

# The Power of Group Investigation Model on Student Critical Thinking, Attitude, and Character in Learning Physics

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**Abstract**— Learning physics in senior high school by using a teacher-centered teaching habit must be changed. It has to empower the investigated-based collaboration. This quasi experimental study aims to analyze the effect of group investigation (GI) model compared to direct instruction (DI) model on critical thinking skills, social and spiritual attitudes, and students character. This experimental study employed a posttest only control group design. The population was 15 classes or 488 students of class X MIPA from three SMAs in Klungkung regency. The research sample was chosen by random assignment technique, and 2 classes were determined in each school, so there were 6 classes (194 students, or 39.8% of the population), 3 classes using GI and 3 other classes using DI. The study was conducted for 5 weeks each 3 hours on energy and momentum learning material. Critical thinking skills were collected by using 15 essay test items. Students social and spiritual attitudes and their character were collected by using questionnaire, every 30 items, 30 items, and 18 item respectively. Data were analyzed by one way MANOVA. The results show that GI model was better than DI model for achieving students critical thinking, social attitudes, spiritual attitudes, and their character in learning physics in the senior high schools.

**Keywords**— Collaborative investigation, critical thinking, social attitudes, spiritual attitudes, character

## I. INTRODUCTION

Physics learning has still kept problems that have not been resolved. Students mainly experience these problems in the context of mastery of physical concepts and adequate learning achievement. Mastery of physics concepts and student achievement in class X high school tends to be low [1]. One of the internal factors as a cause is that high school students often view physics as a difficult and very abstract lesson [2, 3]. External factors which also trigger the low mastery of physics concepts and the low achievement of learning physics are

caused by learning implemented in physics learning tends to be teacher-centered [1][2].

One of the student achievements in school is critical thinking skills in learning physics. The effectiveness of teacher-centered learning is one factor that has not been optimal in achieving students' critical thinking skills. The results of the previous studies have revealed that students' critical thinking skills are still lack [4][5][6][7][8]. Students' critical thinking skills are the direct impact of learning applied by the teacher. If the learning designed by the teacher tends to be centered on students, the opportunity for students to move in learning physics will be reduced. Lack of students' activity in learning will undoubtedly dwarf their potential thinking, including critical thinking skills students will become weak in growth. In fact, students' critical thinking skills are needed in facing the challenges of the 21st century [9][10]. They highlight that critical thinking is an important part that students must build in schools in the 21st century. Critical thinking skill is one of the skills that can be relied upon in facing rapid changes in all lines of society [11] and in facing all the demands of the times [12]. Therefore, teacher-centered learning must be considered not to be applied in learning.

One of teacher-centered learning programs is direct instruction (DI). DI program in schools is generally carried out with linearly programmed learning models. The teacher follows step by step, the lesson-by-lesson approach that follows the sequence of skills that have been determined and then given to students. The prescribed approach to teaching is fast and linear which aims to maximize timeliness in carrying out tasks and positively reinforce student behavior [13]. The teacher provides rigorous training by following the teacher's guidebook. The teacher focuses more on efforts to present curriculum material. Material presentations are followed by assigning assignments, giving tests, and conducting assessments that are in line with predetermined learning goals.

Evaluation results are followed by feedback to change behavior, grouping abilities, and emphasis on academic skills. Because the focus of learning is more on academic achievement, the impact of accompaniment is often excluded from learning. Character development, social attitudes, and spiritual attitudes of students are no longer an important part of learning. As a result, students often show characters that are not good, low social attitudes, as well as their spiritual attitudes do not experience development in a better direction.

Students from the past to the present generation often carry out some destructive actions, bad behavior, substance abuse, stealing, and other crimes [14]. According to them, the phenomenon shows that the character of students is still bad, so it needs to be improved in a better direction. These bad characters make educators, teachers, parents, religious organizations, and the government are worried. Another fact also states that students' social attitudes at school are still low, so it needs to be improved in educational praxis [15][16]. As an impact of accompanying learning, students' spiritual attitudes also need to be improved in learning in school [17].

Based on the facts described above, and given the importance of developing critical thinking skills, character, social attitudes, and spiritual attitudes of students in learning physics at school, naturally DI implementation cannot be maintained anymore. Physics learning must apply a new paradigm of learning that has the potential to accommodate the efforts to develop critical thinking skills, character, social attitudes, and spiritual attitudes of students. In other words, DI must be abandoned and must begin to apply the student centered learning (SCL) approach. One of the derivatives is the group investigation (GI) model. The GI model has proven its superiority in learning various fields of science. In writing learning in elementary school, the GI model turns out to be the most superior compared to the accelerated learning team also superior to the role playing model [18]. In physics learning, the GI model is superior to conventional models in achieving physics learning achievement in high school [19]. In learning physics in high school, it has also been proven that the GI model is superior to the conventional model in achieving conceptual understanding [20]. The GI model has also proven its advantage in speaking learning on English subjects for high school students [21]. The GI model has also been tested for its superiority in physics learning, motion and style material for first semester students, compared to the learning together model, which is superior to the DI model in achieving learning achievement [3]. In learning mathematics in junior high school, the GI model was tested superior to conventional models in achieving learning achievement [22]. In learning English in high school, the GI model was proven to improve speaking skills for students [23]. In learning the physics of the concepts of temperature and heat, the GI model is superior to conventional learning in achieving conceptual understanding and science process skills [1]. In class XI high school physics learning it has also been proven that the GI model is superior to the Jigsaw model in achieving learning achievement [2]. The GI model has also been shown to improve student achievement in vocational schools [24].

## II. METHOD

This study used a quasi-experimental method with a post-test control group design involving three state senior high schools in Klungkung district in the even semester of the school year 2017/2018. These schools were SMA Negeri 1 Semarang, SMA Negeri 2 Semarang, and SMA Negeri 1 Banjarnagan. This study involved class X students in learning physics. The total number of classes were 15 classes consisting of 5 classes or 183 students of SMA Negeri 1 Semarang, 7 classes or 228 students of SMA Negeri 2 Semarang, and 3 classes or 77 students of SMA 1 Banjarnagan. The sample was selected randomly to determine 2 classes in each school as a class sample. The total sample was 6 classes (194 students or 39.8% of the total population) which were divided into two groups, namely 3 classes (97 students) subject to GI treatment and 3 classes (97 students) subject to DI treatment. This experiment was conducted by physics teachers in each high school. Previously, they were given 5 days of training on physics learning using GI models and DI models. Physics subject matters which is the object of this research were the materials of effort, energy, impulse, and momentum. The implementation of this treatment adapted to the subject matter and the time allocation available on K-13. The treatment procedures in the GI and DI groups were presented in Table 1.

TABLE I. DESCRIPTION OF LEARNING STEPS AND STUDENTS ACTIVITIES IN THE GI AND DI MODELS

GI Model		DI Model	
Learning Steps	Learning activities	Learning Steps	Learning activities
Identify topics and form study groups	Students study and choose topics that are relevant to themselves and their groups	motivating students	The teacher motivates students regarding the subject matter discussed
Plan learning tasks	Students in groups form plans for investigations according to the roles of each group to achieve group goals	delivering lesson material	The teacher presents the subject matter followed
Carry out an investigation	Students seek information, analyze data, and draw conclusions, exchange ideas, discuss, clarify, and synthesize ideas	forming groups of students	The teacher instructs students to form groups of 3-5 people and share group assignments
Prepare final report	Students sort and choose important concepts and principles that need to be reported, compile reports, prepare presentations, share presentation assignments	students learning in groups	Students work on assignments given by the teacher in each group and formulate the report on the results of the discussion
Present the final report	Students make presentations alternately according to their	students reporting the results of the discussion	The teacher appoints the group in turn to report the

GI Model		DI Model	
Learning Steps	Learning activities	Learning Steps	Learning activities
	assignments in groups and answer questions that arise		results of the discussion
Evaluation	Students receive feedback from the teacher, conduct self-assessments, and work on individual evaluations	teachers evaluating student reports	The teacher assesses student discussion reports and gives quizzes

The treatment as in Table 1 was carried out for 5 meetings. At the 6th meeting, students in both groups were given a critical thinking test in learning physics with an allocation of 90 minutes. Over the next 30 minutes, students answer social attitudes, spiritual attitudes, and character questionnaires.

- Critical thinking tests

Critical thinking tests were arranged in the form of an essay with each item's rubric using a 0-5 scale, while the questionnaire uses a 1-4 scale. The trial results set 15 items of the critical thinking instrument used in collecting data. The different power index (DPI) of this instrument moves from 0.20 to 0.62, their item difficulty index (IDI) moves from 0.22 to 0.84, and item-total correlation coefficients ( $r_{xy}$ ) moves from 0.44 to 0.88. Cronbach's alpha coefficient of 12 test items which stated the reliability of critical thinking instruments were 0.899 with very high qualifications.

- Social attitudes questionnaire

The social attitude consisted of 4 dimensions, namely 1) the attitude of organizing groups, 2) the attitude of negotiating solutions, 3) the attitude of maintaining personal relationships, and 4) attitude in carrying out social analysis. The 4 dimensions of social attitudes are translated into 30 items of social attitude instruments. Each item uses a Likert Scale by removing neutral elements so that the scale is degraded 1-4. The results of the trial on 291 subjects showed that the correlation coefficient of the total item of social attitude questionnaire moves from 0.36 to 0.60 with 30 item reliability is 0.91 with very high qualifications.

- Spiritual attitude questionnaire

Spiritual attitude uses eight dimensions adapted from subscales and spiritual attitudes and involvement lists (SAIL) items consist of 1) Meaningfulness, 2) Trust, 3) Acceptance, 4) Awareness in the present, 5) Caring for others, 6) Connectedness with nature, 7) Transcendent experiences, 8) Spiritual activities. The eight dimensions of spiritual attitudes are differentiated into 30 items. Each item uses a Likert Scale by removing neutral elements so that the scale becomes 1-4. The results of trials on subjects as many as 294 people showed that the correlation coefficient of the total item of spiritual attitude questionnaire move from 0.30 to 0.61 with 30 item reliability is 0.84 with high qualifications.

- Character Questionnaire

The character of the student consists of 10 dimensions [37], namely 1) the love of God and all of his creation, 2)

independence and responsibility, 3) honesty/trust, 4) diplomatic, 5) respect and polite, 6) generous, like helping each other and collaboration, 7) confidence and hard worker, 8) leadership and justice, 9) good and humble, 10) tolerance, peace, and unity. Student character data was collected by questionnaire, consisting of 18 statement items, each equipped with four degradation options using a scale of 0-4. Description of each scale of degradation 0-4 is 0 = disagree, 1 = less agree, 3 = agree, 4 = strongly agree. The correlation coefficient of Pearson Product moment item-total moves from  $r = 0.36$  to  $r = 0.72$ . The reliability index was determined by the Alpha Cronbach coefficient  $\alpha = 0.80$ .

### III. RESULTS AND DISCUSSION

#### A. Descriptive Results

The results of this descriptive analysis present the influence of GI compared to DI in achieving the 4 dependent variables, namely critical thinking skills, social attitudes, spiritual attitudes, and the student's character of SMA Negeri 1 Semarang, SMA Negeri 2 Semarang, and SMAN 1 Banjarmasin. The results of the analysis are presented in Table 2.

TABLE II. THE SUMMARY OF THE RESULTS OF THE DESCRIPTIVE ANALYSIS OF CRITICAL THINKING SKILLS, SOCIAL ATTITUDES, SPIRITUAL ATTITUDES, AND THE CHARACTER OF THE STUDENTS.

Dependent Variable	Model	Mean	SD	N
Critical	GI	30.6907	5.77415	97
	DI	21.0412	6.29305	97
Social	GI	100.2577	9.06145	97
	DI	94.4433	7.01185	97
Spiritual	GI	97.5670	10.49395	97
	DI	89.8866	5.82358	97
Character	GI	59.7423	5.88833	97
	DI	57.8351	4.73392	97

The results of the descriptive analysis in Table 2 show that the critical thinking skills, social attitudes, spiritual attitudes, and character of students are higher achieved by students who study with the GI model than the DI model.

Test assumptions carried out include the normality test of data distribution using Kolmogorov-Smirnov and Shapiro-Wilk statistics, Box's Test of Equality of Covariance Matrices, and Levene's Test of Equality of Error Variances. A summary of the test results is presented in Table 3, Table 4, and Table 5.

TABLE III. SUMMARY OF THE RESULTS OF THE NORMALITY TEST OF THE DISTRIBUTION OF EXPERIMENTAL DATA

Source	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Critical in GI	0.110	97	0.096	0.964	97	0.089
Social in GI	0.061	97	0.200	0.986	97	0.370
Spiritual in GI	0.066	97	0.200	0.986	97	0.411
Character in GI	0.074	97	0.200	0.979	97	0.114
Critical in DI	0.128	97	0.101	0.933	97	0.115
Social in DI	0.121	97	0.125	0.931	97	0.165
Spiritual in DI	0.100	97	0.117	0.971	97	0.128
Character in DI	0.224	97	0.088	0.885	97	0.092

Based on the results of the normality test in Table 3, it appears that the Kolmogorov-Smirnov and Shapiro-Wilk statistical values on the four dependent variables show the numbers of significance that are greater than 0.05. So the data of critical thinking skills, social attitudes, spiritual attitudes, and character of students are normally distributed.

TABLE IV. BOX'S TEST OF EQUALITY OF COVARIANCE MATRICES

<b>Box's M</b>	<b>55.355</b>
F	1.411
df1	10
df2	176242.231
Sig.	0.217

The results of Box's Test of Equality of Covariance Matrices as shown in Table 4, that the Box'M statistic value is  $F = 1.411$  with a significance number of  $sig = 0.217$  which is greater than 0.05 significance. It shows that the covariance matrices of the dependent variable are homogeneous. The results of this test are the assumptions of the Multivariate Analysis of Covariance.

As an assumption, Tests of Between-Subjects Effects requires Levene's Test of Equality of Error Variances. A summary of the test results is presented in Table 5.

TABLE V. LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES

Dependent Variables	F	df1	df2	Sig.
Critical	0.385	1	192	0.536
Social	2.860	1	192	0.116
Spiritual	2.502	1	192	0.096
Character	2.521	1	192	0.065

Table 5 shows that the Levene statistics on all dependent variables have a significance number greater than 0.05. Therefore, the fourth variant of the dependent variable from the two GI and DI treatment groups was homogeneous. Based on the analysis that MANOVA assumptions have been fulfilled, Table 6 shows the Multivariate Analysis of Covariance.

TABLE VI. MULTIVARIATE ANALYSIS OF COVARIANCE

Statistic	F	Hypothesis df	Error df	Sig.
Pillai's Trace	40.058	4.000	189.000	<b>0.000</b>
Wilks' Lambda	40.058	4.000	189.000	0.000
Hotelling's Trace	40.058	4.000	189.000	0.000
Roy's Largest Root	40.058	4.000	189.000	0.000

Based on Table 6, it appears that the Pillai's Trace statistics, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root are  $F = 40,058$  with a significance number of  $sig = 0.001$  which is smaller than  $sig = 0.05$ . Thus, compatible with the four dependent variables showed a significant difference between GI and DI treatment. These results provide clues that the need for Tests of Between-Subjects Effects as presented in Table 7.

TABLE VII. TESTS OF BETWEEN-SUBJECTS EFFECTS

DV	Type III Sum of Squares	df	Mean Square	F	Sig.
Critical	4515.959	1	4515.959	123.821	0.000
Social	1639.670	1	1639.670	24.981	0.000
Spiritual	2860.954	1	2860.954	39.725	0.000
Character	176.418	1	176.418	6.181	0.014

Table 7 shows that separately the four dependent variables differed significantly between the results of GI and DI treatments. Based on Table 2, GI treatment was superior in achieving the four dependent variables, namely critical thinking ability ( $M = 30.69$ ;  $SD = 5.77$ ) students compared to DI treatment ( $M = 21.04$ ;  $SD = 6.29$ ); social attitudes on the GI,  $M = 100.26$ ;  $SD = 9.06$  and in DI,  $M = 94.44$ ;  $SD = 7.01$ ; spiritual attitude on GI,  $M = 97.57$ ;  $SD = 10.49$  and in DI,  $M = 89.89$ ;  $SD = 5.81$ ; and student character on GI,  $M = 59.74$ ;  $SD = 5.89$  and in DI,  $M = 57.83$ ;  $SD = 4.73$ .

**B. Discussion**

The GI model as one of the SCL models is superior to the DI model in achieving critical thinking skills, social attitudes, spiritual attitudes, and good character development for students in physics learning. The results of this study are in accordance with previous studies [1, 2, 3, 19, 20, 25, 26]. Thus, the GI model is a learning model that is effective in improving student physics learning achievement compared to the DI learning model.

The superiority of the GI model is because the GI model is one of the innovative learning models that applies the cooperative approach and investigation in the learning process. The GI model provides learning activities by providing opportunities for students to conduct group investigations related to physical problems related to contextual learning material so that learning is more student-centered. The GI model can facilitate students through investigative and discussion activities to determine and decide on alternative solutions that are considered the best so that they can help students develop thinking skills, problem solving skills, and intellectual skills in the learning process. Thus mastery of learning material will increase and also lead to increasing student learning achievement [19].

In physics learning, it was found that the GI model was more effective than the teacher centered learning model in achieving academic achievement in motion and style learning [3]. The GI model is one of the student centered learning (SCL) models. In recent years, studies related to physics show that teacher centered learning is not enough to educate students, and therefore, students learn physics superficially [3]. The implementation of learning in the GI model which is part of SCL actively involves students in learning and independent learning and provides permanent learning. The main purpose of this GI application is to give responsibility to students, their learning, and interactions with one another. Learning that occurs in the GI model provides an atmosphere of learning to listen to each other as peer age groups of students who can be fun and interesting to them, and this type of learning activity motivates them [3]. Thus, students share their opinions with other students in different groups, improve their shortcomings together and learn about different things

that are very intensive involving high-level thinking skills and deep-based collaborative abilities and beliefs. These competencies are the fundament for students in developing their attitudes, including good social attitudes, good character, and good spiritual attitudes. It is the basis that in this study it was proven that social attitudes, spiritual attitudes, and character of students with better quality could be achieved by students studying with the GI model compared to DI models.

In research that uses material business objects, energy, impulses, and momentum, it is evident that the GI model is superior to DI in achieving critical thinking skills, social attitudes, spiritual attitudes, and the character of high school students. However, the treatment with GI models has not yet achieved the minimum completeness criteria. The results achieved this time was critical thinking skills  $M = 30.69$  on a scale of 75 or  $M = 40.92$  on a scale of 100, with fewer categories. These results are still far below the minimum completeness criteria, namely  $M = 70$  on a scale of 100. This is a challenge in the application of the next GI model, especially in efforts to achieve students' critical thinking skills in physics learning. The lack of achievement of the minimum completeness criteria for achieving students' critical thinking skills is because students are not familiar with this model so that 5 times the treatment has not shown optimal results. In other words, the application of the GI model should be continued on an ongoing basis, so students become accustomed to using the GI model. In this case, students may need more time to change their views on learning models [40].

Although the direct impact of learning especially in achieving critical thinking skills, GI model has not shown optimal results, but the accompanying impact of learning can be achieved namely social attitudes, spiritual attitudes, and student character, this model has shown results as expected. The accompanying impact of learning that can be achieved is, social attitudes  $M = 100.26$  on a 120 scale or  $M = 83.55$  on a scale of 100, with a good category; his spiritual attitude is  $M = 97.57$  on a scale of 120 or  $M = 81.3$  on a scale of 100, with a good category; and the character of students  $M = 59.74$  on a scale of 72 or  $M = 82.97$  on a scale of 100, with good categories. This is because, in the application of the GI model, students in the class are aware of their evolving academic, social, moral, and spiritual ways of life, namely established standards, and expectations. Teachers try to maintain a healthy academic, social, moral, and spiritual order. The GI model provides a pattern of negotiation of community-style meanings. The negotiation process of the meaning facilitates students to learn the academic domain of knowledge, and in the end, they are involved in solving social, moral, and spiritual problems [26, 27]. This potential is the basis that the GI model can reach categories both in social attitudes, spiritual attitudes, and character. This potential is not found in learning with DI models.

#### IV. CONCLUSION

The GI model is more advanced than the DI model in achieving critical thinking, social attitudes, spiritual attitudes, and character of students in learning physics in class X of SMA Negeri 1 Semarang, SMA Negeri 2 Semarang, and SMA Negeri 1 Banjarangkan Klungkung in the subject

matters of work, energy, impulse, and momentum. Critical thinking of students is the direct impact of the GI model, while social attitudes, spiritual attitudes, and student character are the indirect impacts. In the learning process, the GI model prioritizes the empowerment of students potential. The application of the GI should be able to be maintained and improved the quality of the process so that it can give a direct impact on students critical thinking to be optimal.

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