JIPF (JURNAL ILMU PENDIDIKAN FISIKA)
p-ISSN: 2477-5959 | e-ISSN: 2477-8451 *Vol. 8 No. 1, January 2023, Page 118-129*

Analysis of the Effect of Learning Models and Gender on Students' Critical Thinking Skills

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Received: November 14th, 2022. Revised: December 10th, 2022. Accepted: January 16th, 2023

Keywords :
Critical Thinking; Demonstration; Gender; ILD Model

ABSTRACT
This study analyzes the implementation of the Interactive Lecture Demonstration (ILD) model and the influence of gender on critical thinking skills in momentum and impulse. This study used a quasi-experimental with a pretest-posttest control group design. The research instruments were observation sheets and critical thinking skills tests. The analysis data were calculating the percentage of activity on the observation sheet, N-Gain, and independent-sample t-test. The results showed that percentage of learning in the experimental class (ILD) for teacher activities was 76% and for students were 77% in a good category. The control class (demonstration) for teacher and student activity was 77% in a good category. The average N-Gain of the experimental class was 0.62 and the control class was 0.55 in the medium category. The t-test results showed that there were differences in the improvement of students' critical thinking skills in the experimental class and the control class. Besides, gender has no effect on students' critical thinking skills in the experimental class. Meanwhile, in the control class, gender affects students' critical thinking skills. Thus, the implementation of the ILD model can improve students' critical thinking skills. Gender does not affect students' critical thinking skills in the ILD model.

INTRODUCTION

The 21st century is a globalisation century that offers a world without a frame in which the flow of globalisation, internationalisation, and developments in technology, information, and communication is increasingly rapid [1]. The development of science and technology has changed the learning paradigm marked by changes in curriculum, media, and technology so that in this century it should have the skills to face the challenges of the 21st century [2] [3]. The skills possessed in the 21st century are career and life skills, innovation and learning skills as well as media, information and technology skills [4] [5]. These skills consist of several aspects that students must have, including learning and innovation skills that consist of four aspects: critical thinking, communication, collaboration, and creativity [6] [7] [8].

Critical thinking is the use of thinking strategies that are used to increase the likelihood of a desired result [9]. Critical thinking skills are skills in examining assumptions, evaluating evidence and assessing conclusions that can improve the quality of decision making [10] [11]. Critical thinking skills are problem-solving activities conducted to prove an absolute problem towards contextual knowledge [12] [13]. Critical thinking skills can enhance experience and help students think more forward, creatively and have a strong motivation as capital to face the development of science and technology in the 21st century [14] [15].

The low critical thinking skills are due to the lack of innovative learning media used by teachers in the learning process [16]. the low critical thinking skills are due to the low level of argumentation and problem-solving skills in students [17]. Besides, the low critical thinking skills are due to the less interactive learning process and the lack of training in critical thinking skills [18] [19] [20].

The low level of critical thinking skills in students' needs to be improved to face the development of the 21st century. However, improving critical thinking skills cannot automatically be realized but requires a process, the wrong process is problem-solving, in which solving problems students must think so that by thinking students can practice critical thinking skills. Learning that is conducted must apply a learning model based on interactive and contextual problem-solving. One of them is the Interactive Lecture Demonstration-learning model (ILD).

Interactive Lecture Demonstration (ILD) is an active learning model that is conducted through problem-solving in improving contextual learning and student understanding [21] [22]. ILD learning is conducted by predicting possible phenomena and proving them through experimental observation and discussion so that students become interactive [23]. ILD learning can improve concept understanding, problem-solving skills, and enhance interactive learning. However, ILD learning takes a long time, requires creativity and great direction from the teacher.

Research conducted by several studies on ILD learning suggests that ILD learning can enhance active and contextual learning. ILD learning can improve high-level skills. ILD learning can minimise misconceptions [24]. Besides, ILD learning can improve conceptual student's understanding [25].

METHOD

This study used a quasi-experimental method with a pretest-posttest control group design [26]. This study used two classes, namely the experimental class for the experimental class the learning was conducted using the Interactive Lecture Demonstration (ILD) model and the control class used the demonstration model. Research design provides in Table 1.

Table 1. Research Design

Group	Pre	Treatment	Post
Experiment	O_1	X	O_2
Control	O_1	C	O_2

The population of this study were students of class X SMAN 1 Kabandungan which consisted of 2 classes with 66 students. The sample used consists of two classes that have heterogeneous abilities, namely class X IPA 1 as an experimental class consisting of 17 female students and 16 male students. Class X IPA 3 as a control class consisting of 22 female students and 11 male students. The research sample was taken using the simple random sampling technique.

The research instruments used were the observation sheet and critical thinking skills test. The observation sheet is used to obtain data on the implementation of ILD learning with stages 1) prediction 2) observation 3) discussion 4) synthesis [21]. Each meeting-learning ILD consists of 23 activities including teacher and student activity. Besides, in control class that used a demonstration

model conducting by following scientific approach that is observing, asking, gathering information/experiments; associating or processing information and communicating. Each meeting-learning demonstration model consists of 20 teacher and student activities. Learning implementation is shown by calculating the average percentage of learning implementation and interpreting it into several criteria (less, medium, good, and excellent).

Critical thinking skills tests conducted on the pre-test and posttest with 12 items based on indicators of critical thinking skills, which are 1) reasoning; 2) hypothesis testing; 3) argument analysis, 4) probability and uncertainty analysis 5) problem solving [12]. The improvement of students' critical thinking skills is shown by calculating the average N-gain score and interpreting it into categories (low, medium, and high) [27]. Hypothesis testing is done using the parametric statistic t-test independent of sample test because the data obtained in two classes with different samples are normally distributed and homogeneous. The data were analyzed by competencies, group, and case (student gender).

RESULTS AND DISCUSSIONS

Analysis data on the implementation of learning conducted using the Observation Sheet (OS). The activities of teachers and students in the experimental class (ILD model) can be seen in Table 2.

Table 2. The Average Teacher and Student Activity in Each Meeting

Syntax	Activity of teacher (%)				Activity of students (%)			
	Each meeting			$\bar{x}$	Each meeting			$\bar{x}$
	I	II	III		I	II	III	
Prediction	67	73	83	74	70	73	87	77
Observation	63	71	80	71	65	71	80	72
Discussion	67	74	93	78	67	73	87	76
Synthesis	69	85	91	81	73	84	93	84
Sum	266	303	348	304	275	302	347	308
Mean	66	76	87	76	69	76	87	77
Interpretation	Enough	Good	Excellent	Good	Enough	Good	Excellent	Good

The implementation of teacher and student activities in learning with the ILD model is categorised as good with a percentage of 76% teacher implementation and 77% student implementation. Student implementation has a higher average than teacher implementation. Because the synthesis stage of each student meeting has a greater percentage so that students are more interactive than the teacher. The Learning ILD model can improve active learning in students so that learning becomes more meaningful [21] [23].

The implementation of teacher and student activities has increased at each stage. The highest average teacher and student activity was obtained at the synthesis stage by 81% teacher activity and 84% student activity in the very good category. The teacher can direct and guide students well so that students can solve problems, validate predictions, and devise conclusions based on observations well. ILD model learning can validate predictions made by students through observation activities so that it can improve students' understanding of concepts [22].

The lowest average teacher and student activity are at the observation stage of 71% of teacher activity and 72% of student activity is in enough category. Students are not used to conducted observations through virtual labs with the PhET simulation application and teachers are less able to guide students in implementing it. Students have difficulty retrieving observational data. PhET simulation is only a simulation that has no instructions on how to use it. So, requires guidance so that the learning process runs well and effectively [28] [29].

Analysis data on the implementation of learning conducted using the observation sheet. The activities of teachers and students in the control class (the demonstration model with a scientific approach) can be seen in Table 3.

Table 3. The Average Teacher and Student Activity in Each Meeting

Activity	Activity of teacher (%)				Activity of students (%)			
	Each meeting			$\bar{x}$	Each meeting			$\bar{x}$
	I	II	III		I	II	III	
Observing	68	87	87	80	60	80	87	76
Questioning	65	80	93	79	65	90	87	81
Applying	64	73	80	72	60	65	80	68
Reasoning	67	67	87	73	67	73	90	77
Communicating	69	74	93	79	73	80	93	82
Sum	333	381	440	385	325	388	436	383
Mean	67	76	88	77	65	78	87	77
Interpretation	Enough	Good	Excellent	Good	Enough	Good	Excellent	Good

Teacher and student implementation activities in learning with the demonstration model are categorised as good with a percentage of 77% in teacher and student activities. Teachers and students at each stage of the demonstration model with a scientific approach are not dominant and have the same opportunity to be active. The implementation of teacher and student activities has increased at each stage. The ILD model is active learning that is conducted by predicting and solving problems through the observation process [30] [31].

The highest average teacher activity was obtained at the observing stage by 80% with a good category. Teachers can provide contextual videos and motivate students to learn. However, the student's response was not good in observing the video so that the highest activity for students was the communicating stage. Students are more enthusiastic in formulating questions and presenting the results of discussions with the group in front of the class. But they are still less active in responding and expressing their own opinions so that learning is less interactive. Demonstration learning requires careful preparation and requires teacher creativity in delivering teaching materials. Thus, students can understand the material and make opinions when discussing learning a more interactive [32]. One of the shortcomings of learning with a virtual lab is that students have difficulty understanding the language of instruction used in the software so that it is difficult to conducted observations [28].

The lowest average teacher and student activity at the application stage were 72% teacher activity and 68% enough category student activity. The students are less enthusiastic in the learning process so that teachers are more interactive. However, teachers are still not maximal in guiding students in finding information. The teacher in demonstration learning affects choosing the right learning material and preparing all the needs needed in the learning process [33].

The improvement of students' critical thinking skills used the N-gain analysis of the pre-test and posttest results on the concepts of momentum and impulse. The data of the pre-test, posttest, and the N-gain analysis in the experimental and control classes can be seen in Table 4.

Table 4. The Pre-Test, Posttest, and N-Gain of Critical Thinking Skills

Group	Average			
	Pre	Post	<g>	explanation
Experiment	30	73	0.62	Medium
Control	32	69	0.55	Medium

The improvement of students' critical thinking skills in both classes was included in the medium category. The average N-Gain in the experimental class (0.62) was greater than the control class (0.55). This difference occurs because in ILD learning there are observation and synthesis stages. Both

of these stages can increase student activeness in developing critical thinking skills. The ILD model is learning that can enhance active learning through observation and synthesis activities. The pre-test, posttest, and N-gain score data for each indicator of critical thinking can be shown in Table 5.

Table 5. The Pre-test, Posttest, and N-Gain for Each Indicator of Critical Thinking Skills

CTS indicators	Average							
	Experiment class				Control class			
	Pre	Post	<g>	explanation	Pre	Post	<g>	explanation
Reasoning	23	67	0.57	Medium	42	75	0.58	Medium
Hypothetical testing	29	72	0.60	Medium	24	66	0.55	Medium
Argumentation analysis	35	82	0.73	High	39	76	0.61	Medium
Analysis of probability and uncertainty	43	77	0.55	Medium	30	64	0.48	Medium
Problem solving	23	75	0.67	Medium	31	67	0.52	Medium
Average	31	74	0.62	Medium	33	70	0.55	Medium

The highest increase in critical thinking skills is found in the argument analysis indicator of 0.73 in the experimental class and 0.61 in the control class. The difference in this increase shows that ILD learning improves student argumentation analysis in solving a problem. ILD learning model is active learning that can improve problem-solving skills [24]. The lowest increase in critical thinking skills is the probability and uncertainty analysis indicator of 0.55 in the experimental class and 0.48 in the control class. Students are still less interactive in understanding information and predicting events in solving problems. Student activeness in the learning process is an important and fundamental issue that must be understood. Student activeness can foster interest in learning. Besides, students can understand the material easily and can apply it to solve a problem [34]. Data on the pre-test, posttest, and N-gain scores critical thinking skills for each sub-concept of momentum and impulse in the experimental and control classes can be seen in Table 6.

Table 6. The Pre-test, Posttest, and N-Gain of Critical Thinking Skills for Each Sub-Concept

Subjects	Average							
	Experiment class				Control class			
	Pre	Post	<g>	explanation	Pre	Post	<g>	explanation
Momentum dan impuls	32	70	0.57	Medium	32	68	0.53	Medium
Law of conservation of momentum	25	79	0.72	High	32	62	0.43	Medium
Collision	30	71	0.59	Medium	35	74	0.60	Medium
Average	29	74	0.62	Medium	33	68	0.55	Medium

The highest increase in the experimental class is the concept of the law of conservation of momentum with an N-gain of 0.72. The control class has the highest increase in the collision concept with an N-gain of 0.60. The lowest increase in the experimental class on the concept of momentum and impulse with an N-gain of 0.57. The lowest increase in control class is on the law of conservation of momentum with an N-gain of 0.43. The low increase occurred because learning the concepts of momentum and impulse with the ILD model was applied for the first time so that it had not run optimally. Besides, in the control class, learning the law of conservation of momentum is conducted in the last hour of learning. Many students do not focus on implementing learning. Learning in the last hour resulted in reduced interest in learning and the level of focus in students' thinking.

Data on the pre-test, posttest, and N-gain scores for critical thinking skills of each gender in the experimental and control classes can be seen in Table 7.

Table 7. The Pre-Test, Posttest, and N-Gain of Critical Thinking Skills of Gender

Gender	Average							
	Experiment class				Control class			
	Pre	Post	<g>	Explanation	Pre	Post	<g>	explanation
Female	30	73	0.62	Medium	28	69	0.56	Medium
Male	29	72	0.61	Medium	34	69	0.53	Medium

The increase in critical thinking skills of female students has a higher increase than that of male students. N-gain of critical thinking skills of female students is 0.62 in the experimental class and 0.56 in the control class. N-gain critical thinking skills of male students of 0.61 in the experimental class and 0.53 in the control class. This difference is because the number of female students in the experimental and control classes has a greater number than male students. Besides, female students are more interactive and enthusiastic in the learning process. Interactive learning can improve problem-solving skills, critical thinking skills, collaboration, and communication [35] [36]. Data on the pre-test, posttest, and N-gain scores for critical thinking skills of indicator of each gender in the experimental class can be seen in Table 8.

Table 8. The Pre-test, Posttest, and N-Gain for Each Indicator of Critical Thinking Skills for Gender

CTS indicators	Experiment class							
	Female				Male			
	Pre	Post	<g>	Explanation	Pre	Post	<g>	explanation
Reasoning	**48**	**76**	**0.55**	**Medium**	**38**	**73**	**0.56**	**Medium**
Hypothetical testing	28	73	0.62	Medium	29	70	0.58	Medium
Argumentation analysis	29	82	0.75	Medium	41	80	0.66	Medium
Analysis of probability and uncertainty	25	67	0.56	Medium	20	66	0.58	Medium
Problem solving	25	71	0.62	Medium	22	78	0.72	Medium
Average	31	74	0.63	Medium	30	73	0.62	Medium

The improvement of critical thinking skills in the experimental class between male and female students is different. The increase in critical thinking skills of female students was higher by 0.63 than male students at 0.62. Female students at the synthesis stage are more enthusiastic and interactive than male students. The highest increase indicators of critical thinking skills of female students were an argumentation analysis of 0.75. While male students were a problem-solving indicator of 0.72. The lowest improvement indicators of critical thinking skills were the reasoning of 0.55 for female students and 0.56 for male students. Students are still not used to provide predictions and prove them through observation. Critical thinking is the ability to make predictions and make logical decisions [12].

Data on the pre-test, posttest, and N-gain scores for critical thinking skills of sub concept of each gender in the experimental class can be seen in Table 9.

Table 9. The Pre-Test, Posttest, and N-Gain Critical Thinking Skills of Sub Concept of Gender

Subject	Experiment class							
	Female				Male			
	Pre	Post	<g>	Explanation	Pre	Post	<g>	explanation
Momentum dan Impuls	34	71	0.57	Medium	34	69	0.53	Medium
Law of conservation of momentum	26	79	0.72	High	23	79	0.72	High
Collision	30	70	0.60	Medium	27	71	0.61	Medium
Average	30	74	0.63	Medium	28	73	0.63	Medium

The increased critical thinking skills of female and male students in each sub-concept have the same of 0.63. The highest critical thinking skills of female and male students were a concept of the law of

conservation of momentum of 0.72. The lowest critical thinking skills of male and female students were concepts of momentum and impulse. The N-gain of critical thinking skills of females (0.57) was higher than male students (0.53) on the concepts of momentum and impulse. ILD model is conducted collaboratively can improve students' understanding of concepts.

Data on the pre-test, posttest, and N-gain scores for critical thinking skills of indicator of each gender in the control class can be seen in Table 10.

Table 10. The Pre-Test, Posttest, and N-Gain for Each Indicator of Critical Thinking Skills for Gender

CTS indicators	Control Class							
	Female				Male			
	Pre	Post	<g>	Explanation	Pre	Post	<g>	explanation
Reasoning	42	74	0.55	Medium	43	76	0.58	Medium
Hypothetical testing	23	62	0.50	Medium	25	68	0.57	Medium
Argumentation analysis	28	77	0.68	Medium	44	76	0.57	Medium
Analysis of probability and uncertainty	32	72	0.59	Medium	31	65	0.49	Medium
Problem solving	18	64	0.56	Medium	34	64	0.46	Medium
Average	29	70	0.58	Medium	35	70	0.53	Medium

The improvement of indicators of critical thinking skills of female and male students was different. The increase in indicators of critical thinking skills of females (0.58) was higher than male students (0.53). Females were better than male students at critiquing and evaluating information. The highest increase in indicator of critical thinking skills in argument analysis. Female students (0.68) were greater than male students (0.57). The lowest increase was probability and uncertainty analysis of female (0.59) and male students (0.49). Male students were not used to analyse the possibility and predicting a problem. Learning is conducted without solving a problem results in less development of thinking patterns. Students are less trained in critical thinking skills [37].

The increase in critical thinking skills of each sub-concept of each gender in the control class is shown in Table 11.

Table 11. The Pre-test, Posttest, and N-Gain Critical Thinking Skills of Sub Concept of Gender

Subject	Experiment class							
	Female				Male			
	Pre	Post	<g>	Explanation	Pre	Post	<g>	Explanation
Momentum dan Impuls	35	68	0.51	Medium	28	70	0.58	Medium
Law of conservation of momentum	32	61	0.43	Medium	33	62	0.44	Medium
Collision	40	74	0.57	Medium	23	72	0.63	Medium
Average	36	68	0.50	Medium	28	68	0.56	Medium

Female students achieve an N-gain of 0.50 and 0.56 in males. The demonstration learning focuses more on teachers and students are less interactive in finding concepts. Learning is less meaningful and understanding of the concepts obtained by each student is different, both men and female. The highest increase in critical thinking skills in the collision concept was 0.57 for female students and 0.63 for male students. The lowest improvement of critical thinking skills on the concept of law conservation of momentum was 0.43 for female students and 0.44 for male students. Teacher-focused learning activities result in lower student achievement [38].

The normality test using the chi-square test (Chi-Squared) in the experimental class and control class was conducted before testing the hypothesis. The results of the normalization test are shown in Table 12.

Table 12. The Result of Test Normality of the Experimental and Control Classes

Criteria	Experiment class		Control class	
	Pre	**Post**	**Pre**	**Post**
Participants	33	33	33	33
x^2_{count}	6.41	5.83	5.63	0.15
x^2_{table}	11.07	11.07	11.07	11.07
Result	$x^2_{count}<x^2_{table}$	$x^2_{count}<x^2_{table}$	$x^2_{count}<x^2_{table}$	$x^2_{count}<x^2_{table}$
Interpretation	Normal distributed	Normal distributed	Normal distributed	Normal distributed

The results of calculations using the chi-square test pre-test and posttest data in the experimental class showed a normal distribution. The calculation result shows X2count was smaller than X2table. The same results were also shown in the control class. The pre-test and pre-test data showed that the data were normally distributed. After conducting the normality test, the homogeneity test was conducted. The results of the homogeneity test can be seen in Table 13.

Table 13. The Result of Homogeneity Test

Criteria	Pre	Post
Participants	33	33
Standard deviation $1(S1)^2$	90.61	79.14
Standard deviation $2(S2)^2$	65.67	25.43
F_{count}	0.72	0.32
F_{table}	4.16	4.16
Result	$F_{count} < F_{table}$	$F_{count} < F_{table}$
Interpretation	Homogeneous	Homogeneous

Homogeneity test data results on the pre-test data show Fcount (0.72) was smaller than Ftable (4.16). The data pre-test was homogeneous. The posttest data show the same results Fcount (0.32) was smaller than Ftable (4.16). The data posttest was homogeneous.

The results of the normality test and homogeneity test showed that the data were normally distributed and homogeneous. Hypothesis testing uses the paired independent sample t-test. This hypothesis test is conducted to determine whether the proposed hypothesis is accepted or rejected. Hypothesis test results are shown in Table 14.

Table 14. Hypothesis Test of Learning Models

	t	**df**	**Sig. (2-tailed)**
Equal variances assumed	3.021	64	0.004

The results of the calculation of the hypothesis test are obtained significance of t-test less than 0.05. Thus, there are differences in students' critical thinking skills in the class experiment (ILD model) and the class control (demonstration model) on momentum and impulse concept. The increase in critical thinking skills in the ILD model is higher than in the demonstration model. However, the increase in students' critical thinking skills was still in the medium category. Students' critical thinking skills can be trained and developed when they are actively involved in learning. Learning using ILD can increase student activity and makes learning more meaningful [23] [39] [40]. Students' critical thinking skills on indicators of argument analysis, problem-solving and decision making can develop well. Problem-solving skills can practis critical thinking skills [41].

The results of testing the hypothesis of whether there is an effect of gender on students' critical thinking skills in the experimental (ILD model) and control classes (demonstration model) are shown in table 15.

Table 15. Hypothesis Testing the Effect of Gender on Students' Critical Thinking Skills

Class	t	Df	Six. (2-tailed)
Experiment	0.129	31	0.898
Control	-2.569	31	0.015

There is no gender effect on students' critical thinking skills in the experimental class (ILD model). The result shows a significance value of 0.898 more than 0.05. Thus, in the ILD model, male and female students can better follow instructions. The ILD model can shift the gender gap in learning to improve critical thinking skills. This finding is confirming the finding by other research when learning activities are designed properly, gender differences in learning can be minimised.

Score in experiment class different from the results obtained in the control class (demonstration model). Gender affects students' critical thinking skills. This is indicated by the significance value for the control class with 0.015 that less than 0.05. This was based on differences in the tendency between male and female students to receive information. Female students are more likely to be dominant in receiving verbal information. Male students are more likely to think analytically. In the demonstration model, the presentation of information tends to verbalise. It indirectly benefits female students. Thus, females get better than male students.

Limitations and Further Research

The lowest stage in learning the ILD model is the observation stage. The stage of observation does with simulations if students are accustomed to conducted using a virtual laboratory. The learning process effectively run and does not take a long time. Besides, teachers should be guide students at each stage of the activities conducted. Each stage can be conducted optimally.

The lowest increase in sub-indicator of critical thinking skills is an analysis of probability and uncertainty. The problems given are more contextual. Students can understand the problems presented based on experiences in everyday life. Male and female students are given equal opportunities to be active during learning. Thus, gender does not affect improving students' critical thinking skills. Besides, the student worksheet is used to develop the level of critical thinking skills of students. Thus, indicators of critical thinking skills of students can be trained properly.

CONCLUSION

We have successfully researched to analyse the implementation of the ILD model and the influence of gender on students' critical thinking skills on the concepts of momentum and impulse. The results of the analysis of the observation sheet showed the average activity of teachers and students in learning the concepts of momentum and impulse has increased every meeting. The implementation of the ILD model in the class experiment was 76% teacher and student activities of 77%. The implementation of the demonstration model in the class control was 77% in teacher and student activities. The learning implementation in both classes is categorized as good. The results of the N-gain critical thinking skills of students have increased in the class experiment (ILD model) of 0.62 and the class control (demonstration model) of 0.55. The increase in critical thinking skills of students in each class in the medium category. The results of the hypothesis test there was a difference in the increase in critical thinking skills of students in the ILD model and the demonstration model. Gender does not affect students' critical thinking skills in a class that applies the ILD model. Whereas in a class that uses a demonstration model, gender affects students' critical thinking skills. Increasing student's critical thinking skills can be improved by providing a more concrete and contextual problems. Gender will affect students' critical thinking skills, depending on the readiness of teachers and students in conducting various activities during learning.

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