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# The Effect Of Group Investigation (GI) Learning Model Based On Laboratory Experiment Skills On Newton's La Material In Grade X Of Senior High School Negeri 2 Percut Sei Tuan Academic Year 2024/2025

**Pinondang Hutapea**

Program Studi Diploma III Teknik Radiodiagnostik Dan Radioterapi, ATRO Yayasan SinarAmal Bhakti Medan.

**Abstract:** Generic (basic) thinking skills can be developed through studying physics. These skills are simpler in nature and can help students think at higher levels, as complex, critical, and creative thinking. The purposes of this research was to: To determine the differences in generic skills due to the effects of the GI type cooperative learning model and the DI model., To find out the difference between high generic laboratory skills and low generic skills. To find out wheter there is an interaction between the Group Investigation type and Direct Instruction type models on students generic skills to improve learning outcomes. The population in the study were all students of class X semester I of Senior High School Negeri 2 Percut Sei Tuan Academic Year 2024/2025 as many as 6 classes (228 people). This research is a quasi-experimental type, with a two-group pre-test and post-test design The research sampel consistet of 2 classes, namely class X-1 and class X-2 which were taken using cluster random sampling, class X-2 was taught with the GI model (experimental class) and class The results of testing using ANOVA two lanes can be concluded that there is an interaction between the GI model and laboratory skills on generic science abilities. The percentage increase in learning outcomes for the experimental class (74.7%) was greater than the percentage increase in learning outcomes for the control class (60.9%) with a difference in improvement between the experimental and control classes of (13.8%). From the calculation results, the percent increase in learning outcomes for the experimental class is higher than the learning outcomes for the control class. This shows that there is a significant difference in the percentage of Physics learning outcomes taught using the GI type learning model with the Physics learning outcomes taught using the DI model.

**Correspondence:**
*Name Pinondang Hutapea*
*Email hutapea.pino@gmail.com*

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## 1. Introduction

Brotosiswoyo argues that generic thinking can be developed through learning physics. This ability is simpler and can help students think at a higher level such as complex thinking, critical thinking, and creative thinking. Learning that improves or trains students' generic skills will produce students who are able to understand concepts, solve problems, and other scientific activities and are able to learn independently effectively and efficiently. The role of parents alone is not enough to foster independence in children; teachers can help parents develop their children's independence. The home and school environments differ, so the efforts of parents and teachers vary accordingly (Collins et al., 2021).

CTL-based learning tools are considered valid because they are based on learning tool development procedures and have been validated and recommended for use. CTL-based learning tools are said to meet the criteria of ease of use, attractiveness, understanding, and speed of use for teachers and students. CTL-based learning tools are said to be effective because the percentage of learning outcomes achieved is (Afniati et al., 2023).

Generic skills are skills that can be used to learn various concepts and solve problems in science (Brotosiswoyo, 2000). Therefore, generic skills are abilities that are generally used in various scientific work, and can be used as a basis for conducting laboratory activities. When working on practice questions (with criteria C1, C2 and C3), students incorrectly state distance, time, and speed in the form of s, t, and v, convert units of time from minutes to seconds or vice versa, from kilometers / hours (km / h) to meters / seconds (m / s), students are also confused about solving questions that connect two equations between $v = s / t$ and $a = \Delta v / \Delta t$. So, it appears that generic science skills in direct observation, logically obeying frameworks and building new concepts do not appear during learning.

In line with that, research on generic science skills has been conducted previously, namely that studied by implementing a guided inquiry learning model to improve generic skills and learning achievement of high school students. As mentioned above, the application of constructivist learning at present is more emphasized on cooperative and inquiry learning. The characteristics of constructive learning include better understanding and responding to the interests, strengths, experiences and needs of students individually, providing opportunities for students to discuss and debate with other students, continuously assessing student understanding, providing guidance to students for sharing responsibilities with other students. The use of the Problem-Based Learning (PBL) learning model also has a significant effect on students' physics learning outcomes (effect size). This depends on the material applied and the use of the PBL learning model. Both learning and non-learning media still have a positive impact on student learning outcomes. This means that the use of the PBL model has a significant impact on the learning process (Permata Sari et al., 2022).

A learning model is the implementation of pre-planned approaches, strategies, and methods, which are crucial for achieving optimal learning. One relevant learning model is the cooperative learning model, which emphasizes active student involvement and collaboration in small groups to solve specific problems. One type of cooperative learning model is the group investigation learning model, which emphasizes the active role of students in the learning process, allowing them to communicate freely and collaborate in planning and carrying out investigations or investigations on their chosen topics (Ritonga et al., 2024).

Learning is a word that is familiar to the community. Where learning is an inseparable part of all their activities in seeking knowledge in formal educational institutions, and they do it every time according to their wishes, with the hope that a change will occur. Direct learning strategies are teacher-centered learning strategies, therefore, this learning strategy implies direct interaction between the teacher and students. Direct learning strategies are learning strategies that are directly directed by the teacher through specific tasks that must be completed by students under the teacher's direct supervision (Khoirun Nisah Lubis et al., 2024).

Johnson & Johnson (2006) said that cooperative learning is a teaching and learning activity in small groups, students learn and work together to achieve optimal learning experiences, both individual and group experiences. Slavin (2008), said that cooperative learning is a learning model where students learn and work in small groups collaboratively whose members consist of four to six people, with a heterogeneous group structure. Learning with the Problem Based Learning model results in a significant increase in student enthusiasm when compared to learning without using the Problem Based Learning model (Dahmiri et al., 2024).

Learning is a two-way communication process, teaching is done by teachers as students, while learning is done by teachers as students, while learning is done by students or pupils. According to UUSPN No.20 of 2003 (Sagala 2005) that: "Learning is a process of interaction between students and teachers and learning resources". The factors causing low levels are students' inability to understand the problem properly, difficulty converting problems into simple sketches, and confusion in determining the physical quantities and content used to solve the problem. Furthermore, students are unable to complete the steps of solving the problem correctly and structured. Finally, students are not fully skilled at executing physics problems because they only memorize formulas and equations mathematically(Framework, 2024).

The learning process using the Direct Instruction model can make students more active and enthusiastic in following informal letter material, actively participating in lessons, being more creative in providing ideas or input for each assignment given in the learning process, having the ability to argue, and being skilled at visualizing to create and package information as uniquely as possible. This is also evident in the assessment of student skills, which has increased from cycles I and II (Febrianti et al., 2023).

To overcome various problems in the implementation of learning, of course teaching models are needed that are considered capable of overcoming the difficulties of teachers in carrying out teaching tasks and also the learning difficulties of students. According to Sagala (2005) states that: "A learning model is a description of a learning environment that describes curriculum planning, courses, design of lesson units and teaching, learning equipment, textbooks, workbooks, multimedia programs and learning assistance through computer programs".

The Problem Based Learning (PBL) model with the TPaCK framework, how it affects students' ability to solve mathematical problems, is proven that the treatment provided has an effective influence to help in efforts to improve mathematical problem-solving abilities(Pratidina & Nindiasari, 2023).

Furthermore, designing learning in such a way as to help students so that learning objectives are achieved.

Syntax of cooperative learning model

Fase a : Provide learning objectives and motivate students.

Fase b : Presenting information.

Fase c : Organizing students
Fase d : Each group works and learns and is supervised by the teacher.
Fase e : Evaluation
Fase f : Give awards.

Group Investigation (investigation group) is probably the most complex and most difficult learning model to implement, Group Investigation was developed by Shlomo and Yael Sharan at Tel Aviv University, is a common classroom arrangement plan where students work in small groups using cooperative questions, group discussions, and cooperative planning and projects Sharan and Sharan, (Slavin, 2017: 24). Effective in developing students' laboratory skills, particularly in designing, implementing, and reporting Astronomy laboratory activities (Pujani, 2014). In line with this, in creating learning plans, it is necessary to consider the relatively limited class hours, diverse student abilities and interests, large student numbers, and incomplete facilities. Teachers are expected to be able to provide clear instructions for each student (Astuti et al., 2020).

Then Joyce and Weil (1980: 230) that "the GI learning model developed by Thelen that education in a democratic society should teach direct democracy". Group Investigation has philosophical, ethical, psychological roots of writing since the beginning of this century. In conclusion, promoting innovation and creativity among learners is essential for preparing them for the future. Problem-solving skills are essential in promoting innovation and creativity among learners. Educators can use various strategies to promote problem-solving skills, such as project based learning, experiential learning, cross-disciplinary collaboration, and technology integration. However, educators need to consider other factors, such as motivation, curiosity, and passion, when promoting innovation and creativity among learners. By prioritizing problem-solving skills, educators can help learners develop the skills they need to succeed (Adeoye & Jimoh, 2023).

The role of the teacher in the classroom implementing the Group Investigation project is that the teacher acts as a resource person and facilitator. This role of the teacher is learned through practice over time, just as the role of the student is. First and foremost, the teacher must model the communication and social skills expected of the students. In Group Investigation, students work through six stages.

Generic science skills (KGS) are basic skills that prospective teachers need to have, can be applied to various fields, and their knowledge does not depend on a particular domain, but leads to cognitive strategies (Gibb, 2002). Darliana (2006) explains generic science skills as skills used to learn various concepts and solve various science problems. Generic skills are cognitive strategies as knowledge that does not depend on the domain. One of the main types of generic skills is thinking skills such as problem-solving techniques (Rahman, 2006). Critical thinking skills are crucial in problem-solving, as they are essential for making informed decisions. Critical thinking is a key element of higher-order thinking and plays a crucial role in learning, particularly in the context of Natural Sciences (IPA) instruction. Students' inability to develop critical thinking skills during science instruction can be caused by various factors, one of which is their tendency to memorize facts and formulas rather than understand concepts (Aprina et al., 2024).

Brotosiswoyo (2000: 7-21) states that generic abilities can be developed through physics learning by paying attention to the methods and topics or learning materials. A number of these abilities are:

a. Direct observation
b. Indirect observation
c. Sense of scale
d. Symbolic language
e. Principled logical framework.
f. Logical inference
g. Law of cause and effect.
h. Mathematical modeling.
i. Building concepts

Modern physics learning for prospective teachers focuses on developing generic skills and mastery of the material. Generic skills developed include awareness of scale, logical inference, symbolic language, cause and effect, and mathematical modeling. The results of the study indicate that a learning model oriented towards generic skills can be applied to both high and low academic ability students. Research conducted by Leggett et al. (2004) examined the perceptions of students and lecturers about the importance of generic skills in science. In this study examines whether there are differences in generic skills due to the effects of the GI type cooperative learning model and the DI model in class X of Senior High School Negeri 2 Percut Sei Tuan, whether there are differences in generic skills of students who have high laboratory skills and low generic skills, and whether there is an interaction between the GI type cooperative learning model and laboratory skills on students' generic skills. This study is expected to be empirical evidence of the potential of cooperative learning models and laboratory skills to improve students' generic skills in learning physics and can enrich the results of similar research, especially learning that uses cooperative models so that later it can be used by various interested parties.

## 2. Materials and Methods

This study is a quasi-experimental study. The population in this study were all students of Class X Semester I of Senior High School Negeri 2 Percut Sei Tuan in the 2024/2025 Academic Year totaling 228 students. The sample of this study was taken from 2 (two) classes of students. Sampling was carried out randomly (cluster random sampling) and obtained class X-2 as an experimental class (38 people) using the GI learning model and class X-1 as a control class (38 people) taught with DI learning. In this study, 3 variables were used, including: (1) Independent variable (X), namely Learning with the GI type cooperative model and DI Learning. (2) The moderator variable in this study is the Generic Skills of Students Who Have High Skills and Low Generic Skills. (3). The dependent variable (Y) is the learning outcomes with students' generic skills.

The research procedures in collecting experimental data are: (1) Preparation Stages include: (a) Preparing a research schedule. (b) Making a teaching plan program. (c) Preparing test items. (2) Implementation Stages include: (a) Determining sample classes from existing classes. (b) Conducting pretests in experimental and control classes to obtain initial data. (c) Conducting analysis of pretest data, namely normality test, homogeneity test and test of differences in average pretest scores of students in experimental and control classes. (d) Conducting teaching in two classes, namely, in the control class, treatment with DI learning is given, while in the experimental class, treatment is given with the GI Learning Model. (e) Giving posttests to experimental and control classes to find out student learning outcomes after being given different treatments. (f) Conducting analysis of posttest data, namely normality test, homogeneity test, 2-way ANOVA test, (3) After the hypothesis test, conclusions can be drawn.

The instrument used to collect physics learning outcome data is the Newton's X Law learning outcome test. The form of the test given to the sample class is Essay, with a total of 11 test items. The test is arranged based on Bloom's taxonomy in the cognitive domain, (Arikunto 2005). namely: (a) Knowledge/(C1). (b) Understanding/(C2), (c) Application/(C3), (d) Analysis/C4. (e) Synthesis/C5., (f) Evaluation/C6.

The test details will be adjusted to the test items being tested and in accordance with the learning indicators as listed in Table 3. The tests that have been prepared in advance are tested for validity or reliability, discriminatory power, and test difficulty level. Arikunto (2009: 39) said, "a test is said to have content validity if the test can measure certain specific objectives that are parallel to the material or content of the lesson given".

Table. 1. Test Validity Test

| No Test | rvalue | rtable | Categori |
|---|---|---|---|
| 1 | 0.451 | 0,304 | Valid |
| 2 | 0.534 | 0,304 | Valid |
| 3 | 0.297 | 0,304 | Invalid |
| 4 | 0.292 | 0,304 | Invalid |
| 5 | 0.503 | 0,304 | Valid |
| 6 | 0.578 | 0,304 | Valid |
| 7 | 0.333 | 0,304 | Valid |
| 8 | 0.316 | 0,304 | Valid |
| 9 | -0.094 | 0,304 | Invalid |
| 10 | 0.368 | 0,304 | Valid |
| 11 | 0.227 | 0,304 | Invalid |
| 12 | 0.520 | 0,304 | Valid |
| 13 | 0.506 | 0,304 | Valid |
| 14 | 0.378 | 0,304 | Valid |
| 15 | -0.054 | 0,304 | Invalid |
| 16 | 0.366 | 0,304 | Valid |
| 17 | 0.387 | 0,304 | Valid |
| 18 | 0.316 | 0,304 | Valid |
| 19 | 0.428 | 0,304 | Valid |
| 20 | 0.461 | 0,304 | Valid |
| 21 | 0.316 | 0,304 | Valid |
| 22 | 0.292 | 0,304 | Invalid |
| 23 | 0.161 | 0,304 | Invalid |
| 24 | 0.714 | 0,304 | Valid |

| | | | |
|---|---|---|---|
| 25 | 0.431 | 0,304 | Valid |
| 26 | 0.488 | 0,304 | Valid |
| 27 | 0.550 | 0,304 | Valid |
| 28 | 0.105 | 0,304 | Invalid |
| 29 | 0.303 | 0,304 | Invalid |
| 30 | 0.570 | 0,304 | Valid |

Based on the results of the validity and reliability tests of the test instrument, calculations showed that of the 30 questions tested, 21 were valid, with a calculated $r_{Count}$ > $r_{table}$. The highest score was 0.714 and the lowest was -0.054. Based on these data, it can be concluded that 21 questions were suitable for use as a research instrument.

Table.2. Reliability Statistics

| Cronbach's Alpha | N of Items |
|---|---|
| .849 | 30 |

The results of the reliability test based on data processed by researchers with the help of SPSS 25 showed that r count (0.849) > r table (0.304). According to Nugroho (2005:72) "The reliability of a variable construct is said to be good if it has a Cronbach's Alpha value > 0.600". Therefore, it can be concluded that the questions in the questionnaire are reliable and suitable for use as a research instrument.

Before being used in the actual research, the test that was prepared was first validated by the validator, and tested on students who were not the research sample. After the data was collected, the data was then processed with the help of the SPSS 25 program. To calculate the validity, the product moment correlation formula from person was used (Arikunto, 2005: 72), with the formula

$$r_{xy} \frac{N(\Sigma XY) - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left\{N\left(\sum X^2\right) - \left(\sum X\right)^2\right\}\left\{N\left(\sum Y^2\right) - \left(\sum Y\right)^2\right\}}}$$

Where:

$r_{xy}$ : Koefisien korelasion product moment

$\sum$ x : The number of students who answered correctly for each item

$\sum$ y : Total score

$\sum$ xy : The sum of the multiplication of item scores and total scores

$\sum x^2$ : Sum of squares X score distribution

$\sum y^2$ : Sum of squares Y score distribution

N : Total number of students

The validity testing criteria are that the question is said to be valid if rxy > rtable and vice versa the question is said to be invalid if rxy < rtable (rtable is obtained from the critical value of r product moment).

Test Reliability.

According to Arikunto (2005: 87) to determine the reliability coefficient, the alpha formula can be used as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma i^2}{\sigma i^2}\right)$$

Where:

$r_{11}$ : Reabilitas test

$\sigma i^2$ : Varians score

n : The number of questions

$\sum \sigma i^2$ : The amount of variance of scores for each question item

Meanwhile, to calculate the variance of each item, the formula used is:

$$\sigma^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{N}}{N}$$

with ; N : Number of students taking the test

$\sigma^2$ : Variance of total score

X : Value each question item

The criteria for testing test reliability are:

0,00 < r ≤ 0,40 = Low reliability

0,40 < r ≤ 0,70 = Currently. reliability

0,70 < r ≤ 0,90 = High reliability.

0,90 < r ≤ 1,00 = Very high reliability.

Test Difficulty Level

According to Arikunto (2005: 208) to determine the level of difficulty of each test item, the following formula is used:

$$P = \frac{B}{JS}$$

Where:

P : Level of difficulty

B : Number of students who answered correctly

JS : Total number of students

Criteria for determining the level of difficulty of test items are:

P: 0,00<TK>0,3, the question is said to be difficult

P: 0,3<TK>0,7, the question is said to be moderate

P:0,7<TK>1,00, the question is said to be easy

Test Distinguishing Power

According to Arikunto (2005: 213) to determine the discriminating power of each test item, the following formula is used:

$$D = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

Where:

D : Distinguishing power

BA : Number of students in the upper group who answered correctly

BB : Number of students in the lower group who answered correctly

JA : Number of students in the upper group

JB : Number of students in the lower group

The criteria for discriminating power according to Arikunto (2005:218) are as follows:

D = 0.00-0.20 : Less

D = 0.21-0.40 : Sufficient
D = 0.41-0.70 : Good
D = 0.71-1.00 : Very good

The sample in this study was grouped into two groups, namely the Experiment group which was given learning with the application of the GI model while the control group was given DI teaching which used more lecture methods.

Table. 3. ANOVA 2-Way

| Learning Model / Generik Abilities | Learning model *GI* ($A_1$) | Learning DI($A_2$) | Average |
|---|---|---|---|
| High Generic Ability ($B_1$) | $A_1$ $B_1$ ($X_1$) | $A_2$ $B_1$ ($X_3$) | $\mu$ KT |
| Low Generic Capability ($B_2$) | $A_1$ $B_2$ ($X_2$) | $A_2$ $B_2$ ($X_4$) | $\mu$ KR |
| Average | $\mu$ PS | $\mu E$ | |

Description:

a. $A_1B_1$ (X1) = Group of students who have high generic science abilities taught with GI.
b. $A_1B_2$ (X2) = Group of students who have low generic science abilities taught with GI
c. $A_2B_1$ (X3) = Group of students who have high generic science abilities taught with DI.
d. $A_2B_2$ (X4) = Group of students who have low generic science abilities taught with DI.
e. $\mu$ PS = Average learning outcomes taught with GI
f. $\mu PE$ = Average learning outcomes taught with DI
g. $\mu$ KT = The average learning outcomes for generic science abilities are high
h. $\mu$ KR = The average learning outcomes for generic science skills are low

## 3. Results and Discussion

Test validity and reliability testing was conducted using SPSS 25. Based on the results of the validity and reliability test of the test instrument, the calculation results obtained that out of 30 questions tested, 21 valid questions had a calculated r value > r table and the question item with the highest value was 0.714 and the lowest value was -0.054. Based on these data, it can be concluded that 11 questions are suitable for use as research instruments.

The results of the reliability test based on data processed by researchers with the help of SPSS 25 showed that r count (0.849) > r table (0.304). According to Nugroho (2005:72) "The reliability of a variable construct is said to be good if it has a Cronbach's Alpha value > 0.600". So it can be concluded that the questions in the questionnaire are reliable and suitable for use as research instruments. Of the 30 questions tested, 19 questions were classified as moderate, and 5 questions were classified as difficult. Of the 30 questions tested, 12 questions were classified as good, 5 questions were classified as moderate, 13 questions were classified as lacking. Based on the results of the validity and reliability test of the questionnaire instrument, it was obtained that of the 30 questions tested, the valid ones were 18 questions with the highest value of 0.583 and the lowest value of -0.100. Based on these data, it can be concluded that 18 questions are suitable for use as research instruments.

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"The reliability of a variable construct is said to be good if it has a Cronbach's Alpha value > 0.600". So it can be concluded that the questions in the questionnaire are reliable and suitable for use as research instruments. Of the 30 questions tested, 19 questions were classified as moderate, and 5 questions were classified as difficult. Of the 30 questions tested, 12 questions were classified as good, 5 questions were classified as moderate, 13 questions were classified as lacking. Based on the results of the validity and reliability test of the questionnaire instrument, it was obtained that of the 30 questions tested, the valid ones were 18 questions with the highest value of 0.583 and the lowest value of -0.100. Based on these data, it can be concluded that 18 questions are suitable for use as research instruments.

Based on the student learning outcome tests, both pretest and posttest, for both the experimental and control classes, descriptive statistics were obtained for each group.

Table.4. Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Pretes Eksperimen | 38 | 15 | 55 | 35,66 | 9.807 |
| Postes Eksperimen | 38 | 65 | 95 | 84.47 | 9.642 |
| Pretes Kontrol | 38 | 15 | 60 | 32,11 | 10.820 |
| Postes Kontrol | 38 | 55 | 95 | 73.82 | 8.733 |
| Valid N (listwise) | 38 | | | | |

Based on the results of the calculation of the data normality test, Asymp. Sig. (2-tailed) was obtained for both the pretest and posttest of the experimental class and the control class. To find out whether the data is normal or not, it can be known by the criteria if the Asymp. Sig. (2-tailed) value is > $\alpha$ = 0.05 then the data is normal. Based on the calculation results, it is known that all Asymp. Sig. (2-tailed) values as a whole are > $\alpha$ = 0.05, so it can be concluded that all data are normally distributed. Based on the results of the calculation of the data homogeneity test above, it can be seen for the Sig. table for both the experimental pretest and the control pretest. To find out whether the data is homogeneous or not homogeneous, it can be known by the criteria if the Sig. value is > 0.05 then the data is homogeneous.

Based on the calculation results, the output of t count is -1.500 and t table is 1.69 at the level of α = 0.05. So after comparing it with the hypothesis testing criteria, Ha is accepted if t count < t table and Ho is rejected if t count > t table. So it is obtained that t count < t table or in other words Ha is rejected. This shows that the initial ability of students Both the control class and the experimental class tend to be the same and do not differ significantly.

Based on the calculation of factorial ANOVA 2 x 2, it is obtained Fcount = 14.804 while the F-table value = 1.91 for dk (36; 38) and the level of significance $\alpha$ = 0.05, it turns out that the F-count value = 14.804> F-table = 1.91 so that the hypothesis test rejects H0. in other words, students who are taught using the GI learning model will get higher learning outcomes compared to students who are taught using the DI learning model. This can be seen from the average learning outcomes of students who are taught using the GI learning model ( $\overline{X}$ = 84.47) which is higher than the learning outcomes of students who are taught using the DI learning model ( $\overline{X}$ = 72.83). In line with that, the implementation of appropriate actions can increase interest in learning, carried out by paying attention to the syntax that has been adjusted by paying attention that the teacher motivates students, and the teacher provides many questions and answers regarding the material, especially students who experience difficulties (Hidayati et al., 2021). Students' problem-solving skills in the material of sequences and series were assessed through essay questions in the form of essays or descriptions at the last meeting, and it was found that students who applied the Problem Based Learning (PBL) learning model had greater mathematical problem-solving abilities than those who did not. The exam scores of students who used the traditional learning model were 77.86>51.44 (Permatasari & Marlina, 2023).

Based on the calculation of factorial ANOVA 2 x 2, it is obtained Fcount = 6.841 with sig is 0.004, while the Ftable value = 1.91 for dk (38;38) and the level of significance $\alpha$ = 0.05, it turns out that the Fcount value = 6.841> Ftable = 1.91 so that the hypothesis test rejects H0.

In other words, students who are taught using the GI learning model will get higher learning outcomes compared to students who are taught using the DI learning model.

This can be seen from the average learning outcomes of students with high emotional intelligence ( $\overline{X}$ = 64.34) which is higher than the learning outcomes of students with low emotional intelligence ( $\overline{X}$ = 47.11). The implementation of the Group Investigation cooperative learning model is effective in improving student learning outcomes. In cycle I, student learning outcomes achieved an average score of 64.6 with a learning completion rate of 34.78%. In cycle II, student learning outcomes increased to an average score of 86.74 with a learning completion rate of 86.9% (Aulia et al., 2020). Previous research has stated that the use of the Group Investigation learning model has a significant effect on creative thinking skills with a significance value of 0.000 <0.05 (Febrianti et al., 2023).

Based on the ANOVA test table, the F count was 17.118 with Sig. 0.00. Therefore, the Sig. value < $\alpha$ = 0.05, it can be concluded that there is an interaction between the GI learning model and laboratory skills in influencing generic science abilities.

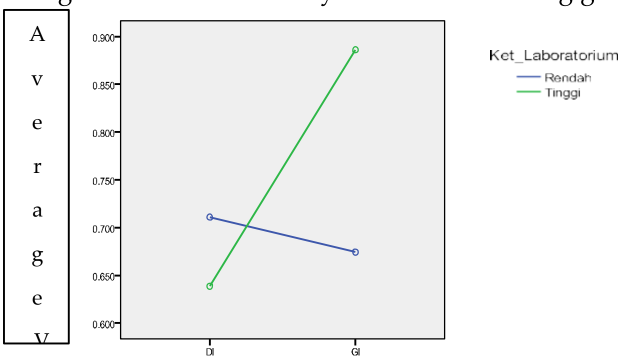


Figure.1. Interaction Line Pattern Between Group Investigation Type Cooperative Learning Model and Direct Instruction Learning Model on Generic Science Ability.

Implementation of PBL model in environmental chemistry subjects of science education program can improve students' conceptual understanding and critical thinking ability. The results shows an improvement from the pretest and posttest averages scores, which were analyzed by t test. and also from the results of the N-gain score. The N-gain result show the improvement in each group (Uliyandari et al., 2021).

Previous researchers stated that the application of the Problem Based Learning method can improve PPKn learning outcomes in class VII-A students of YAKPI 1 DKI JAYA Junior High School. This can be seen from the learning outcomes of students in cycle I with an average of 70 which is included in the sufficient category, with an absorption capacity of 70% while classical completeness is 50% of the 28 students who completed cycle I. While in cycle II the average learning outcomes of students is 82 in the good category, with an absorption capacity of 82% and classical completeness of 92% of the 28 students who completed (Khakim et al., 2022).

The percentage increase in learning outcomes can be calculated using the g-factor formula (normalized score gain). The g-factor formula is used to determine students' gains in generic science skills. To calculate the percentage increase in learning outcomes, the average value of all gains can be calculated by multiplying it by one hundred percent as follows:

$$^{0}/_{0}\ Kelas\ Eksperimen\ (\bar{X}) = \frac{\sum X}{n} x\ 100\ ^{0}/_{0}$$

$$= \frac{28{,}37}{38} x 100\ ^{0}/_{0}$$

$$= 0{,}747 \times 100\%$$

$$= 74{,}\ 7\ \%$$

$$^{0}/_{0}\ Kelas\ kontrol\ (\bar{X}) = \frac{\sum X}{n} x\ 100\ ^{0}/_{0}$$

$$= \frac{23{,}16}{38} x 100\ ^{0}/_{0}$$

$$= 0{,}609\ 100\%$$

$$= 60{,}\ 9\ \%$$

The percentage increase in learning outcomes for the experimental class (74.7%) is greater than the percentage increase in learning outcomes for the Control class (60.9%) with a difference in increase between the experimental and control classes of (13.8%). There is a significant difference in the scientific literacy skills of students in the experimental and control classes, statistically controlling for initial abilities and curiosity. The PhET-assisted problem-based learning e-module can significantly improve scientific literacy skills in the contextual aspect, reviewed from the initial abilities and curiosity of students (Collins et al., 2021). This shows that there is a significant difference in the percentage of learning outcomes of Physics taught using the GI learning model with the learning outcomes of Physics taught using the DI learning model. The Problem-based Learning (PBL) learning model should have an impact on physics learning outcomes because it is able to improve student learning outcomes (Rahmi et al., 2021).

## 4. Conclusions

Based on the results of data processing that has been done using the SPSS 25 method, it was concluded that: (1) Students who are taught using the Group Investigation Type Cooperative learning model obtain higher Physics learning outcomes than students who are taught using the Direct Instruction learning model. This can be seen from the average score of Physics learning outcomes with the Group Investigation Type Cooperative learning model producing a higher average value than the average value of those taught with Direct Instruction on Newton's Law for class X Semester I at Senior High School Negeri 2 Percut Sei Tuan Based on the results of data processing that has been done using the SPSS 25 method, it was concluded that: (1) Students who are taught using the Group Investigation Type Cooperative learning model obtain higher Physics learning outcomes than students who are taught using the Direct Instruction learning model. This can be seen from the average score of Physics learning outcomes with the Group Investigation Type Cooperative learning model producing a higher average value than the average value of those taught with Direct Instruction on Newton's Law for class X Semester I Senior High School Negeri 2 Percut Sei Tuan Academic Year 2024/2025. (2) The generic skills of students who have high laboratory skills and low generic skills, have a significantly different influence on the results of the Newton's Law material. (3) There is an interaction between the interaction between the GI type cooperative learning model and the DI learning model with laboratory skills on students' generic skills in influencing Physics learning outcomes. This means that the learning model and Generic Science Ability together influence student learning outcomes. This means that the learning outcomes of students taught using the GI type cooperative learning model tend to be better than those of students taught using the Direct Instruction cooperative learning model, and in terms of generic science abilities, students who have high laboratory skills are better than those with low generic science laboratory skills, there is an interaction between GI type cooperative learning and generic skills in generic science abilities. As for the semi-sophisticated behavior, it is a behavior between the routine behavior and the sophisticated behavior category. In order to improve students' problem-solving behavior, it is recommended that teachers pay attention to the processes students use in solving problems. In the learning process, teachers can use teaching methods that can help students find the right strategy for solving problems (Hafizatunnisa et al., 2024). The PBL model and other diverse learning methods are being used more frequently in teaching, especially in subjects requiring problem-solving skills. This approach can increase student motivation, critical thinking skills, and comprehensive conceptual understanding. Thus, the PBL model can be an effective alternative for improving student learning outcomes (Hidayana et al., 2022). Based on the research results and research conclusions, the following implications are given: (1) With the acceptance of the first hypothesis, it is necessary to consider it for parties in efforts to improve teacher teaching skills that can support learning outcomes, especially learning outcomes in Newton's Law. (2). With the acceptance of the second hypothesis, each delivery of lesson material must pay attention to student characteristics, whether they have high Generic Science Ability or low Generic Science Ability. This increase in learning motivation is indicated by an increase in motivation scores, and students have achieved high motivation. Therefore, the results of this study have met the established success indicators (Diaz et al., 2024). Based on the results of data analysis and conclusions presented previously, the following are suggested: (1) This GI learning model can be used as an alternative in learning on Newton's Law selectively in utilizing time and the use of LCD projectors when implementing the problem solving learning model so that each stage in the learning process can be carried out optimally. (3) Further researchers can ask for help by adding fellow researchers to discipline students during the learning process. (4) For further researchers who want to research the same problem are advised to conduct research at different locations and materials and first pay attention to the weaknesses in this research to achieve better learning outcomes.

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