Effect of Collaborative Inquiry on the Understanding of the Concept and Ability of Critical Thinking

*Priastuti Priastuti[1,] Ridwan Abdullah Sani[1], Derlina Derlina[1], Ahmad Fauzi Pohan[2]

[1]*Department of Physics on Post Graduate Program, State University of Medan, Indonesia*
[2]*Department of Physics, Faculty Mathematical and Science, University of Andalas, Indonesia*
Corresponding author. Email: priastuti.p@gmail.com

ABSTRACT

The need for human resources in the 21st century is emphasized on communication skills, collaboration, critical and creative thinking, this study aims to determine whether there is an influence of collaborative inquiry learning on understanding the concepts and critical thinking skills of students on thermodynamic in SMA N 1 Tanjungtiram North Sumatra. This type of research is quasi-experimental. Sampling was done by cluster random sampling by taking two classes from six classes, namely class XI IPA-3 as an experimental class with class XI IPA-1 as a control class, each with 30 students. The instruments used were 11 concept comprehension tests and 5 critical thinking skills tests in the form of validated essay tests. Research data were tested using two-way ANOVA. The results showed that there was a significant influence of the collaborative inquiry learning model on the understanding of students 'concepts with a value of $F= 9.569 > F_{crit} = 3.881$ and there was a significant effect of the collaborative inquiry learning model on students' critical thinking skills with a value of $F = 120.184 > F_{crit} = 2.643$ when compared to conventional learning (direct instructions learning).

Keywords: Collaborative Inquiry, Understanding of Concept, Critical Thinking

1. INTRODUCTION

Education is one of the efforts made to improve the quality of human resources. The 21st century is a century known as the century of openness in science and technology that the role of humans has begun to be replaced by technology [1-2]. These demands have an impact on changes in competencies that are expected in human resources, namely, communication, collaboration, critical thinking, and creativity. [3-4].

Some of the obstacles encountered in the world of education include difficulty solving problems [4], which is caused by students not being encouraged to think creatively and also to critical thinking [5-10], and also the ability of students to understand concepts, especially for thermodynamic material which still very low, as many as 27.66% of the total students studied by [11]. Other than that, students are only directed to the child's ability to memorize information [12].

To overcome this problem, several solutions are offered by applying several learning models such as the guided inquiry [13-14] and inquiry training model [15-16], which are very effective in overcoming students' critical thinking skills but have not shown the conceptual ability of these students. both critical thinking skills and conceptual skills are directly proportional to each other [17] with a correlation coefficient of 0.651 [18].

As for the collaborative inqury learning model, it has been carried out by [19-20]. This learning model makes students and educators interested in dealing with problems so that students can indirectly have the potential to improve students 'conceptual skills as well as students' critical thinking abilities.

In addition, based on the results of an interview conducted with Mrs. Halimah, a Physics teacher at SMA N 1 Tanjungtiram. Mrs. Halimah, also stated that students are less active and difficult to critical thinking when learning is taking place and some of the results of her monthly evaluation show that only a few students understand the concepts on material such as law I of thermodynamics, law II of thermodynamics 6% and 9.5% respectively. We will study the effect of the collaborative inquiry model to see critical thinking skills as well as students' conceptual understanding abilities.

2. METHOD

2.1. Research Samples and Variables

Sampling in this study using cluster random sampling technique with IX IPA-3 totaling 30 students for the experimental class and XI IPA-1 totaling 30 students for the control class.

There are two variables in this research, namely:

1. Independent Variables: Collaborative Inquiry Learning Model and Direct Learning Model.

2. Dependent Variables: Students' Critical Thinking Ability

3. Moderator Variables: Students' Understanding of the Concept.

2.2. Research Samples and Variables

This research is quasi-experimental research, which is a research that is intended to determine whether there is a result of something imposed on students, namely students. The research design of the study with the design: two group pretest-posttest design. (Table. 1), The research design for two-way ANOVA (2 x 2 factorial design) is in the Table. 2.

Table 1. Pretest-posttest design

Sample	Pretest	Treatment	Posttest
Eksperiment Class	T_{11}	X_1	T_{21}
Control Class	T_{12}	X_2	T_{22}

where T11 is the pretest of the experimental class, T12 is the pretest of the control class, T21 is the posttest of the experimental class, T22 is the posttest of the control class, X1 is learning to apply the learning model of Collaborative Inquiry learning model, and X2 is learning to apply conventional learning models.

Table 2. Two-way ANOVA Research Design (2 x 2 factorial design)

Understanding of the Concept (B)	Ability of Critical Thingking		Average
	Direct Intruction Model (A1)	*Collaborative Inquiry Model (A2)*	
Above average (B$_1$)	$\mu A_1 B_1$	$\mu A_2 B_1$	μ_R
Bottom average (B$_2$)	$\mu A_1 B_2$	$\mu A_2 B_2$	μ_T
Average	μ_K	μ_e	

where

$\mu A_1 B_1$ = The average understanding of the concept is above average using the direct instruction model

$\mu A_2 B_1$ = The average understanding of the concept is above average using the collaborative inquiry model

$\mu A_1 B_2$ = The average understanding of the concept is below average using the direct instruction model

$\mu A_2 B_2$ = The average understanding of the concept is below average using the collaborative inquiry model

μ_k = The average critical thinking ability of students using the direct instruction model

μ_e = The average critical thinking ability of students using the collaborative inquiry model

μ_R = The average critical thinking ability of students in understanding the concept was above average.

μ_T = The average critical thinking ability of students in understanding the concept was bottom average.

2.2. Collaborative Inquiry Model

Table 3. Collaborative inquiry model phase

Phase	Behaviormof Teachers and Students
problem framing	During this stage, the team defines a shared vision, develops investigations into the relationship between professional practice and student learning outcomes, and formulates a theory of action.
collecting evidence	In the second stage, the collaborative investigation team determines the types of data to be collected, how to collect the data, and where to collect it.
analyzing evidence	Students explore ideas that attract the learning team to make data meanings by identifying patterns and themes and formulating conclusions.
celebrating and sharing	During this final stage, the team came together to present and share their new insights.

Collaborative Inquiry is a process where students come together to check their learning practices systematically and carefully using research techniques. There are four phases of Collaborative Inquiry [21] which can be seen in Table 3.

3. RESULT AND DISCUSSION

3.1. Distribustion of Pretest and Postest Data

The control class and the experimental class were tested for their initial ability (pretest), the distribution of the two classes is shown in Fig. 1 (a) and 1 (c), for understanding students 'concepts and figures 1 (b) and 1 (d) for students' critical thinking skills. Judging from the distribution of data and testing for normality and

homogeneity, the two classes have relatively the same abilities (homogeneous) and are normally distributed.

After each class was treated differently, for the experimental class applying the collaborative inquiry learning model and applying the direct instruction model for the control class, it was retested by looking at the students' final ability (posttest). Fig. 2 (a) and 2 (c) for the distribution of post-test scores for the control class and distribution of post-test scores for the experimental class (Fig. 2 (c) and 2 (d). The recapitulation of the distribution of pretest and posttest data is shown in Table 4

After the two data obtained, both the experimental class and the control class for concept understanding and critical thinking skills, then performed hypothesis testing using two-way ANOVA as in Table 5.

Table 4. Distribustion of Pretest and posttest scores

Class	Pretest		Posttest	
	Average	*Standard Deviation*	*Average*	*Standard Deviation*
Understanding of the concept control	33,03	42,29	63,33	167,68
Understanding of the concept experiment	34,16	39,00	67,04	138,48
Critical thinking control	38	100,17	60,91	142,88
Critical thinking experiment	45,5	193,27	66,41	174,86

Table 5. Hypothesis testing research with two-way ANOVA

Source of Variation	SS	df	MS	F	P-Value	F-crit
Sample	1194,631831	1	1194,631831	9,56987362 9	0,00222 1	3,88 1853
Columns	45008,88 891	3	15002,96297	120,184692 9	5,49E-47	2,64 3511
Interaction	328,9358 224	3	109,6452741	0,878 33874	0,45298 5	2,64 3511
Within	28961,15 408	23 2	124,8325607			
Total	75493,61 065	23 9				

3.2. The Effect of Collaborative Inquiry Learning Model and Direct Intruction on Concept Understanding

Based on table 4, it can be seen that the pretest and posttest scores of students from each class, as for the control class in understanding the concept, they get an average pretest score of 33.03 and an average post-test

score of 63.33 and for the experimental class, the average pretest score 34.16 and 67.05 for the mean score of the class posttest. It can be seen that the increase in the value for the control class only reaches 30.30, while for the experimental class, it reaches a more significant growth, namely an increase in score of 33.89. This is in line with research conducted by [10,16], showing that the rise in the mean score of the pretest and posttest in the experimental class is higher when compared to the control class.

The above opinion is also supported by performing statistical analysis of two ways ANOVA (Table 5), the value of $F = 120.1846$, while for the value of $F_{crit} = 2.6435$. From these results, the $F > F_{crit}$ statistical testing concluded that there was a significant difference in students 'ability in understanding students' concepts between the collaborative inquiry learning model carried out in the experimental class and the conventional learning model carried out in the control class.
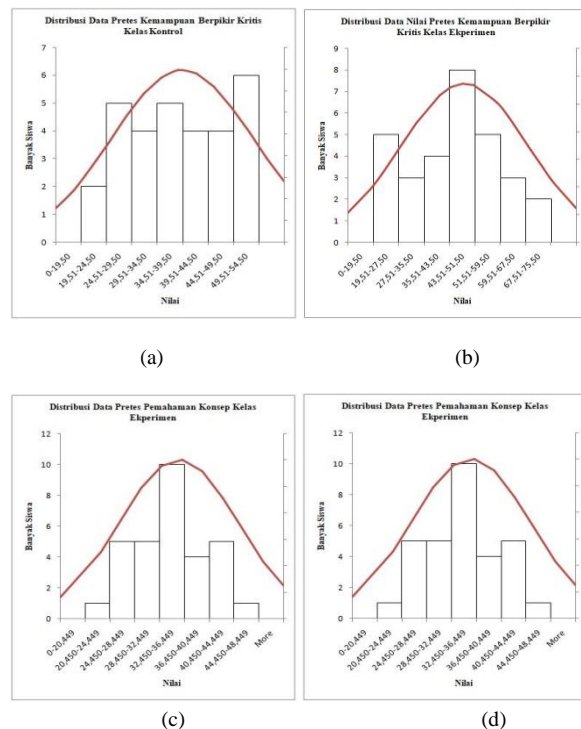

(a) (b)

(c) (d)

Fig. 1. The distribution of pretest data for each class (a) understanding the concept of the control class, (b) understanding the concept of the experimental class, (c) the critical thinking ability of the control class, (d) the critical thinking ability of the experimental class.
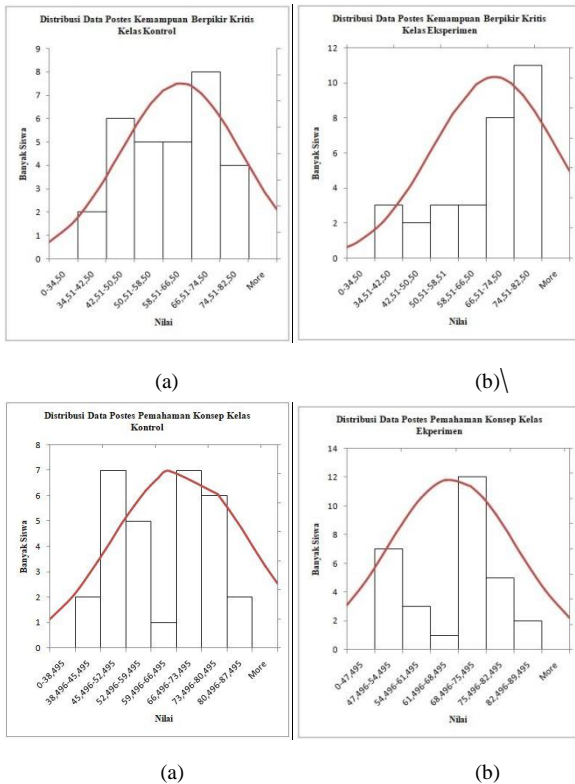
(a)   (b)

(a)   (b)

Fig. 2. The distribution of posttest data for each class (a) understanding the concept of the control class, (b) understanding the concept of the experimental class, (c) the critical thinking ability of the control class, (d) the critical thinking ability of the experimental class.

3.3. The Effect of Collaborative Inquiry and Direct Instruction Model on Critical Thinking Ability

The increase in the pretest and posttest scores can be seen in table 4, as for the control class in critical thinking skills got an average score of 38.00 and 60.91 for the pretest and posttest scores, respectively, which the critical thinking ability score got an average score. 45,50 for the pretest score and 66.41 for the posttest score, it appears that the post-test mean score for the experimental class gets higher scores when compared to the post-test score for the control class. This is in line with research conducted by [22-23]. They said that learning with the collaborative inquiry model can increase critical thinking skills and creativity by facilitating students and directing students to summarize the findings of existing problems by searching and solve the problems faced so that the results of students' innovative thinking are more creative and more developed.

The above is also supported by statistical analysis using two-ways ANOVA (Table 5), the value of F = 9.5698 is obtained, while for the value of Fcrit = 3.8828. From these results, the F> Fcrit statistical test concluded that there was a significant difference in students' critical thinking abilities between the collaborative

inquiry learning model carried out in the experimental class and the conventional learning model carried out in the control class.

4. CONCLUSION

There is a significant effect of the collaborative inquiry learning model on concept understanding and also on students' critical thinking skills. What is shown by $F > F_{crit}$ that *9,5698 > 3,8818* is for understanding concepts and *120,1846 > 2,6435* for students' critical thinking skills.

ACKNOWLEDGMENTS

REFERENCES

[1] Hidayah. R., Salimi. M. and Susiani. T.S.. Critical Thinking Skill: Konsep dan Inidikator Penilaian. Jurnal Taman Cendekia. **1**, 127 – 133 (2017).

[2] Wijaya, Y. E. Sudjimat, A. G. and Nyoto, A, Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia Di Era Global. *Prosiding Seminar Nasional Pendidikan Matematika*. Vol 1. (2016), pp. 263 – 278.

[3] Frydenberg, M. & Andone, D. 2011. *Developing Digital Literacy Skill Through Interactive Images, Multimedia, Mashups, And Global Groups*. Learning for 21 st Century Skills.

[4] Tapung, M., Maryani, E. & Supriatna, E. Improving Students' Critical Thinking Skills in Controlling Social Problems Through the Development of the Emancipatory Learning Model for Junior High School Social Studies in Manggarai. Journal of Social Studies Education Research. **9**, 162-176 (2018).

[5] Azizah. R. Yuliati. L. and Latifah. E. Kesulitan Pemecahan Masalah Fisika Pada Siswa SMA. *Jurnal* Penelitian Fisika dan Aplikasinya (JPFA). **5,** 44 – 50. 2015.

[6] Anas, L. H., Rajagukguk, J., & Bunawan, W. (2020, March). Video Technology Media based on Heat and Temperature to Improve of Learner Critical Thingking. In Journal of Physics: Conference Series (Vol. 1485, No. 1, p. 012037). IOP Publishing.

[7] Ulfah, M., Harahap, M. B., & Rajagukguk, J. (2018, December). The Effect of Scientific Inquiry

Learning Model for Student's Science Process Skill and Self Efficacy in The Static Fluid Subject. In 3rd Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2018). Atlantis Press.

[8] Bergili, B. Creative and Critical Thinking Skills in Problem-based Learning Environments. Journal of Gifted Education and Creativity. **2**, (2015), pp, 71 – 80.

[9] Santos, F.L. The Role of Critical Thinking in Science Education. Journal of Education and Practice. **8,** (2017), pp, 159 – 173.

[10] Kurniawati, I, D.**,** Wartono**.** and Diantoro, M. Pengaruh Pembelajaran Inkuiri Terbimbing Integrasi Peer Instruction Terhadap Penguasaan Konsep dan Kemampuan Berpikir Kritis Siswa. Jurnal Pendidikan Fisika Indonesia. **10**, (2014.), pp, 36 – 46.

[11] Rahmawati, D., Wiyono, K. and Syuhendri. Analisis Pemahaman Konsep Termodinamika Mahasiswa Pendidikan Fisika Menggunakan Instrumen Survey Of Thermodynamic Processes And First And Second Laws (Stpfasl). Jurnal Ilmu Fisika dan Pembelajarannya (JIFP). **1**, (2017), pp, 17 – 27.

[12] Sanjaya, W. *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan.* (Jakarta: Kencana, 2007), pp, 25 -30.

[13] Murawski, L. M. 2014. Critical Thinking in the Classroom and Beyond. Journal of Learning in Higher Education. **10**, (2014), pp, 25 – 30.

[14] Sochibin, A., Dwijananti, P. & Marwoto, P. Penerapan Model Pembelajaran Inkuiri Terpimpin untuk Peningkatan Pemahaman dan Keterampilan Berpikir Kritis Siswa SD. Jurnal Pendidikan Fisika Indonesia. **5**, (2009), pp, 96 -101.

[15] Kurniawan, A. D. Metode Inkuiri Terbimbing dalam Pembuatan Media Pembelajaran Biologi untuk Meningkatkan Pemahaman Konsep dan Kreativitas Siswa SMP. *Jurnal Pendidikan IPA Indonesia.* **2**, (2013), pp, 8 – 11.

[16] Mahulae, P.S., Motlan, S., and Makmur, S. The Effect of Inquiry Training Learning Model Using PhET Media and Scientific Attitude on Students' Science Process Skills. IOSR Journal of Research & Method in Education (IOSR-JRME). **7**, (2017), pp, 24-29.

[17] Yuliani, K. and Saragih, S. 2015. The Development of Learning Devices Based Guided Discovery Model to Improve Understanding Concept and Critical Thinking Mathematically Ability of

Students at Islamic Junior High School of Medan. Journal of Education and Practice. **6**, (2015), pp, 116 – 128.

[18] Alatas, A. Hubungan Pemahaman Konsep Dengan Keterampilan Berpikir Kritis Melalui Model Pembelajaran Treffinger Pada Matakuliah Fisika Dasar. Edusainns. **6**, (2014), pp, 88 – 96.

[19] Kasimatris, A., Petropoulou., Retalis, S., Dimopoolos, I., Psaromiligkos, I. and Karaggelis, K. Using Moodle Abd E- Assessment Methods During A Collaborative Inqury Learning Scanario. Jurnal Pedagogical and Technological Education. **1**, (2014), pp, 1 – 7.

[20] Ramadani, F., & Rajagukguk, J. (2020, March). The Design of Video Technology Based on Scientific experimental for Geometrical Optics Subject as ICT Implementation. In Journal of Physics Conference Series (Vol. 1485, No. 1, p. 012040).

[21]   Donohoo. J. Collaborative Inquiry A Fasilator's Guided. (Canada: MISA, 2011).

[22]   Lawrie, G. A., Matthews, K. E., Bailey, C., Kavanagh, I. J., Gahan, L. R., Weaver, G. C. Adam, P. and Long, P. D. Technology Supported Facilitation And Assessment Of Small Group Collaborative Inquiry Learning In Large First-Year Classes. Journal Of Learning Design. **7**, (2014), pp, 120 – 135.

[23] Brailas, A., Avani, S. M., Gkini, C., Deilongkou, M. A. & Koskinas, K. 2017. Experiential Learning In Action: A Collaborative Inquiry. Journal The Qualitative Report. **22**, (2017). pp, 271 – 288.