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The Development of Flipped Classroom-Based Human Reproductive System Learning Devices to Improve Students' Science Literacy Skills

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Abstract

Students' science literacy skills in Indonesia are still low. This is evidenced by studies conducted by PISA every three years. There needs to be an update of the learning model to improve students' science literacy skills. The outbreak of the COVID-19 pandemic in Indonesia caused learning to be done remotely. This study aims to produce appropriate learning devices that can be used during the COVID-19 pandemic. The method used is Research and Development which is modified into eight research steps. The research was conducted in the odd semester of the 2020/2021 academic year in the XII MIPA 1 and XII MIPA 3 classes of SMA N 1 Karangrayung. Data retrieval using questionnaires, interviews, and tests. The characteristics of the learning devices developed in this study were designed with a flipped classroom model that starts with self-asynchronous, then continues synchronous learning, and ends with collaborative asynchronous. The results showed (1) components of learning devices consisting of the syllabus, RPP, LKS, and evaluation tools were declared very feasible by experts; (2) the components of the learning device get excellent response from the biology teacher and get an excellent response from the student. Based on these results, the learning devices developed are very feasible to be used in the process of online learning.

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INTRODUCTION

Entering the 21st century, science and technology mastery is an important key to a nation's success. It is a benchmark of the nation's progress in the international arena. Frydenberg and Andone (2011) states that one must have critical thinking skills, science literacy, digital literacy, information literacy, media literacy and technology to face education in the 21st century. Science literacy is defined by PISA (2018) as the ability to engage in science-related issues and ideas as reflective citizens. The importance of science literacy skills can help students overcome various problems related to knowledge and technology in the future (Hidayati and Julianto, 2018). PISA's assessment study revealed that science learning in Indonesia has not succeeded in improving the ability of science literacy in terms of knowledge, the context of science applications, and competence. It is a great responsibility for educators to evaluate the learning process.

Ismail (2015) states that 21st century skills need technology for learning to connect globally. This is supporting the situation and conditions in the 2020/2021 academic year, where there is a COVID-19 pandemic. Director-General of Paudasmen Kemendikbud (2020) stated that if face-to-face services in schools are carried out, it has the potential to result in new clusters of COVID-19. Following up on this, Issued Circular Letter No. 4 of 2020 on the implementation of education policy in the emergency period of the spread of COVID-19 by the Ministry of Education, where learning is diverted based online or distance learning. Therefore, learning devices are required that can be used for distance learning.

Learning devices are handles used by teachers in carrying out learning activities to run effectively. The learning device component consists of the syllabus, RPP, LKS, and evaluation tools. In developing learning devices, a learning model is required that matches the characteristics of the material, students, and situations and conditions. The COVID-19 pandemic requires a model that can facilitate students to learn online but remain effective. One solution that can be done is to use a flipped classroom model. Steele (2013) defines flipped classrooms as using technology to help direct instruction diversions so students have plenty of time to work on tasks that require a lot of cognitive knowledge. Implementation of flipped classroom model during the COVID-19 pandemic can be done by combining asynchronous and synchronous learning. Asynchronous learning is online learning where teachers and students do not have to do the learning process simultaneously. At the same time, synchronous learning is the process of learning online at the same time. Thus, the learning requires a platform that can bring teachers and students together virtually, both asynchronous and synchronous.

One platform that can facilitate meetings asynchronously is google classroom. In google classroom students can discuss, download materials, and do the work given by the teacher. Heggart's research (2018) shows that google classroom can make students have flexibility in the work of assignments and students can express ideas that are owned when they are not delivered in the classroom. In contrast, one of the platforms that can facilitate meetings synchronously is Zoom Cloud Meeting. Referring to the research results of Ismawati & Prasetyo (2020) that Zoom, as one of the video conference platforms can support distance learning and facilitate students in absorbing the learning delivered.

Reproductive system material is one of the materials in grade 11 in even semester. Based on the results of national exams in the Puspendik year 2016 to 2019 on the reproductive system's material indicators, the absorption of SMA N 1 Karangrayung students has not reached 55.00%. Based on the results of an interview conducted at one of the biology teachers at SMA N 1 Karangrayung, students' KKM completion in learning before the COVID-19 pandemic has not reached 50%. These results are one reason why other learning models need to be used in reproductive system materials.

The human reproductive system discusses processes that occur in the body and cannot be observed directly. Video is one solution for students to understand processes that cannot be seen in person. The first syntax on the flipped classroom model is to observe video views performed asynchronously. Through video observation, students can get to know the learning materials, to train low-level thinking skills. In comparison, synchronous meetings can be used to train high-level thinking skills by discussing under the guidance of teachers. Based on the statement, the flipped classroom is expected to be one of the learning models that can improve students' science literacy skills, especially in human reproductive system materials.

The purpose of this study is to produce flipped classroom-based human reproductive system

learning devices to improve student science literacy that is adapted to learning in the new habits of the COVID-19 pandemic and is worthy of use in learning.

RESEARCH METHOD

This research was designed using Research and Development design. The development model used refers to Sugiyono (2012). According to Sugiyono (2012), the development model has ten research stages, but this study was limited to eight steps until a limited-scale trial. This is due to adjusting the situation and conditions with the research conducted. The research was conducted at SMA N 1 Karangrayung in the even semester of the 2020/2021 academic year with research subjects' class XII MIPA 1 and XII MIPA 3. Data collection methods using questionnaires, interviews, and tests. The data of feasibility questionnaire results by experts and responses of teachers and students were analyzed descriptively percentages at intervals in Table 1. In contrast, the interview result data were analyzed descriptively qualitatively, and test results for evaluation tools were analyzed based on feasibility analysis of question items.

Table 1 The Eligibility criteria and responses to learning devices

Interval	Eligibility Criteria	Response Criteria
81.25 % < score ≤ 100 %	Ver feasible	Very good
62.50 % < score ≤ 81.25 %	Feasible	Good
43.75 % < score ≤ 62.50%	Feasible enough	Good enough
25 % < score ≤ 43.75 %	Not feasible	Not good

Learning devices are said to be worth using when the average expert validation reaches >62.50% with a decent category according to the assessment instrument used. According to the assessment instruments used, learning devices are good when getting teachers and student responses reaching >62.50% in the good category.

RESULTS AND DISCUSSION

Characteristics of Learning Devices

The learning devices developed in this study are syllabus, RPP, LKS, and evaluation tools. The syllabus was developed by modifying the Ministry of Education's syllabus (2013) and adapted to the flipped classroom model in the new habits of the COVID-19 pandemic. The syllabus consists of KI, KD, subject matter, learning activities, assessment, time allocation, and learning resources. The syllabus characteristic is that there are two kinds of learning activities, asynchronous learning and synchronous learning. Learning activities begin with asynchronous learning independently, then continued with synchronous learning and ended with asynchronous collaboratively.

The learning implementation plan is designed by adjusting the syntax of the flipped classroom model put forward by Steele (2013) and science literacy-based learning according to Abidin *et al.* (2017). The Conformity of flipped classroom models with science literacy-based learning can be seen in Figure 1. Learning activities begin by observing video views. In the activity, students are given the task to summarize and make questions that have not been mastered to be asked to the teacher. The allotted time is following the characteristics of asynchronous learning, which can be done anytime and anywhere. To avoid excessive time, self-asynchronous learning activities are given of 1x24 hours.

Asynchronous learning requires a platform to control learning. This learning device used google classroom. On this platform, teachers can control the work of students so that learning is more optimal. Through google classroom teachers can find out which students have done work and those who haven't done an assignment, create a list of grades, and provide feedback on the assignments they've collected. The ease of other features include teachers can arrange the topic of learning according to the learning activities carried out.

Other learning activities are designed using synchronous learning. The characteristic is that teachers and students carry out distance learning at the same time. Therefore, a platform is needed that is

able to facilitate virtual meetings between teachers and students. This learning device is used the Zoom Cloud Meeting platform. One of the advantages of the feature is that there is a breakout room that can divide students into small groups. This is very suitable for the learning steps flipped classroom peer instruction type, where students must be given questions to then be divided into the right group. The wrong group Breakout room feature in Zoom Cloud Meeting is able to facilitate the learning step. Students can discuss with friends who have the same arguments to then return to the main room and discussion under the teacher's guidance.

The use of breakout rooms in online learning provides students with the opportunity to learn from other learners. With this breakout room feature, group learning activities with discussions can still be done as in face-to-face meetings. This is in line with Chandler's opinion (2016), that breakout room are beneficial for distance learning, giving students little chance of meeting their friends in person. Supported by Nasir *et al*. (2020), one of the advantages of Zoom is that it has a breakout room feature that can make students feel unencumbered because most of their discussion activities can only be heard by their friends. Teachers do not fully monitor the course of discussions in small groups, teachers as hosts can enter the discussion room to see the course of the discussion because the results are delivered in the main room.

Once synchronous is done, collaborative asynchronous learning is designed to analyze scientific articles relevant to learning material. This is so that students are able to know the application of materials in daily life. The knowledge obtained can be used for decision-making in solving life problems, thus training the science literacy skills of learners.

The theory of constructivism learning supports the flipped classroom model. This theory emphasizes that learners' activities in constructing their knowledge play a significant role in learning. Students should be actively involved in learning, such as being active in discussions, actively thinking, and drafting concepts as a process of knowledge formation. In this case, the teacher no longer transfers the knowledge possessed but facilitates the student to form his knowledge (Siregar and Nara, 2011). The learning devices developed are designed to engage students actively in learning, such as observing video views, discussing, and analyzing scientific articles in groups. With the design of the activity, it is expected to facilitate students in constructing knowledge.

LKS was prepared for four meetings, each consisting of observing and summarizing the video's content, question used to discuss with peer instruction flipped classroom techniques, and activities to analyze scientific articles. The questions presented raise the problems of the human reproductive system in daily life so that learners are able to understand the application of theory studied in asynchronous learning. This is in line with the opinion of Ardianto and Rubini (2016) if students interact with the environment through the problems and phenomena presented, indirectly, they have been involved in developing thinking skills and developing student science literacy.

The activity of analyzing scientific articles is used to develop knowledge about the theories that have been studied in the application of daily life. This stage is the fifth stage in the learning of science literacy according to Abidin *et al.* (2017), namely the nexus phase or concept development phase outside the context of learning. Scientific articles are sciences obtained from research activities based on scientific methods and learning resources following science development (Rahayu *et al*. 2013). By analyzing scientific articles, students can acquire knowledge according to the development of science so that they can apply the knowledge learned in daily life.

The evaluation tool developed refers to the human reproductive system's learning indicators (KD 3.12 and 4.12) and is adapted to the aspects of science literacy according to the PISA framework (2018). There are three indicators of scientific literacy that serve as a reference for developing evaluation tools, namely identifying phenomena scientifically, designing scientific investigations, and interpreting data and evidence scientifically. Multiple choice evaluation tool that has five answer options. There is one right choice, and the other four as a casting. The developed items raise daily life problems that are relevant to the material of the human reproductive system.

	Peer Instruction Flipped Classroom	Cognitive Level	Science Literacy-Based Learning
Asynchronous	Observe videos uploaded through google classroom	L1	Contact Phase
	↓		↓
	Give students time to summarize the content of the video and create curious questions		Curiosity Phase
	↓		↓
Synchrlearning	Give students individual concept questions through Zoom Cloud Meeting	L2	Elaboration Phase
	↓		↓
	Grouping students who answer the concept correctly and students who answer the concept is not yet right		
	↓		
	Strengthening arguments to form the right concept (teachers act as facilitators to justify student misconceptions)	L3	
	↓		
	Decision making based on the right concept		Decision-Making Phase
	↓		↓
Asynchronous	Given the task of exploring knowledge through scientific articles outside the context of learning		Nexus Phase
	↓		↓
	Evaluation	L1 L2 L3	Evaluation Phase

Figure 1 The Conformity of flipped classroom models with science literacy-based learning
Description:
L1: Cognitive Level 1
L2: Cognitive Level 2
L3: Cognitive Level 3
Source: (Steele, 2013) (Abidin *et al.* 2017)

Results of Learning Devices Validation by Experts

The learning device's feasibility is determined based on the validation results by the appropriate experts in their field. Experts in this regard are Lecturers of Biology Department in Faculty of Mathematics and Sciences Universitas Negeri Semarang. The validation results of the learning devices can be seen in Table 2.

Table 2 Results of Expert Product Validation

Components	Data Source	Percentage	Criteria
Syllabus	Learning Experts	82.35%	Very Feasible
RPP	Learning Experts	83.65%	Very Feasible
LKS	Material Experts	91.66%	Very Feasible
	Media Experts	95.83%	Very Feasible
Evaluation Tool	Evaluation Experts	94.00%	Very Feasible

Expert validation results show that the learning devices developed are very worthy of being used in learning. The learning devices developed are in line with flipped classroom-based learning, and designed

learning activities lead to improved science literacy skills. This is supported by Wijayanti's statement (2015) that valid learning devices can measure student's competence through a series of learning activities designed in it. Learning devices including syllabus, RPP, LKS, and evaluation tools developed have met the criteria and deserve to be tested in human reproductive system learning.

Learning Device Small Scale Trial Results

The limited/small-scale trial involved teachers and students at SMA N 1 Karangrayung. Teachers as respondents respond to learning devices, including syllabus, RPP, and LKS. While the students as the subject of research learning devices in the form of LKS and evaluation tools. Small-scale trials on LKS were conducted with 15 students who had low, moderate, and high abilities based on recommendations from the biology teachers of 12th grade. The results of teachers' responses to learning devices can be seen in Table 3 and the students' responses to LKS can be seen in Table 4.

Table 3 Teacher Responses to Learning Devices

Components	Score		Average (%)	Criteria
	Teacher 1	Teacher 2		
Syllabus	100%	98.52%	99.26%	Very good
RPP	99.03%	99.03%	99.03%	Very good
LKS	100%	98.52%	99.26%	Very good

Based on Table 4, they obtained learning eligibility criteria by Biology teachers with very good criteria. This suggests that the learning devices developed can be used in the learning of the human reproductive system.

Table 4 Student responses to student worksheets

No	Statements	Score	Percentage	Criteria
1.	LKS is presented with an attractive look	58	96.66%	Very good
2.	The composition of colors used in LKS is interesting	54	90.00%	Very good
3.	Writing LKS using easy-to-read size and typeface	56	93.33%	Very good
4.	There are no writing/typing errors that make it difficult for the reader	54	90.00%	Very good
5.	Instructions for use of LKS are clear and easy to understand	55	91.66%	Very good
6.	LKS is presented in order so that it is easy to understand	58	96.66%	Very good
7.	The steps of activities in LKS are clear and easy to understand	56	93.33%	Very good
8.	Activities in LKS stimulate curiosity	53	88.33%	Very good
9.	Activities in LKS contain daily problems related to learning materials	51	85.00%	Very good
10.	Presentation of LKS accompanied by video links that facilitate in understanding learning materials	51	85.00%	Very good
11.	The video (link connected to YouTube) contained in LKS is clear and easy to understand	54	90.00%	Very good
12.	The picture contained in the LKS is clear	55	91.66%	Very good
13.	The language used in LKS is easy to understand	56	93.33%	Very good
14.	The language used in LKS is unambiguous and clear	53	88.33%	Very good
15.	The language used in LKS is easy to understand	53	88.33%	Very good
	Percentage Average	**817**	**90.77%**	
	Criteria		**Very good**	

Based on the LKS readability trials results, obtained a result of 90.77% with a very good category. This shows LKS easy to understand and interesting to learn. Thus, it is expected that LKS is able to encourage the spirit of learners to be active and not cause boredom in participating in learning activities. The activeness of learners is indispensable as an effort to construct their knowledge. This is in accordance with the Prastowo's (20120) opinion that LKS as interesting teaching material for students can motivate them to learn harder in understanding the material.

In addition to quantitative data, in the LKS trial there are also qualitative data containing comments or suggestions of students to the developed LKS. The average student gives a positive and

enthusiastic comment to the developed LKS. One of the highlights is that LKS has been connected to YouTube links to make it easier to understand learning materials through video. Quantitative data results showed that as many as 85.00% of students agreed with the presentation of LKS with video links can facilitate understanding learning materials. Then as many as 90.00% of students stated the video presented is clear and easy to understand. The human reproductive system involves a variety of processes that cannot be observed directly. With the help of video, students do not need to imagine these processes abstractly. This is in accordance with the results of Saputra's research (2018), that learning videos can provide a better understanding of concepts compared to lecture methods. And supported by Chen's research (2012), learning videos can encourage learners to be more involved in learning to get more information.

Many students who provide recommendations using LKS developed can provide ease in learning in the new habit era of the COVID-19 pandemic. This is because they have difficulty finding videos that match the learning materials. The characteristics of distance learning are very different from the characteristics of face-to-face learning. In face-to-face learning, students get an explanation directly from the teacher. While in distance learning, students' explanation are very limited, so they have to look for additional information to provide understanding. With LKS connected in YouTube videos, they no longer have trouble finding references to increase understanding. In addition, they are facilitated to ask questions if they cannot understand the material contained in the video. In addition to recommending the use of LKS, some students also provide suggestions for improvement. Among them are more thorough writing, added a small image so as not to be boring, and not all videos use foreign language explanations. The suggestion is used as input for improvement. LKS added some pictures and videos that use Indonesian explanations.

The learning device component in the form of evaluation tools was tested on 47 students from class XII MIPA 1 and XII MIPA 3 SMA N 1 Karangrayung. The items tested numbered 40. The test results are then analyzed using The Test Analysis Program software. The evaluation tool was developed by referring to scientific literacy indicators according to PISA (2018), namely explaining phenomena scientifically, designing and evaluating scientific investigations, and interpreting data & evidence scientifically based on the context of the human reproductive system.

After the trial, 20 questions were selected that represented learning indicators and science literacy indicators according to the question item rules. Analysis of question items aims to identify the problem to obtain a quality question item so that it is worth using as an evaluation tool. Kusaeri and Suprananto (2012) revealed the aspects needed to analyze the problem item is the degree of difficulty, differentiation, and dissemination of answer options. Based on the distinguishing power index, a question can be known whether it has been accepted, revised, or rejected. The different power of a question serves to distinguish students with the low ability with the high ability. The higher the power index, the higher the ability of the problem in distinguishing clever learners with the less.

Based on the trial result, selected questions that have a high power index in one indicator take into account the difficulty of the question. The greater the index of the difficulty level obtained, the easier the item of the question. A decent question item is selected based on a high different power index with a moderate difficulty level. This is supported by Fu'adah *et al.* (2017)'s opinion that differentiation power combined with the degree of difficulty can be used in knowing the quality of the question item.

The third aspect in analyzing the question item is the pattern of dissemination of answers. Some items have to be repaired, because none of students do not choose the casting / distractor provided. This is in line with Arikunto's opinion (2013) that casting can function properly if selected by 5% of test-takers. Furthermore Kusaeri (2012) states that casting can work when chosen more by less clever learners. Several factors can cause the lack of proper functioning of the casting. First, casting has a language that is difficult for learners to understand. Another factor is that students have learned that the choice of answers provided is not the right choice. Based on the trial results, 20 decent questions were selected according to the analysis of the question items. Then the calculation using the spearman-brown formula obtained a reliability value of 0.842. This suggests the evaluation tools developed are highly reliable so that they can measure science literacy-based learning.

Researchers also conducted interviews on several students involved as subjects in the evaluation

tool trials. Based on the interview results, students showed enthusiasm for the evaluation tools developed. This is because of the amount of information that can be obtained related to the application of learning materials in daily life. One example is the influence of cigarettes on spermatogenesis. The question is provided discourse in the form of scientific research results so that the source's level of trust is high because of the results of laboratory-based research. Therefore, it is expected that teachers can provide learning that connects problems with theory in the classroom. So that student can start thinking about how to solve problems using the concept of science. Thus, it is expected that science literacy-based learning can be achieved and students' science literacy can be improved.

Also, students find it difficult with indicators of designing and evaluating scientific investigations. In that question, they were given the task of mentioning variables that influenced the research. Students argue that the problems presented are not as simple as those taught by teachers in the classroom. Therefore, teachers are expected to implement more complex learning so that students get more information.

The student's responses to the indicators interpret the data and scientific evidence that even though the question has been repeatedly, but they are still not correct in choosing the answer. This is because in answering the question requires high accuracy. The amount of reading in the evaluation tool does not make students saturated because the topics provided are interesting and found in daily life for example, the influence of soy on spermatogenesis. Previously, the students did not know the link between the content in soy and the spermatogenesis process. By working on the evaluation tool developed, the learners realized that soy contains phytoestrogens that can lower androgen levels in the spermatogenesis process. Associating phenomena that occur in daily life with materials in the classroom is necessary for students to understand the application of these theories. Thus, students are trained to solve problems using science knowledge in their daily lives to improve their science literacy skills.

CONCLUSION

Based on the results of the study, it can be concluded that flipped classroom-based learning devices to improve the ability of science literacy are feasible to be used in the distance learning process during the COVID-19 pandemic. This is proven by expert validation results that state the learning devices are very feasible, excellent teacher responses, and excellent responses from learners. Teachers play an important role in building and developing students' science literacy skills through learning. Therefore, the design of learning and the tools used are very influential on the learning objectives. With learning designed to improve science literacy, students are expected to meet the demands of the times and solve all problems in life using the concept of science.

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