The Level Affected of Investigation-Based Group Inquiry Model on Student Cognitive Learning Outcomes

Jurubahasa Sinuraya[1], Motlan[2], Satria Mihardi[3]

{jurubahasa@unimed.ac.id[1], motlan@unimed.ac.id[2], mihardi@unimed.ac.id[3]}

Physics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, Medan, Indonesia[1,2,3]

Abstract. The average cognitive test results for students studying general physics over the past four years were lower than the required minimum standard scores. This data shows that the cognitive competence of students as candidate teachers of High School Physics is still low. The Inquiry-based group inquiry model is applied still very rarely in the learning process. This study aims to determine the level of effect of the investigation-based group inquiry model on student cognitive learning outcomes. The instrument consists of 15 multiple-choice questions relating to Newton's theories of motion. Data analysis techniques used independent t-tests to evaluate significant differences. The result of the study is implied in the average value between the experimental class and the control class. These results demonstrated that the investigation-based group inquiry model was quite effective in improving student competence on the matter of Newton's laws of movement.

Keywords: Cognitive; Inquiry Group; Investigation; Learning Models; Learning Outcomes

1 Introduction

Inquiry is the key to developing and increasing individual knowledge [1]–[3]. Through inquiry activities, students have a very deep curiosity that can be expressed. Expressing curiosity becomes a process in learning to find information as a basis for the solutions presented. Physics needs individuals who have a strong inquiry to express it. Without inquiry, students are not very enthusiastic about studying physics. Inquiry is the main thing that every student must have in learning something. This is what encourages the development of inquiry-based learning. Starting with approaches/strategies, methods, and learning models. This is in line with the learning achievements that each learner wants to achieve by considering related learning theories. However, in its implementation, there are still many shortcomings and weaknesses found in the implementation of the activities in question. These weaknesses have an impact on the lack of optimal learning outcomes obtained by students.

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Data that illustrates that student learning outcomes are not yet optimal is obtained from the results of students' cognitive tests in general physics courses for the last four years, which on average are smaller than the minimum standard score [4]. This data illustrates that students' cognitive competence as prospective high school physics teachers is still lacking. Efforts that have been made to improve students' cognitive competence include the existence of school physics courses. Material that students have not mastered in General Physics lectures can be followed up for improvement in school physics courses. It is hoped that continuous improvements in students' mastery of concepts will be able to meet student competency standards in teaching physics in schools in general, especially at the high school level. One of the classes of school physics courses is a high school physics course. The objectives of this course include reducing misconceptions and increasing students' mastery of physics concepts taught at the school level, especially in high school [5].

Another effort that is no less important in improving the quality of student learning processes and outcomes is establishing a learning model. One of the learning condition variables that must be considered in determining the learning model is the nature of the course itself [6]. The essence of science is a body of knowledge (science as a collection of knowledge), a way of thinking (science as a way of thinking), and a way of investigating (science as a way of inquiry) [7]. This shows that learning science/physics involves the use of several five senses, hands-on, and mind. Inquiry is a process that students take to solve problems, plan experiments, conduct experiments, collect and analyze data, and draw conclusions.

The connection between the advantages of inquiry learning and the nature of science/physics as a whole is an appropriate strategy to be developed into an alternative learning model for achieving effective learning goals, allowing the learning process to be more flexible and interesting compared to the advantages of face-to-face learning, and the learning used by lecturers will become more meaningful (meaningful learning) so that improvements in students' inquiry abilities can be optimized in facing the competition of today's life. The application of inquiry-oriented learning shows that student learning outcomes taught with inquiry-based innovation are better and can improve student inquiry [8]–[11]. Through inquiry strategies, students' abilities can be maximally involved in searching and investigating systematically, critically, logically, and analytically, so that they can formulate their findings with full confidence [12]. One learning model that is oriented to the nature of science and inquiry is the investigation-based group inquiry model. Empirical evidence for this model is still limited to limited trials, concluding that the investigation-based group inquiry model is quite effective in improving student learning outcomes with a normalized gain value of <g> 0.63, and student responses to the application of the model in general physics lectures are at very good category with an average score of 85 [13].

The Investigation-based group inquiry model is designed based on learning activities through an investigation process using six learning phases, namely: case orientation on phenomena or situations based on facts, getting plans from the hypothesis for the solution, data evidence gathering-verification condition and situation, justification based on experiments, consideration analysis, and verification and analysis of achievement process. This study aims to determine the effect size of the investigation-based group inquiry model on student cognitive learning outcomes. Each individual in the group has an inquiry thought to combine which is called group inquiry. The inquiry thoughts constructed through observing videos or pictures of physical phenomena by each individual constitute the individual's basic hypothesis, which is then

discussed in each group to produce a hypothesis grant. Proving the truth of the hypothetical grant is carried out through investigative activities [13].

The learning model will be effective in improving student learning processes and outcomes if the model is supported by learning tools such as teaching materials, worksheets, media, and assessment instruments that match the characteristics of the learning model used. Learning materials related to inquiry strategies can improve student learning outcomes [14]–[16]. The intended learning outcomes can be cognitive, critical thinking, and creative thinking.

2 Methods

This type of research is quasi-research with a two-group pretest design used to test the effect size investigation-based group inquiry model on student cognitive learning outcomes. The experimental group was taught by applying the investigation-based group inquiry model, while the control group was taught using conventional learning. This research was carried out for 8 weeks with 8 offline lectures by lecturers who taught the course. Before the lecture was carried out, the researcher discussed with the course lecturer to equalize perceptions regarding the application of the investigation-based group inquiry model.

Participants involved in this activity are first-year students who are taking even semester lectures in high school physics courses for the 2022/2023 academic year at the Physics Department, Universitas Negeri Medan. The class sampling technique was used to determine the experimental and control groups. Using a random sampling technique, 30 people were selected from each class as samples. The instrument used is a learning outcomes test in the form of 15 multiple-choice questions relating to Newton's laws of motion which will be answered by students within 50 minutes. The validity test of the learning outcomes test uses Pearson correlation statistics and the reliability test uses Cronbach's alpha statistics. The calculations were carried out with the help of SPSS version 17.0. The range of validity calculation results is 0.48 to 0.73 (valid), and the reliability calculation results are 0.83 (reliable).

Data collection was carried out after written research permission from the Chair of the Research Institute and Community Services and the Dean of the Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan. At the beginning of the lecture, a pretest was given for the experimental and control groups to determine the initial abilities of both groups. The two groups were treated differently by the same lecturer. The number of learning activities per week is 150 minutes. The topics discussed are Newton's 1st, 2nd, and 3rd laws of motion. At the end of the lesson, a posttest is given.

3 Results and Discussions

The Independent Sample T-test tested for similarity in students' cognitive pretest scores and tested for significant differences in students' cognitive posttest scores between experimental and control groups. Before performing parametric statistical tests, the Kolmogorov-Smirnov test was used to ensure data normality, and the Levene Statistical test was used to ensure homogeneity of data. The results of statistical tests showing pretest and post-test scores in the experimental and control classes are normally distributed ($p > 0.05$) shown in Table 1.

Table 1. Summary of Kolmogorov-Smirnov and Shapiro-Wilk Test Cognitive Pretest and Posttest Data

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig. (p)	Statistic	df	Sig. (p)
Post	Control	.153	30	.070	.955	30	.230
	Experiment	.149	30	.087	.952	30	.186
Pretest	Control	.155	30	.065	.951	30	.180
	Experiment	.155	30	.063	.934	30	.062

a. Lilliefors Significance Correction

The results of the Levene Statistics test show that the variance of pretest and post-test data between experimental and control classes is homogeneous ($p > 0.05$) shown in Table 2.

Table 2. Summary of Levene Test Statistical Data Pretest and Cognitive Posttest

		Levene Statistic	df1	df2	Sig.
Post	Based on Mean	.297	1	58	.588
	Based on Median	.301	1	58	.586
	Based on the Median and with adjusted df	.301	1	57.674	.586
	Based on trimmed mean	.316	1	58	.576
Pretest	Based on Mean	.765	1	58	.385
	Based on Median	.378	1	58	.541
	Based on the Median and with adjusted df	.378	1	57.253	.541
	Based on trimmed mean	.812	1	58	.371

Conducted an initial similarity test between the experimental class and the control class as a prerequisite test for limited experimental design. Data related to initial abilities are obtained through the results of a set of cognitive tests. After the average similarity test was met, the difference in the average value of post-test cognitive between the experimental group and the control group continued. The statistic used to analyze the difference in cognitive post-test mean values between experimental and control groups was the Independent Sample T-test. The summary of the Independent Sample T-test is in Table 3.

From the table 3 obtained: for pretest data ($p > 0.05$), it was concluded that the initial ability of the two classes statistically was no different (the same); for the data post-test ($p < 0.05$), it was improved that there was a significant difference between the average value of the experimental class and the average value of the control class. This difference illustrates that Investigation-Based Group Inquiry Model is more effective than conventional models in improving students' cognitive learning outcomes.

Table 3. Summary of Independent Sample t Test of Cognitive Posttest Data for Experimental and Control Groups

		t-test for Equality of Means				
		95% Confidence Interval of the Difference				
		t	df	Sig. (2-tailed) (p)	Mean Difference	Std. Error Difference
Pretest	Equal variances assumed	-.555	58	**.581**	-1.367	2.463
	Equal variances not assumed	-.555	57.35	**.581**	-1.367	2.463
Posttest	Equal variances assumed	-2.084	58	**.042**	-4.333	2.079
	Equal variances not assumed	-2.084	57.69	**.042**	-4.333	2.079

The results of this study showed that there was a significant difference in the average score of the experimental class with the average score of the control class. This difference in average scores illustrates that the Investigation-Based Group Inquiry Model is more effective than conventional models in improving students' cognitive learning outcomes. This shows that the Investigation-Based Group Inquiry Model has advantages over conventional models used as control classes. The Investigation-Based Group Inquiry Model consists of 6 phases, phase 1 is related to the submission of cases / physical phenomena accompanied by direct guests that can attract students' attention and argumentation. This ability is needed by lecturers to invite students to imagine and observe directly from the teaching given. Students have started inquiry thinking to be discussed scientifically and rationally in their respective groups to formulate grant hypotheses. This hypothesis grant was afterward recorded through investigation. Submission of phenomena/cases that are simple but require an in-depth process is one of the advantages of this Investigation-Based Group Inquiry Model compared to other models. Phases 2-4 train students to have scientific attitudes and scientific communication skills, and students can learn meaningfully and feel more realistic in learning the material because the presentation is authentic. Phases 5-6 can improve the presentation of a scientific nature and communication that builds in collaboration.

The Investigation-Based Group Inquiry Model is the result of a study of the inquiry training learning model and the group investigation model. On this basis, research findings related to the effects of the inquiry training learning model and the group investigation learning model can support the Investigation-Based Group Inquiry Model [13]. Some research results relevant to the Investigation-Based Group Inquiry Model include: the results that concluded that the group of students taught by inquiry training obtained better average learning outcomes than conventional [17]; The average learning outcomes of students taught through the inquiry training model are in the high category, while students taught through the conventional model

are in the medium category. Other research findings relevant to this Investigation-Based Group Inquiry Model concluded, among others, that there were significant differences in physics learning achievement between the group studied with character-laden physics learning tools and investigation group settings [18]. In line with this study, the Camtasia Video-assisted modification investigation group learning model is more effective than the unmodified investigation group learning model in improving mathematics learning outcomes and student social responsibility characteristics [19]. From some of the relevant research findings above, it means that the effect of the effectiveness of the Investigation-Based Group Inquiry Model that is better than conventional models does not occur by chance, but is caused by the effect of the Investigation-Based Group Inquiry Treatment model on learning activities.

4 Conclusion

The result of the study is implied in the average value between the experimental class and the control class. Subsequently, the result of the level effect test for cognitive learning outcomes is 0.29 which included adequate categories. These results demonstrated that the investigation-based group inquiry model was quite effective in improving student competence on the matter of Newton's laws of movement.

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