Flipbook E-Module-Assisted 8e Learning Cycle Model on Improving High School Students' Concept Mastery on Heat and Heat Transfer Material

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Abstract *– Physics concept mastery is a demand that is to be achieved in learning at high school level. In addition, the development of 21st century technology requires teachers to be able to use technology in organising students to learn. This study aims to determine the effect of flipbook e-module-assisted 8e learning cycle model on improving high school students' concept mastery on heat and heat transfer material. This research is a quantitative study that uses quasi experimental design with Nonequivalent Control Group. Participants included 70 students of class XI (eleventh graders) in a MAN (State Islamic High Schools) in Bandung, which were selected using convenience sampling technique. Data collection was done through a pretest and a posttest encompassing as many as 12 items of two tier multiple choice questions on concept mastery. The data analysis used N-gain test to determine the increase in concept mastery, and Mann Withney test to determine the effect of flipbook e-module-assisted 8e learning cycle model on students' concept mastery. The results showed that there was an increase in concept mastery after treatment was given, that is, by 0.60 (moderate). There is a significant difference in the improvement of the concept mastery between the experimental class and the control class, especially in the cognitive aspect of C3, which is 54.65%, and the material aspect of heat transfer, which is 36.42%. In conclusion, flipbook e-module-assisted 8e learning cycle model has an effect on improving students' concept mastery.*

Keywords*: Concept Mastery, 8e Learning Cycle, Flipbook E-Module, Heat and Heat Transfer*

INTRODUCTION

Physics concept mastery is a demand that is to be achieved in learning at the level of senior high school (SMA) and the like (Agus Budiyono et al., 2019). This is stated in the Regulation of the Minister of Education and Culture (Kemendikbud) Number 22 of 2016 concerning Standard Process for Primary and Secondary Education which states that every student in high school should be able to master knowledge so that they can optimally follow secondary education. This shows that concept mastery in physics lessons is highly emphasised as the success of physics learning. As an effort to achieve the standards set by the government, physics learning must be able to provide learning experiences that can make students' concepts mastery optimal, so that it can be implemented in everyday life.

One high school physics material that requires concept mastery is heat and heat transfer. Based on the results of a preliminary study conducted through a concept mastery test at one high school in the city of Bandung (the subject encompassed class XII MIPA—12th graders majoring science—totalling 61 students), 29.5% of the students mastered the concept of heat, while 70.5% did not. Meanwhile, 25.8% of the students mastered the concept of heat transfer while 74.2% did not. Based on such data, it can be inferred that the learning objective for heat and heat transfer material has yet to be achieved. This is indicated by the number of students who still have low concept mastery.

Based on the results of interviews conducted with physics teachers in one of the private high schools in Bandung, it was found that there were two aspects in learning that were considered lacking. The two aspects are the more frequent use of teacher-centred, conventional learning model and the use of less innovative learning media. In addition, teaching materials in the form of textbooks have also not been able to improve students' concept mastery. This is because students in these schools are still lacking basic concept mastery. In this case, teachers find it difficult to use varied learning models and make innovative media. The reason is because the process of making learning tools such as lesson plans and preparing media innovations takes a long time.

In addition, the results of an interview conducted with one of the students at the private high school obtained the information that students often feel bored when learning physics. This occurs when the teacher continues to explain the material in the front of the class without involving the students to participate actively in learning. Learners prefer doing lab work over listening to the teacher's explanation when learning physics. In addition, students also feel that the teaching materials used are still ineffective and have not been able to teach students independently.

Students’ lack of ability to master physics concepts is not only influenced by their inability to receive lessons delivered by teachers, but also by the teachers’ ability to prepare and manage teaching and learning activities. That the teaching and learning activities that take place is only teacher-centred and students are less actively involved in the learning process indicates students’ lack of interest in learning which certainly has an impact on students’ low concept mastery, causing students to have difficulty in mastering concepts. In addition, another cause of the emergence of these problems is the unavailability of innovative learning media that can support the improvement of students' concept mastery.

The problems mentioned above can be overcome by applying media-assisted models that can support and facilitate the improvement of concept mastery and active participation of students through meaningful learning activities. One of the learning models in constructivist theory and meaningful learning theory is the learning cycle. The learning cycle model is an organisation that makes it easy to master new concepts and to rearrange learners' knowledge (Huda, 2013). The learning cycle model is a series of activity stages (phases) organised in such a way that learners can master the competencies that must be achieved in learning by playing an active role (Ngalimun, 2014).

The learning cycle model continues to evolve, from 3e learning cycle to 9e learning cycle. From the various types of learning cycle model developments described above, researchers chose the 8E learning cycle model as a solution to facilitate the improvent of students' concept mastery, because through the 8 stages, namely: Engage, Explore, E-search, Elaborate, Exchange, Extend, Evaluate, and Explain, learners can discover and master a concept through case studies and experimental activities. This activity can train learners in making hypotheses, designing experiments, comparing, analysing, applying, concluding, explaining, and evaluating the results of case investigations through experiments, which are indicators of concept mastery. At the E-Search, Elaborate, Exchange, and Extend stages, students can develop their knowledge by looking for learning resource references through flipbook e-modules, discussing with friends, and expanding their knowledge by doing practice questions. Then, at the final stage of learning, namely the Explain stage, students are asked to explain the concepts that have been obtained from their findings.

In addition, a review of relevant previous research including research conducted by Elsa Mahardika et al. (2018) suggested that the application of 8E learning cycle decreased the percentage of students who experienced misconceptions of the concept and increased the percentage of students who understood the concept. Another study also focuses on the 8E learning cycle model. Such study was carried out by Annisa Fitri (2019), who concluded that the use of 8E learning cycle model has a positive effect on student learning outcomes. Furthermore, research conducted by Wika Junilita et al. (2022) found that learning using the 8E learning cycle model affects students' concept mastery.

The 2013 curriculum demands that teachers can use technology to organise students in learning (Pardomuan, 2013; Wika, Syafi'i, and Azhar, 2022). The development of the 21st century technology can facilitate teachers and students in the learning process, especially with physics learning. Digital-based learning media not only helps students learn, but also helps them deal with technological developments (Abror et al., 2020). This is in line with the basic principles of education in Permendikbud No. 22 of 2016, namely that the use of technology facilitates the learning process and is considered more effective and efficient (Manzil et al., 2022). In addition, combining learning models with media innovations that utilise technology can enable interactive participation between learners and teachers (Kinshuk, 2016; Rianhe, Endang, and Baskoro, 2023).

One of the learning media innovations that utilise technology is flipbook-based e-module. Flipbook e-module can be created online on the heyzine website. This flipbook e-module does not only take the form of text. We can also insert images, graphics, sound, links and videos in it (Thenu, 2016). It is expected that the flipbook form, which uses the transition effect of page switching, can attract students' learning motivation (Gea, 2017). This flipbook-based e-module is available in software form so that students can easily access it wherever they are. The results of research by Soejana et al., (2020) state that the use of this media can be an alternative for teachers to facilitate concept mastery, and can foster students' interest and motivation to learn. In addition, this flipbook e-module can also provide opportunities for students to be actively involved in the learning process and discover a concept for themselves.

Based on research conducted by Sugiharti et al., (2019), it is concluded that the use of e-module-assisted learning cycle model is more effective for improving critical thinking skills than just the learning cycle model alone. This is because students have to look for material using e-modules and connect the learning material themselves instead of just receiving all the learning materials from the teachers. In line with that, research conducted by Nerliana and Retno (2022) concluded that the learning outcomes of students that used e-module-assisted 8E learning cycle model were higher than the Minimum Completeness Criteria (KKM) set. Meanwhile, this study aims to see the effect of flipbook e-module-assisted 8e learning cycle model as learning materials to replace existing textbooks on improving students' concept mastery in heat and heat transfer material.

Based on the description above, the flipbook e-module-assisted 8e learning cycle model is expected to support the improvement of students' concept mastery ability. In addition, it is also expected to make students active and independent in learning the concept of heat and heat transfer. Therefore, researchers are interested in conducting research in revealing the effect of the flipbook e-module-assisted 8e learning cycle model on improving the concept mastery of high school students on heat and heat transfer material. The framework of this research is shown in Figure 1.

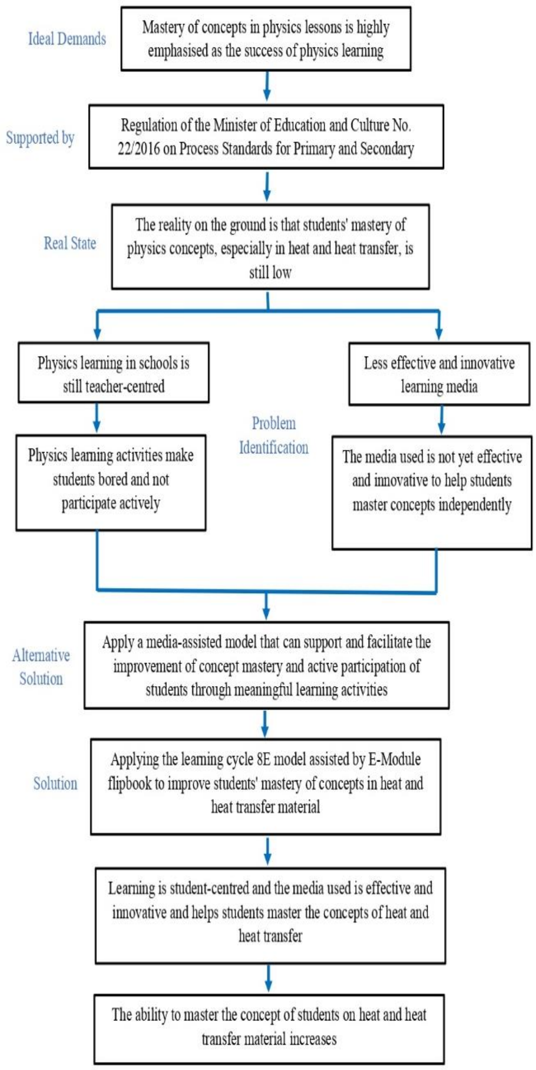

Figure 1. Research Framework

RESEARCH METHODS

The method used in this research is quantitative. It used Quasi Experimental Design with Nonequivalent Control Group Design. The research design is visualised in Table 1.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Treatment (X)	Posttest
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

Source: Sugiyono, 2013

Description:

Experiment : Experimental group (flipbook e-module-assisted 8e learning cycle model)

Control : Control group (8e learning cycle)

O_1 : Same pretest in both groups

X_1 : Treatment with flipbook e-module-assisted 8e learning cycle model

X_2 : Treatment with 8e learning cycle

O_2 : Same posttest in both groups

This research was conducted in the even semester of the 2023/2024 academic year in one of the MAN in Bandung City. The population in this study were all students of class XI MIPA (11^{th} graders majoring math and science) and the sample was determined by convenience sampling technique. Therefore, class XI MIPA A was given treatment in the form of flipbook e-module-assisted 8e learning cycle model and class XI MIPA B in the form of 8e learning cycle without the help of the flipbook e-module.The independent variable in this study was the use of flipbook e-module, and the dependent variable was students' concept mastery. Meanwhile, the control variable is 8e learning cycle applied to the experimental and control classes.

The procedure in this research is divided into three stages, namely the preparation stage, the implementation stage, and the final stage. The following figure is an overview of the three stages of preparation, implementation, and final stage, which is used as a reference for the implementation of the research.

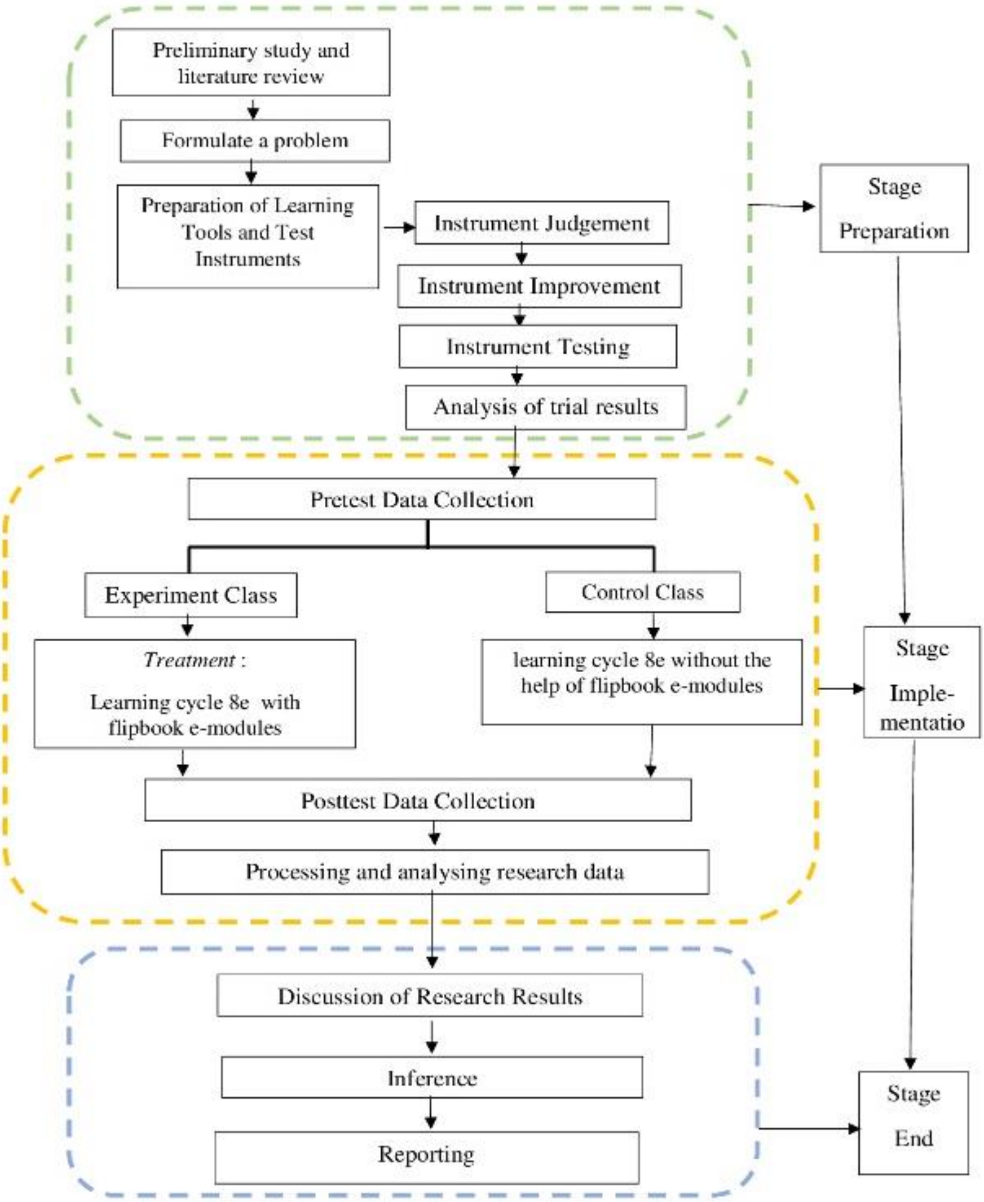

Figure 2. Research Procedure Chart

The data collection instrument used was a concept mastery test encompristing 12 items of two tier multiple choice questions that was valid and reliable, encomprised easy, medium, and difficult difficulty levels, and had good differentiating power. This instrument development technique is processed using Rasch Model analysis. This concept mastery test instrument was made with reference to the cognitive dimensions of Anderson & Krathwol's taxonomy (2010). The concept mastery indicators include remembering (C1), understanding (C2), applying (C3), analysing (C4), evaluating (C5), and creating (C6). In this test, four of the six indicators were chosen by the researcher, namely C2 to C5 as these are related to the dimensions of factual, conceptual, and procedural knowledge as a reference in making Competency Achievement Indicators. A total of 7 items were adapted and then modified from Meliyani Hasanah (2015), and 5 items were made by the researcher. This instrument was then applied before and after the learning treatment in the experimental and control classes. Each item consists of two tiers with a perfect score of 2 (mastering the concept). Thus, if you only answer correctly on one tier then you would only get a score of 1 (misconception), and if you answered incorrectly for both tiers then you would get a score of 0 (not mastering the concept) (Winari & Masturi, 2023). After given a score, the next step is to calculate the percentage of students who fall into the category of mastering the concept. The percentage is interpreted based on Arikunto's (2008) criteria in Hara et al. (2023) shown in Table 2 below.

Table 2. Concept Mastery Criteria

Percentage	Criteria
0% < P < 20%	Very Low
20% < P < 40%	Low
40% < P < 60%	Medium/Sufficient
60% < P < 80%	High
80% < P < 100%	Very High

The data analysis used is the N-gain test, which is to determine the increase in students' mastery of concepts. Normalised gain is the ratio between the gain score obtained by students and the maximum gain score that can be obtained. Mathematically it can be written as follows:

$$<g>=\frac{S_{post}-S_{pre}}{S_{maks}-S_{pre}} \quad (1)$$

with <g> being the normalised gain, S S_{post} the posttest score obtained by students, S_{pre} the pretest score obtained by students, and S_{max} the ideal maximum score. The interpretation of the normalised gain score is shown in Table 3 below.

Table 3. N-gain Score Interpretation

N-gain Score	Criteria
$g \geq 0,7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

Source: Hake, 1999

The pretest, posttest, and N-gain scores were also analysed using the shapiro-wilk test to determine whether the data were normally distributed. The normality test was conducted by comparing the significance P-value of the test results with the significance level (α = 0.05). If the P-value of significance of the test results is smaller than the significance level, the data is said to be not normally distributed. Meanwhile, if the P-value of significance of the test results is greater than and equal to the significance level, the data is said to be normally distributed.

Furthermore, the Levene test was conducted to determine whether the data variance was homogeneous. The results of the Levene test homogeneity test are obtained by comparing the significance value of the test results with the significance level (α = 0.05). If the significance value of the test results is smaller than the significance level, the data variance is said to be nonhomogeneous. Meanwhile, if the significance value of the test results is greater than and equal to the significance level, the data variance is said to be homogeneous.

If the data is normally distributed and homogeneous, then the hypothesis test, namely the independent t test, will proceed. However, if one or both of the data are not normally distributed, then, the mann-whitney test will proceed. This test was conducted using IBM SPSS Statistic 29. The test criteria for hypothesis testing based on the significance value and t value are shown in Table 4 which is as follows.

Table 4. Hypothesis Testing Criteria

Criteria	Conclusion
If sig. (2 −tailed) < α	H_0 is rejected and H_1 is accepted
If sig. (2− taled) ≥ α	H_0 is accepted and H_1 is rejected

Source: Santoso, 2014

The results of the test on the pretest and posttest data are used to determine whether there are differences in the concept mastery abilities in the two classes before and after the treatment. While the results of the test of the N-gain data are used to determine whether there is a significant difference in the improvement of the concept mastery in the two classes after learning.

RESULTS AND DISCUSSION

After obtaining pretest data from both classes, the data were then analysed and normality, homogeneity, and hypothesis tests were carried out using IBM SPSS Statistic 29. In data processing, the normality test used the shapiro-wilk test while the homogeneity test used the levene test. The results of pretest data processing are shown in Table 5.

Table 5. Pretest Data Processing Results

Data	Class	
	Experiment	Control
N	35	35
Mean	45.41	39.05
Median	41.70	37.50
Standard Deviation	17.91	15.65
Sig Normality	0.004	0.210
Sig Homogeneity	0.504	
Mann-Whitney Test Asymp. Sig (2-tailed)	0.201	

Based on Table 5, it is obtained that the average score of the experimental class pretest is greater than the control class. This means that the experimental class has a higher concept mastery ability than the control class. The distribution of pretest data in the experimental class is not normally distributed because the normality significance value is less than 0.05, while the distribution of pretest data in the control class is normally distributed because the normality significance value is more than 0.05. However, even so, the variance of the pretest data of both classes was homogeneous. This is indicated by the homogeneity significance value of more than 0.05. To find out whether there is a significant difference in the average pretest score between the experimental class and the control class, a non-parametric hypothesis test, namely the mann-whitney test, is carried out. This is because there is one data that is not normally distributed. The mann-whitney test results show that the asymp. Sig (2-tailed) is more than 0.05. This means that there is no significant difference in the average pretest score between the experimental and control classes. The percentage of students' concept mastery based on cognitive and material aspects is shown in Figure 3 and 4.

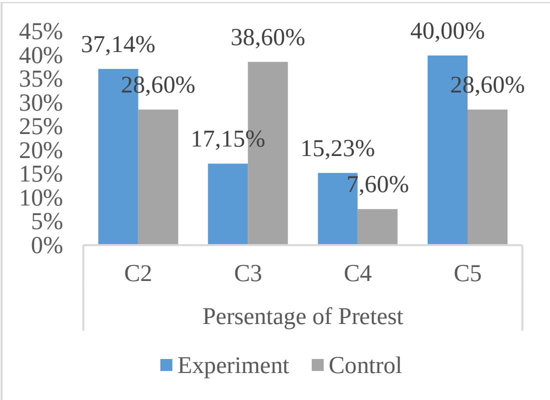

Figure 3. Percentage of Initial Concept Mastery Based on Cognitive Aspects

Based on Figure 3, for the cognitive aspects of C2, C4, and C5, the percentage of concept mastery in the experimental class is greater than in the control class, but for the cognitive aspect of C3, the percentage of concept mastery in the control class is greater than the experimental class. However, even so, based on the cognitive aspects, concept mastery of students in both classes fall into the category of "Low".

Based on Figure 4, on the basis of the aspects of heat and heat transfer material, the percentage of concept mastery in the experimental class is greater than that in the control class, with a large percentage difference of 3.91% and 3.60%, respectively.

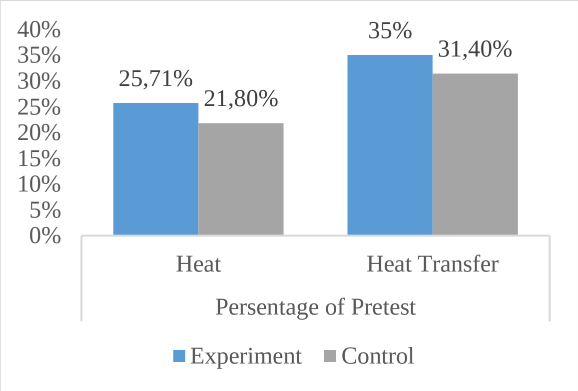

Figure 4. Percentage of Initial Concept Mastery Based on Material Aspects

But even so, from the material aspect, the initial concept mastery of students in both classes is included in the "Low" criteria. This shows that overall, students in both the experimental and the control class have low initial concept mastery abilities, even though the percentage of that in the experimental class students is greater than that in the control class students.

After the pretest, both classes continued with learning. The experimental class was treated with flipbook e-module-assisted 8e learning cycle model while the control class with only 8e learning cycle.

Table 6. Posttest Data Processing Results

Data	Class	
	Experiment	Control
N	35	35
Mean	80.11	55.11
Median	81.25	58.3
Standard Deviation	12.53	13.74
Sig Normality	0.064	0.023
Sig Homogeneity	0.478	
Mann-Whitney Test Asymp. sig (2-tailed)	<0.001	

Furthermore, both classes were given a posttest. The posttest data was then analysed and normality, homogeneity, and hypothesis test were conducted using IBM SPSS Statistic 29. In processing the normality test data, the researcher used the shapiro-wilk test while for the homogeneity test, the levene test. The results of posttest data processing are shown in Table 6.

Based on Table 6, the average score of the experimental class posttest is greater than the control class. This means that the experimental class has a higher concept mastery ability than the control class after being treated. The distribution of posttest data in the experimental class is normally distributed because the normality significance value is more than 0.05. Meanwhile, the distribution of posttest data in the control class is not normally distributed because the normality significance value is less than 0.05. However, even so, the variance of the posttest data of both classes is homogeneous. This is indicated by the homogeneity significance value of more than 0.05. To find out whether there is a significant difference in the average posttest score between the experimental class and the control class, a non-parametric hypothesis test, namely the mann-whitney test, is carried out. This is because there is one data that is not normally distributed. The mann-whitney test results show that the asymp. Sig (2-tailed) is less than 0.05. This means that there is a significant difference in the average posttest score between the experimental and control classes.

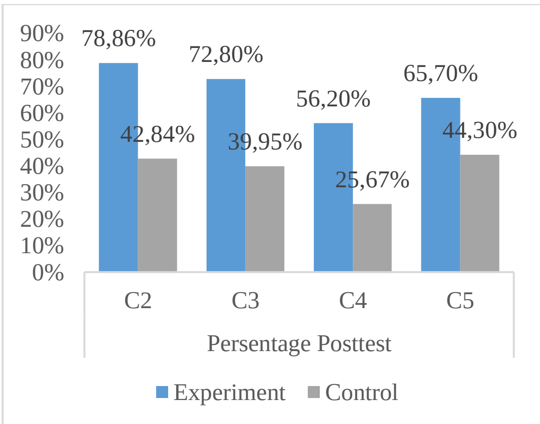

Figure 5. Percentage of Concept Mastery after Treatment Based on Cognitive Aspects

The percentage of students' concept mastery after being treated based on cognitive and material aspects is shown in Figures 5 and 6. Based on Figure 5, it is obtained that after being treated for cognitive aspects, the percentage of students' concept mastery in the experimental class is greater than that of students in the control class. Overall, the experimental class had an average percentage of concept mastery of 68.39%, which is included under the criteria "High", while the control class had an average percentage of concept mastery of 38.19% which is included under the criteria "Low".

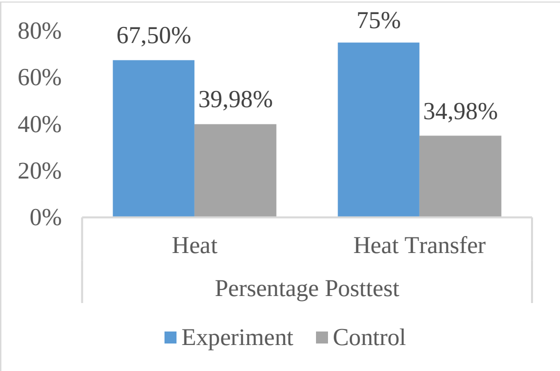

Figure 6. Percentage of Concept Mastery After Treatment Based on Material Aspects

Based on Figure 6, it is obtained that based on the material aspect, the percentage of students' concept mastery in the experimental class is greater than that of students in the control class. The experimental class had an average percentage of 71.25% which is included under the "High" criteria, while the control class had an average percentage of 37.48% which is included under the "Low" criteria.

From the explanation above, it can be concluded that as regards the students' ability to master concept after being treated for both the cognitive aspect and the material aspect, students in the experimental class have a higher concept mastery ability than students in the control class.

To find out the increase in the concept mastery of the experimental and control class students, the N-gain test was used. In this study, the N-gain value was processed using the IBM SPSS Statistic 29 application. After processing, the resulting data is then interpreted into several categories. The following is a summary of the results of N-gain data processing in both classes (shown in Table 7).

Table 7. Summary of N-gain Data Processing Results

	Experimental Class' N-gain			Control Class' N-gain		
	High	Medium	Low	High	Medium	Low
Number of students	15	17	3	0	11	24
Percentage	42.8 %	48.6 %	8.6 %	0 %	31.4 %	68.6 %
Mean	0.81	0.5	0.15	0	0.47	0.13
		0.60			0.24	

Based on Table 7, for the experimental class, as many as 3 students obtain the N-Gain category "Low", 17 students obtain the N-gain category "Medium", and 15 students the N-gain category "High". This means that there are still some students with low concept mastery improvement, but most students in the experimental class have improved concept mastery. This is indicated by the average N-gain value of 0.60 (under the "Medium" category). As for the control class, the data obtained suggested that as many as 24 students obtain the N-gain category "Low", while 11 with the N-gain category "Medium". There are no learners with the N-gain category "High". This shows that most students in the control class experienced a low increase in concept mastery. This is also indicated by the average N-gain value of 0.24 in the "Low" category.

From the explanation above, it can be concluded that the application of the 8e learning cycle model in the experimental and control classes can improve students' mastery of concepts. This is in line with research conducted by Elsa Mahardika (2018) which found that by applying the 8e learning cycle model, the percentage of students who experience misconceptions decrease and the percentage of students who understand the concept increases.

However, although both classes experienced an increase in concept mastery, students in the experimental class had a higher concept mastery ability than the control class. This can happen because in the experimental class the learning is assisted by flipbook e-module which are arranged systematically so that learning is more directed and students are to find sources of information and understand the material easily. The material in the flipbook e-module is presented in an interesting and interactive manner and is equipped with learning videos so that students do not only read the material in reading form when conducting information studies. In addition, this flipbook e-module can be used anytime and anywhere. In this case, learning can be done in class or outside the classroom, so that students can repeat and study the material that has been learned independently. This is also in line with Hamdani's (2011) statement in Fanani (2021) that the benefits of e-modules for students include training students to learn independently, being able to study material outside of class hours so that they are more free to express their learning methods, having the opportunity to test themselves, being able to teach themselves, and developing students' ability to directly interact with the environment and learning resources.

To find out whether or not there is a difference in the increase in the concept mastery of students in experimental and control class, a hypothesis test is carried out. The hypothesis test results using IBM SPSS 29 are shown in Table 8.

Table 8. Hypothesis Test Result N-gain Data

Data	Class	
	Experiment	Control
N	35	35
Sig Normality	0.440	0.019
Sig Homogeneity	0.278	
Mann-Whitney Test Asymp. sig (2-tailed)	<0.001	

Based on Table 8, it is obtained that the distribution of N-gain data in the experimental class is normally distributed because the normality significance value is more than 0.05. Meanwhile, the distribution of N-gain data in the control class is not normally distributed because the normality significance value is less than 0.05. However, even so, the variance of the N-gain data of both classes was homogeneous. This is indicated by homogeneity significance value of more than 0.05. The hypothesis test used a non-parametric statistical test namely the mann-whitney test because there is one data that is not normally distributed. The mann-whitney test results show that the asymp. Sig (2-tailed) is less than 0.05. This means that there is a significant difference in concept mastery improvement between the experimental and the control class. Percentage of the increase in students' concept mastery based on cognitive and material aspects is shown in Figure 7 and 8.

Figure 7 displays the data which shows that for cognitive aspects C2, there was a 33.2% percentage difference in students' concept mastery between the experimental and control groups; for cognitive aspects C3, the difference was 54.65%; for cognitive aspects C4, the difference was 25.9%; and for cognitive aspects C5, the difference was 9.8%.

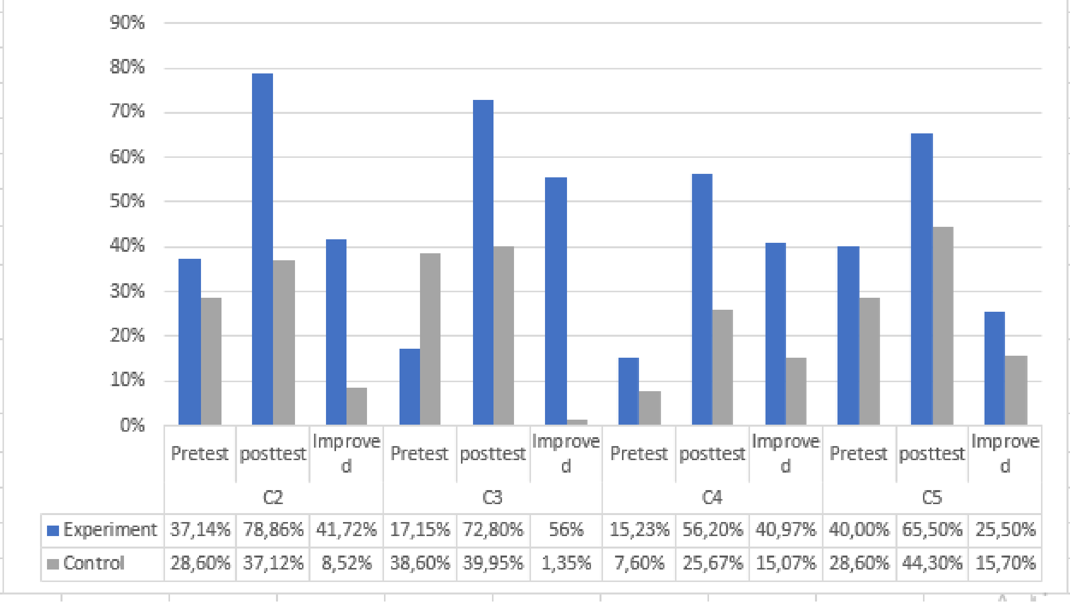

Figure 7 . Percentage of Concept Mastery Improvement Based on Cognitive Aspects

This shows that there is a significant difference in the increase in the concept mastery of the students of the experimental and the control classes, especially in the cognitive aspect of C3.

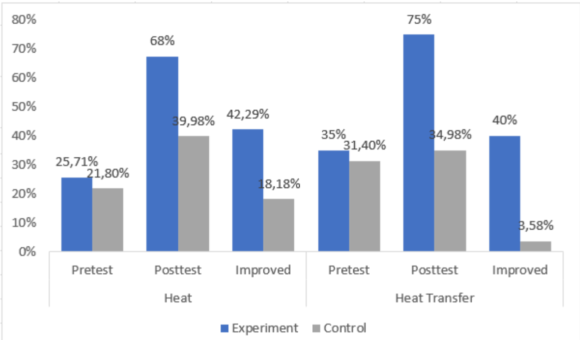

Figure 8. Percentage of Concept Mastery Improvement Based on Material Aspects

Figure 8 displays the results which indicates that there is a 24.11% percentage difference in the experimental class's and the control class's gain in concept mastery for the heat material and a 36.42% percentage difference for the heat transfer material. This shows that there indeed is a significant difference in the increase in concept mastery between the students of the experimental class and those of the control class—especially in the aspect of heat transfer material.

Because there is a significant difference in the increase in students' concept mastery between the experimental and control classes, it can be concluded that the flipbook e-module-assisted 8E learning cycle model has an influence on increasing students' concept mastery. This is in line with the results of research conducted by Nerliana and Retno (2022), which concluded that the learning outcomes of students using e-module-assisted 8E learning cycle model were higher than the standard score for the Minimum Completeness Criteria (KKM) set.

In line with that, the results of research conducted by Sugiharti et al., (2019) concluded that the use of e-module-assisted learning cycle model is more effective for improving critical thinking skills rather than just using the learning cycle model alone. This is because students have to look for material using e-modules and connect the learning material themselves instead of just receiving all learning material from educators. Whereas in this study, the researcher aims to see the effect of the flipbook e-module-assisted 8E learning cycle model on improving students' concept mastery on heat and heat transfer material. In addition, the results of research conducted by Wika Junilita, Muhammad Syafi'i, and Azhar (2022) also found that the media innovation-assisted 8e learning cycle model can have an influence on students' concept mastery. In the study, students experienced an increase in concept mastery by 73%.

CONCLUSION

Based on the results of the study, flipbook e-module-assisted 8e learning cycle has an influence on the improvement of students' concept mastery. This is indicated by the significant difference in the concept mastery of the experimental class treated with flipbook e-module-assisted 8e learning cycle and the control class treated with only 8e learning cycle—especially in the cognitive aspect of C3 which is 54.65% and the material aspect of heat transfer which is 36.42%.

Learning using the flipbook e-module-assisted 8e learning cycle can help teachers improve the quality of physics learning, especially in improving students' concept mastery on heat and heat transfer material. In addition, with this learning, students are actively involved in the learning process. Such thing can increase students' interest in learning which has an impact on increasing students' mastery of concepts.

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