretest |                |    | Posttest |                |    | Sig   | N-gain |
|-----------------|---------|----------------|----|----------|----------------|----|-------|--------|
|                 | N       | Mean           | SD | %        | Mean           | SD | %     |        |
| Nominal         | 61      | 71.00          | 16.00 | 47.00   | 61             | 84.00 | 13.00 | 2.00  | 0.00  | 0.53  |
| Functional      | 61      | 50.00          | 13.00 | 7.00    | 61             | 75.00 | 14.00 | 0.00  | 0.00  | 0.57  |
| Structural      | 61      | 64.00          | 17.00 | 36.00   | 61             | 88.00 | 11.00 | 28.00 | 0.00  | 0.77  |
| Multidimensional| 61      | 48.00          | 20.00 | 10.00   | 61             | 94.00 | 6.00  | 70.00 | 0.00  | 0.87  |
| Average         | 61      | 58.25          | 16.50 | 25.00   | 61             | 77.75 | 11.00 | 25.00 | 0.00  | 0.69  |

Table 5 suggests that the highest average of Biological literacy pretest found in nominal dimension with percentage of students who mastered the dimension of 47%, whereas the highest average of Biological literacy posttest was in multidimensional dimension. The multidimensional dimension had the highest percentage of students, which was 70%. It meant that there was an improvement in dominance from the pretest result, which was 60%. Based on Table 5, the improvement in Biological literacy score was significant in all dimensions. The results of normalized gain test implied that the highest score was in multidimensional dimension (N-gain = 0.87).

There were 6 reproductive system topics that were integrated into the RMS-based Bio-Repropedia media and the Biological literacy test instruments. The topics consisted of anatomy-physiology (R1), gametogenesis (R2), menstruation (R3), fertilization-lactation (R4), technology (R5), and reproductive system disturbance (R6). The improvement in the six topics was measured according to the Biological literacy pretest and posttest as illustrated in Figure 2.

Figure 2. Average Pretest and Posttest Scores based on Question Topics

The hypothesis testing carried out using statistical analysis of paired t test at $\alpha = 0.05$. The test conducted using SPSS version 24 application. According to the t test result as summarized in Table 6 $p$ value < $\alpha$, which was 0.00 < 0.05. It meant rejecting $H_0$ and there was a significant difference between pretest and posttest scores after the students learnt using RMS-based Bio-Repropedia.
Table 6. Summary of Hypothesis Testing Results

| Test Type       | alpha (α) | p-Value | Test Result | Description       |
|-----------------|-----------|---------|-------------|-------------------|
| Paired t test   | 0.05      | 0.00    | 0.00 < 0.05 | Rejecting H₀     |

The calculation of the normalized gain score carried out with the lowest score range of 40 in the pretest and the highest score range of 100 in the posttest. The calculation results are summarized in Table 7.

Table 7. Results of Normalized Gain Test

| N   | X̄ Pretest | X̄ Posttest | Normalized Gain | Category |
|-----|------------|-------------|-----------------|----------|
| 61  | 57         | 86          | 0.69            | Medium   |

The calculation results indicated a normalized gain score of 0.69 suggesting that there was an improvement in the posttest score against the pretest score.

3.2 Discussion

The research aimed to find out the effectiveness of Bio-Repropedia website based on reading, mind mapping and sharing (RMS) learning model in reproductive system content learning against the improvement of students’ Biological literacy. The effectiveness test carried out to determine whether or not the RMS-based Bio-Repropedia media could be massively utilized in learning [38]. It was conducted after the students treated with learning using RMS-based Bio-Repropedia media. The data collection in this stage used test instruments of multiple choices amounted to 30 questions that had been previously validated in the pretest and posttest activities. The pretest given before the students conducted the reproductive system content learning. The classroom learning process was online using Google Meet guided by RMS syntax that became the learning model in the development research. The RMS-based Bio-Repropedia media utilization in the learning had its uniqueness. Students perceived that their intensity of reading increased when utilizing the RMS-based Bio-Repropedia, especially the media has interesting display as stated by the validators so as it triggered students’ interest in learning the reproductive system. The RMS-learning model could improve the Biological literacy as it contained reading syntax that required students to conduct critical reading activity; hence, they could understand and link their understanding to the daily life [26]. Based on the hypothesis testing and descriptive test results (Table 5 and 6) there was an increase in the average score from pretest to posttest, especially in the multidimensional dimension. It was indicated by more students who mastered the dimension. To be in the dimension or multidimensional level students must master the dimension or levels below the multidimension, such as nominal, functional, and structural. Deep understanding on Biology topics would be achieved if students master and understand Biology foreign terms. In turn, the students could link the understanding to the daily life [39].

Once the increase between pretest and posttest scores was known the scores were calculated using Normalized gain formula (Table 7) to identify the significance of the increase in average of both scores [40]. The calculation resulted in normalized gain score that indicated that the Bio-Repropedia included in the medium category [41]. The increase that occurred in the pretest to posttest scores, in Biological literacy dimensions, in sub topics (Figure 2) as well as in Normalized gain score implied that the utilization of RMS-based Bio-Repropedia in reproductive system learning could improve students’ Biological literacy. The hypothesis testing results using paired sample t test (Table 6) in the pretest and posttest scores after the utilization of the RMS-based Bio-Repropedia suggested that there was a significant difference regarding students’ Biological literacy. It proved that through the RMS-based Bio-Repropedia students could improve their Biological literacy.
The RMS-based Bio-Repropedia applied in the learning was a great help for students in improving Biological literacy. In addition to its interesting display and content quality, the Bio-Repropedia was easy to understand and attracted students to learn the reproductive system anywhere and anytime; hence, critical reading activity closely related to the learning activities. It was supported by Uno & Bybee’s [39] theory stating that improvement in Biological literacy could be facilitated through the understanding of basic principles of reading or investigation activities. Another factor influencing the improvement of Biological literacy comprise critical reading activity through learning model so as students are capable of understanding the basic concepts of content and ready to understand the content more [26]. Understanding acquired from the critical reading activity that was integrated in the RMS model could last longer in the brain compared to memorizing activity [37]. Biology learning using website-based media takes place via internet, which is in a domain address that is usually in a platform with one condition that teachers put their teaching materials in the platform [42]. Website utilization as learning media could improve learning effectiveness as well as connect students to world global network; thus, unlimited science and insight access [43,44].

Improvement in Biological literacy also displayed during the learning process using RMS-based Bio-Repropedia, especially in the syntax. Each RMS syntax provided stimulus to students so as they read and tried to understand both text and non-text elements containing in the Bio-Repropedia. The first syntax that was crucial was reading, which was a critical reading activity related to reproductive system content through Bio-Repropedia [25]. The second syntax was mind mapping. It was an activity of creating a mind map by students based on the critical reading activity results. The mind mapping was implemented in group and mind map quality improvement occurred in each meeting.

The mind mapping activity could improve students’ concept understanding and sharpen their Biological literacy [45]. It was supported by a research by Sutami, Suharsono & Warpala [46] indicated that collaboration activity in the mind mapping syntax could improve students’ responsiveness in understanding content. Mind mapping also facilitates students to generate ideas based on their understanding on the content and transfer the ideas into the mind map [47,48]. The mind mapping activity directly assists students to plan, communicate in solving problems in the topic being studied, and focus their attention on compiling explanation as the results of their understanding on the topics [47]. The last syntax was sharing, which was an activity of presenting the mind mapping results from the previous syntax. The activity was done virtually through Google Meet in each meeting. Reflection and evaluation processes in sharing syntax is a social interaction for each students that allows effective impact on content understanding in each sub-topic [49]. The sharing activity could indirectly trained students’ critical thinking skills in group that presented the mind mapping results [50]. The interaction process occurred in the sharing activity is an example of social interaction that could encourage students to be more confident, expand aspects in thinking, and solve problems with other students [51]. All syntaxes in the RMS were summarized in the Bio-Repropedia; thus, all syntax could be well implemented in one learning.

4. Conclusion

According the hypothesis testing results, the RMS-based Bio-Repropedia media application was proven to affect and improve students’ Biological literacy in reproductive system content. Another result indicated that the improvement was general, which was it occurred in all Biological literacy dimensions from nominal, functional, structural, to multidimensional. The RMS-based Bio-Repropedia media had a limitation, namely the lack of face-to-face meeting to balance the learning so as it not fixated on one type of learning. It is recommended for further research to balance the direct face-to-face meeting with online learning using the RMS-based Bio-Repropedia media.

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