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Effects of Flipping STEM Classroom Learning Model Assisted by Live Worksheet on Students' Science Literacy on Concept of Heat Transfer Material

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Despite the importance of scientific literacy for learning, Indonesian students typically lack adequate literacy skills. The goal of this study is to determine whether teaching methods that use live worksheets and the flipping stem class paradigm can aid students in developing their scientific literacy. A quantitative quasi-experimental research design was used for this investigation. All pupils in class XI IPA 1–5 at a high school in Serang District made up the study's population. Class XI IPA 1 served as the experimental class for this study, and class XI IPA 2 served as the control class. Pretest, posttest, and student response questionnaires were the instruments used in this study. The posttest findings revealed that the experimental class outperformed the control class in terms of average score. This is demonstrated by utilizing the t-test to assess the outcome of the final test, where the values of t-count> t-table are 5.56>2.00. The control class's N-Gain scores 0.52 in the medium category and the experiment class 0.76 in the high category. According to the results of the student response survey, learning was put to good use in 87.1% of cases. According to the research, teaching with live worksheet while having the class turn around can enhance students' reading abilities, particularly in physics classes on heat transfer materials.

Keyword: : *Learning model, Flipping STEM classroom, Live worksheet, Scientific literacy*

INTRODUCTION

Science literacy is one of the skills that students must have. Science literacy is used to apply scientific knowledge in scientific ways in decision making and problem solving. Science literacy is currently used as the main goal in science education (Setiawan, 2017). The importance of science literacy encourages various studies to be able to improve students' literacy skills (Nulhakim et al., 2022). In order to develop students' science literacy competencies, teachers must create a learning environment that focuses on developing students' scientific knowledge, scientific processes, scientific attitudes, and understanding of science. Teachers should also encourage students to apply what they have learned at school in their daily lives. In addition, teachers should create a student-centered learning environment where teachers act as facilitators and students are encouraged to be active learners. Finally, teachers should also focus on digital skills, which is an important part of science literacy in the 21st century.

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Students are expected to have good science literacy skills, including problem-solving, decision-making and inquiry skills (Pratiwi et al., 2019). In addition, students must also master academic orientation, self-efficacy in science literacy learning so that learning is expected to teach students useful values, including important facts and concepts that can be applied in everyday life. However, research conducted by Mukharomah et al (2021) shows that students' science literacy tends to be low. Students are less enthusiastic in doing science learning, this is because the learning process, especially in physics, has not applied various learning models and media and only relies on textbooks (Nulhakim et al., 2019). Based on PISA, science literacy is determined through four aspects, namely competence, knowledge, science context, and attitude (Rosidah, 2017).

The competency aspect is also known as the scientific process. Where this scientific process involves understanding the process to answer questions or solve a problem. PISA also divides the competency aspect into three indicators, namely identifying scientific issues or questions, explaining phenomena scientifically, and using scientific evidence. These indicators are intended to help students develop science literacy skills based on logic, reasoning, and critical and creative analysis (Jufri, 2017).

The knowledge aspect contains perceptions of science needed to understand natural events and changes caused by human activities. This aspect aims to describe the extent to which students apply their knowledge in a context relevant to everyday life (Asyhari, 2015). The knowledge aspect includes content knowledge relevant to life, procedural science for exploration and variable identification.

The context aspect of science is a concept needed to understand events and changes made to nature through human activities (Bahriah, 2015). This dimension of science literacy also contains definitions of positions related to the utilization of science in real life. To create and develop the science literacy aspect, namely the context of science in students, teachers must design learning conditions that focus on developing science knowledge in everyday life. In addition, teachers need to encourage students to apply the knowledge they gain at school in their daily lives (Sidiq et al., 2018).

The attitudinal aspects include student independence in learning, scientific thinking skills, curiosity and critical thinking skills. Attitudes in science literacy also include self-confidence, beliefs, values and actions. The attitude aspect is also related to students' interests and responses to the influence of science and technology issues that affect human existence (Wulandari and Sholihin, 2015). Science literacy that is oriented towards developing scientific attitudes can help students develop an open and critical attitude towards scientific information and knowledge (Setiawan, 2020). In addition, the attitudes that students need to have include having a positive attitude towards science and being able to develop scientific attitudes in everyday life.

Interviews conducted by researchers in one of the public high schools in Serang Regency stated that 9 out of 10 students thought that students did not like physics learning. They argue that physics lessons need a lot of analyzing and only emphasize on many formulas so that it makes students confused when applying it to problems. In addition, the students also answered that they had never heard what science literacy was, so it was concluded that students were less than optimal in understanding physics learning, especially for literacy-

based ones, because students were less able to analyze a problem in the form of mathematical solutions. This is reinforced by research conducted by Sidiq et al (2018) which states that student science literacy, especially in Indonesia, is still relatively low. Likewise, research conducted by Pratiwi et al. (2019) which states that students' science literacy skills still need to be improved. For this reason, innovation is needed, one of which is the use of appropriate learning models and media to improve and improve the quality of physics learning (Saefullah et al., 2017).

One way to overcome these problems is to use the right learning model. The learning model used by researchers is the flipping STEM classroom. This model is a unique learning model because it reverses the traditional learning sequence. In this model, students will first study the subject matter at home through videos or reading materials, then in class students will carry out discussion activities related to the subject matter, do assignments, and so on (Juniantari et al., 2019). The flipping classroom model can be adjusted to the needs of students and the material being studied (Sonia, 2022). In using the flipping classroom model, teachers need the help of multimedia devices and technology such as videos or reading materials to facilitate learning.

Bergmann and Sams (2012) claim that the flipping classroom model has a basic concept that if learning is usually done in class, then in this model learning will be done at home. The flipping classroom model combines learning outside the classroom and in the classroom to maximize activities in the classroom and requires students to play an active role during learning by being equipped with material that has been given outside the home before the learning process takes place. This model emphasizes efficient time in the classroom, reduces activities such as explaining material, and others and maximizes interaction between students and teachers so that the learning process will be better and improve students' thinking process abilities (Ozdamli and Asiksoy, 2016). The steps of the flipping classroom model (Bishop and Verleger, 2013) are as follows:

1) Phase 0 self-directed asynchronous activities when students study independently at home before learning takes place, the teacher provides material through the LMS.
2) Phase 1 synchronous activities are classroom learning activities, at this time students are divided into groups to work on tasks related to the material.
3) Phase 2 of the activity students carry out discussion with their groups by working on projects or worksheets related to the material, the teacher's role is to facilitate the course of the discussion.
4) Phase 3 is an activity to measure student understanding by presenting the results of the discussion and taking the posttest given by the teacher.

The STEM approach used in this study is combined with the flipping classroom model. Previous research entitled "Reconstruction of Stem-Based Teaching Materials to Improve Students' Science and Technology Literacy on the Concept of Magnetism" (Rusyati, et al., 2019) explained that the use of STEM can improve science literacy for students with an average pretest result of 18.9% and an average posttest result of 52.5% and N-gain of 41.47% including in the medium category. The STEM approach in learning, especially in physics learning, is expected to become students who can solve problems, able to apply understanding and learning to new situations.

In this research, the media used is called live worksheet. Live worksheet is an online-based media used by teachers to create student worksheets. Live worksheets make it possible to transform traditional student worksheets into interactive online student worksheets with automatic corrections and grades. This live worksheet media can be used in student learning and is included in the excellent media category (Sihombing et al., 2022). By using live worksheets, students can do exercises and assignments online and get immediate feedback from the teacher. Live worksheets also provide a variety of features that can help teachers in creating worksheets such as images, videos, audio and text.

This student worksheet has been created, developed and operated through the help of a computer system using the internet network. Live worksheet is considered appropriate to be used as an evaluation media for students because it can be accessed practically and free (not paid). This media can facilitate the work of teachers in correcting and giving grades to students. Live worksheet can correct answers automatically with multiple choice and short form questions. Learners can also immediately know the results of the test they have done if the teacher wants to display it. Live worksheet media can display the subject matter being discussed, evaluation questions in the form of videos, images and interesting symbols that allow students to increase their learning motivation.

The flipping STEM classroom learning model is a learning model that includes discussion, investigation, and discovery activities during learning activities. This model is designed to make students more active during the learning process, so the flipping stem classroom model has the ability to be used during learning to support science literacy skills for students and utilize information technology and have unlimited creativity (Patandean and Indrajit, 2021). Research conducted by Fung (2020) explains that the use of the flipping-practical-discussion model in STEM learning can improve students' critical thinking skills so that it can also improve students' literacy skills well. The flipping STEM classroom model can increase student involvement in learning, allowing students to learn independently.

Flipped classroom learning implements developments that occur around the environment. This means that the teacher must explain the material first in the form of videos, pdfs, books or others to students to study at home, then when learning takes place at school students and teachers discuss the material together using the STEM approach. To improve science literacy for students, students need such a learning process, so that it can save time and increase student understanding during learning activities and which aims to improve student literacy results, especially in physics lessons, therefore researchers will conduct research on "*The Effect of the Flipping STEM Classroom Model Assisted by Live Worksheet to Improve Student Science Literacy on the Concept of Heat Transfer Material.*"

METHODS

This research uses quantitative methods. The quantitative method is a method of measuring objective data and statistics through scientific calculations derived from samples or sections and certain phenomena and causal relationships (Sugiyono, 2018). Researchers use a quantitative approach because it aims to describe systematically and accurately the facts and characteristics of a particular population or field. The research design used is quasi-experimental. This design is one of the research designs used to measure the effect of one

treatment or intervention on a group (Abraham and Supriyati, 2022).

Population is the overall object of research that has certain characteristics in a study conducted. The population of this study were all students of class XI IPA odd semester of the 2022-2023 academic year. The sample is a small part of the population chosen by the researcher to be the object of research. The sampling technique must be chosen appropriately so that the sample taken can represent the population. The sampling technique was carried out with a purposive sample approach or based on certain criteria. The selected samples were students of class XI IPA 1 (experimental class) and class XI IPA 2 (control class) who both studied heat transfer material in physics.

Research instruments are tools or media used to collect data in a study. Research instruments can be in the form of tests, questionnaires, interview questionnaires, and so on. Data collection instruments were in the form of 20 multiple choice questions and student response questionnaires. The multiple-choice questions used the aspects of science literacy. The student response questionnaire was used to determine the effectiveness and student response to the learning model and media used during learning.

Data analysis techniques are steps or methods used to process data into information that can be understood and used to make decisions. Data retrieval techniques in this study used inferential statistics in the form of prerequisite tests and hypothesis tests. Inferential statistics are used to help researchers in making decisions in this study. This study also used the n-gain test to determine the learning model category whether it was included in the low, medium or high category. Student response questionnaires were analyzed using a Likert scale calculated using Microsoft Excel.

RESULTS AND DISCUSSION

Results

Analysis of Students Basic Literacy Skills

At the beginning of the study, researchers conducted a pretest to the experimental and control classes to determine the initial ability of students' science literacy in both classes. Before conducting hypothesis testing, first conduct inferential statistical tests. Inferential statistical tests include normality tests and homogeneity tests. After knowing the normality and homogeneity tests, then proceed with hypothesis testing using the t-test. Table 1 will explain the normality test, homogeneity test, and hypothesis test on the pretest scores of the experimental and control classes.

Table 1. Pretest Normality, Homogeneity and Hypothesis Tests

Test Type	Group		X^2 table	F table	T table	Conclusion
	Experiment	Control				
Normality	3.248	10.621	11.07	-	-	Normal
Homogenity	0.91		-	1.84	-	Homogeneous
Hypothesis (Uji-t)	1.92		-	-	2	No difference

Based on Table 1 shows X^2 count of 3.248, and X^2 table of 10.621. X^2 count < X^2 table then the data is normally distributed. Table 1 shows F-count of 0.91 and F-table of 1.84. F-

count < F-table then the data is homogeneous. After knowing the data is homogeneous, then proceed with hypothesis testing. Table 1 shows the results of the hypothesis test or t test of the pretest results of the two classes, namely the experimental and control classes. It is known that t-count < t-table so it is stated that Ho is accepted. This means that there is no difference in the initial literacy skills of students in both the experimental and control classes or both classes have the same science literacy skills before being given different learning models.

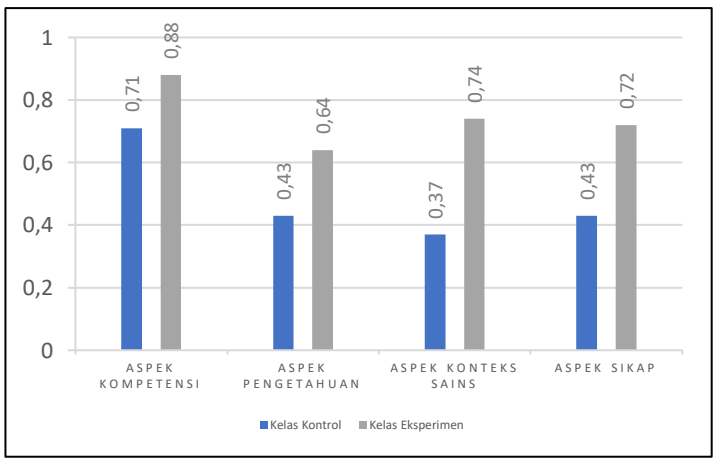
Effect of Learning Model on Students Science Literacy

Further hypothesis testing was carried out on posttest data. The posttest was conducted after students received different learning models. The experimental class used the flipping stem classroom model while the control class used the expository model. This test was conducted to determine whether the learning model and media used had an effect or not. Before testing the hypothesis, the normality test and homogeneity test were first carried out.

Table 2. Posttest Normality, Homogeneity and Hypothesis Tests

Test Type	Group		X^2 table	F table	T table	Conclusion
	Experiment	Control				
Normality	3.347	6.494	11.07	-	-	Normal
Homogenity	1.76		-	1.84	-	Homogeneous
Hipothesis (t-test)	5.56				2	Difference

Table 2 shows X^2 count of 3.347, and X^2 table of 6.494. X^2 count < X^2 table then the data is normally distributed. After knowing the data is normally distributed, then proceed with the homogeneity test. Based on Table 2 shows F-count of 1.76 and F-table of 1.84. F-count < F-table then the data is homogeneous. After knowing the homogeneous data, proceed with the hypothesis test and get results as in table 2 which shows the results of the hypothesis test or t test of the posttest results of the two classes, namely the experimental and control classes. Based on table 2, it is known that t-count> t-table so it is stated that H1 is accepted. This means that there is a difference in students' literacy skills both in the experimental and control classes.



Picture 1. N-Gain Value Aspect of Science Literacy

After hypothesis testing on posttest scores, the posttest scores were then analyzed using n-gain as shown in Figure 1 per aspect of science literacy. Based on the results of the n-gain analysis, in the experimental class there were no students who occupied low criteria after participating in flipping stem classroom learning assisted by live worksheets. A total of 9 students in the experimental class occupied moderate criteria, while 22 other students

occupied high criteria. The overall average n-gain value in the experimental class was 0.76 with a percentage of 76.41% and included in the high criteria. The competency aspect in Figure 2 in the control class obtained a value of 0.71 and was included in the high category. The experimental class got a higher n-gain value of 0.88 and was included in the high category. The knowledge aspect in the control class obtained a value of 0.43 and was included in the medium category. The experimental class obtained a higher n-gain value of 0.64 and was included in the medium category. The experimental class obtained a value of 0.74 which was included in the high category, while the control class obtained a value of 0.37 which was included in the medium category in the aspect of science context. The experimental class obtained a value of 0.72 which was included in the high category, while the control class obtained an n-gain value of 0.43 which was included in the medium category for the attitude aspect.

The questionnaire was distributed to find out the response of students in the experimental class to learning using the flipping stem classroom model assisted by live worksheets to improve students' physics literacy skills. The questionnaire contains ten statements with a scale of 1-7. With a scale of 7 stating strongly agree, scale 6 stating agree, scale 5 stating slightly agree, scale 4 stating neutral, scale 3 stating slightly disagree, scale 2 stating disagree, and scale 1 stating strongly disagree. The student response questionnaire was given after the learning was complete and filled in by students using a google form whose link had been provided by the researcher. Overall, student responses occupy an average percentage of 87.1% with very agreeing criteria or it is concluded that learning using the flipping stem classroom model assisted by live worksheets is effective based on student responses.

Discussion

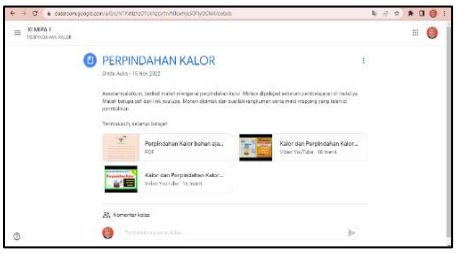
The use of the flipped STEM classroom model can have a positive impact on improving students' science literacy competencies. This model can help students understand science concepts better and improve their critical thinking skills. Therefore, the flipping STEM classroom model can be used as an alternative in improving students' science literacy. This is in line with research conducted by Haque et al (2021) which states that 21st century science learning with science literacy can be improved by using the flipping classroom model. The STEM approach is also known to improve students' science literacy by integrating the application of science and technology in learning (Ramlawati and Yunus, 2021). This is also in accordance with the use of technology, namely live worksheets as media in learning in experimental classes.

After the pretest, the two classes received different treatments. Where in the experimental class using the flipping stem classroom model with additional live worksheet media while the control class uses an expository model without any additional media. In the experimental class, before the learning takes place, the teacher provides material first through google classroom to be studied independently by students. Students are also asked to summarize and make mind mapping from the material that has been given. Then, in classroom learning, the teacher uses the STEM approach, then does group activities using live worksheets. The LKPD that is usually used is changed by the teacher to e-LKPD into a live worksheet. This is because it is necessary to switch from conventional media to media based on technology and information in order to improve the quality of learning (Herawati et al., 2016). In addition, e-LKPD is easier for students to use because it uses electronic assistance such as smartphones, laptops, and others (Sa'diah et al., 2022). Figure 2 is the LKPD used by the experimental class:

Picture 2. Activity to Fill in the Right Answer Through Pictures

The utilization of live worksheets during learning makes students feel less bored and increases their curiosity about the use of the live worksheet. Students will be interested and find it easier to understand the material when the learning process takes place (Choiroh et al., 2023). Students also become more enthusiastic in learning and foster a positive competitive spirit between students. Each group is required to rise and share the results of group discussions during the final stage of learning. The teacher then gave a posttest to both the experimental and control classes after both classes had completed their learning. Posttest questions were answered in writing on paper given to the control class while on live worksheets in the experimental class.

The results showed a significant difference between the level of science literacy of experimental and control class students on heat transfer material. The results of the hypothesis test calculation show that the experimental class science literacy is better than the control class, with t count > t table of 5.56 > 2.00. This happened due to several things including strong student participation in learning. This is reinforced by research conducted by Roudlo (2020) where he argued that learning using a flipped classroom requires students to better understand the material independently and seek their own sources of knowledge so that it helps students in exploring the material they learn. In the experimental class, learning was carried out using the flipped stem classroom model with the help of live worksheets. This kind of learning provides opportunities for students to learn more about the subject at hand and also to actively participate in the process. In this case, before carrying out learning in the classroom, students are involved in constructing their own knowledge, because the teacher has shared the material to be studied through the learning management system (LMS) on the google classroom platform. Students access the material independently through YouTube videos and pdf materials provided by the teacher.



Picture 3. Providing material by the teacher through Google Classroom

In Figure 3, the teacher provides students with material through google classroom. The students' task is to study it by themselves, then summarize in their respective notebooks. This is in accordance with the findings made by Yanah et al (2018) where students can build their own expertise using the basic information, they get from the instructional videos provided by the teacher. STEM is used to conduct activities in the classroom. Through reading, writing, observing, and doing science, students will be able to demonstrate science and technology literacy which is the goal of this method (Bybee, 2013). Students collaborate in a group to complete group activities. Teachers actively communicate, listen and participate in the learning. Students are more participative as the learning progresses. The flipped classroom model places students as topics and objects that can accommodate individual differences during learning. Two techniques called asynchronous and synchronous activities were directly used to teach in the experimental class. In asynchronous activities, students are required to create their own knowledge, such as learning materials in the form of audio, video, articles, power points, and so on (Rindaningsih et al., 2021), through materials provided by the teacher through google classroom. As a result, students are more receptive to learning because they have access to the materials that must be learned to participate in face-to-face learning. The STEM approach to direct synchronous helps students better understands the information they have learned through a separate asynchronous procedure.

Overall, there are research results in this study, namely both experimental and control classes have the same initial literacy skills or there is no difference, this is shown in the hypothesis calculation where t count < t table. While after doing different learning, the results showed that the use of the flipping stem classroom model assisted by live worksheets had an effect on students' science literacy skills. Where there is a significant increase in students' science literacy skills in the experimental class rather than the control class. This can be seen from the hypothesis results where t-count> t-table and the difference in the n-gain values of the experimental class and the control class. The experimental class got an n-gain value of 0.76 in the high category and the control class 0.52 in the medium category. Furthermore, the results of student responses can be seen in the student response questionnaire which gets a result of 87.1% related to learning by using the flipping stem classroom model assisted by live worksheet which is included in the effective category used during the learning process. For further research, it is recommended to prepare the research better, such as using the flipping stem classroom model assisted by live worksheet on other physics materials not just the subchapters, then this research is only limited to measuring science literacy skills only, for it is hoped that further research can measure other student abilities such as critical thinking skills, problem solving, numeracy literacy, and so on. Despite the many benefits of the flipping classroom model, there are some disadvantages. For example, learning in a flipping classroom cannot be monitored or regulated, and teachers cannot be sure whether students are really learning because it is possible for them to duplicate classmates' summaries. In addition, it requires an adequate internet connection to access videos or other materials, not many students still have difficulty in accessing technology so it takes more time to learn (Permana, 2020). Asynchronous activities cannot be fully controlled, relying only on the honesty of students whether they have engaged in asynchronous learning or not.

CONCLUSION

Based on the results of the research that has been done, it shows the results of hypothesis testing using the t-test that the average value of increasing the science literacy skills of students who use the flipping stem classroom model assisted by live worksheets is better than students who use expository learning with the acquisition of the t-count > t-table or 5.56> 2.00. N-Gain in the experimental class amounted to 0.76 in the high category and the acquisition of the control class amounted to 0.52 in the medium category. The results of student responses to learning are also very good, this can be seen in filling out student response questionnaires which obtained results of 87.1% related to learning by using the flipping stem classroom model assisted by live worksheets. So, the use of the flipping stem classroom model assisted by live worksheets can improve students' science literacy skills on the concept of heat transfer. The flipping STEM classroom model has differences with the expository learning model in improving science literacy. The flipping STEM classroom model prioritizes the role of students in learning and integrates the application of science, technology, engineering, and mathematics in one lesson. In addition, the flipping STEM classroom model also uses technology in learning, so it can help students understand science concepts better and improve their critical thinking skills. Therefore, the flipping STEM classroom model can be used as an alternative in improving students' science literacy.

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