THE EFFECT OF THE STRUCTURED INQUIRY LEARNING MODEL ON STUDENTS' CRITICAL AND COLLABORATIVE THINKING SKILLS

Laely Faizati Al Hidayah* and Tutut Nurita

Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia

*Email: laely.18064@mhs.unesa.ac.id

Abstract: The study aims to describe the effect of the inquiry learning model on student critical thinking skills and collaborative skills. The one-group pretest-posttest design was used in the study. The samples were 31 students in grade eight of junior high school in Surabaya, Indonesia. Learning performance data is obtained through observation methods, students' critical thinking skills data through writing test methods, and collaborative skills with observation methods. Learning implementation data is then analyzed with mode formulas. Critical thinking skill data is analyzed using the paired-sample t-test. Collaboration skill data is analyzed with the mode formula. Critical thinking skills indicators are providing simple explanations, building basic skills, concluding, providing advanced explanations, and organizing strategies and tactics. Collaborative skill indicators are working productively with a group of friends, being jointly responsible for getting work done, participating respectfully in discussions, debates, and disagreements, committing to putting group goals first, showing flexibility, and compromising. The study showed that $t_{count}=12.961$ and $t_{table}=30$. It means that a structured inquiry learning model can improve students' critical and collaborative thinking skills.

INTRODUCTION

In the 21st century, education is required to achieve four skills: critical thinking skills, collaboration, creative thinking, and communication, usually called 4C skills. These demands can be met if education is carried out by developing the curriculum as a reference. The curriculum is an educational system that makes learning orderly and measurable [1]. The 2013 curriculum is the curriculum that is enforced in Indonesia today, which provides an understanding that the learning experience obtained by students is much more crucial than just formulating the final goal that must be achieved. The 2013 curriculum emphasizes the activeness of students and their learning independence. Learning independence can grow by providing a learning stimulus that makes students engaged ably in learning so that learning focuses on students. Learning whose primary focus is on students will train high-level thinking skills in students. The better the high-level thinking ability means that, the better the critical thinking skills. Critical thinking skills will be higher if students' independence is also high [2].

Critical thinking skills are an important topic among others in education, where critical thinking skills play a big role in decision-making and problem-solving skills involving high-level thought reasoning and analysis processes. Critical thinking skills are important to be trained in students because there is a creative and logical attitude in problem-solving so that students have competitive abilities and cooperate well with other nations in the future [3]. Based on surveys conducted by PISA (program for international student assessment) followed by 600,000 students from 79 countries for about 15 years, Indonesia was ranked in the bottom 7 in 2018. PISA questions require proficiency in solving problems and reasoning well. So the results indicate that the level of proficiency in solving problems and reasoning owned by Indonesian students is still low. Students are said to have skills in solving problems and reason well when they can apply their knowledge to situations that have never been encountered before. This ability is commonly referred to as critical thinking skills [4], so it can be stated that students' critical thinking skills in Indonesia are still low.

Classroom learning is certainly influenced by various components, especially educators, students, and the models used. But beyond that, other components affect the level of learning success, including learning motivation, students' collaborative skills, and the means used. Collaborative skills are no less important in the educational process leading up to the 21st century. It is proven that the quality of learning of learners will increase when they are actively involved in the learning process in groups. Students should be taught to be able to collaborate with a variety of individuals. Collaborating with various heterogeneous individuals, namely having different backgrounds in family, culture, and daily values. Collaborative skills are skills that students have to construct knowledge and achieve meaningful learning goals through a group where students can cooperate and respect each other's performance in the group [5].

The fact that the science learning class has not run optimally can be seen from the observation in August to December at Junior High school (JHS) 60 Surabaya. There are obstacles in the actualization of the learning process, including the material taught is

difficult by students, rarely practicum, lack of enthusiasm students in learning, learning tends to be teacher center, and the high order thinking skills mastered by students are still low. Not infrequently, there are still many students who do not know each other because only a face-to-face meeting in about one month causes a lack of communication between students. Their understanding stops him without any discussion with others. Supported by the results of the pre-research test, the results of critical thinking skills of class VII-B students only reached 40%. It was also known that there were only four completed students, and 27 others were not completed. In addition, the teacher interviewed results show that students consider the heated material and its transfer as difficult. Various influences from the existence of heat transfer and types of heat transfer cannot be just by reading and developing. It is also explained that fellow students are still reluctant to ask each other questions and discuss when it is difficult to understand the material.

The success of the learning process must, of course, combine the learning system and the type of material taught with the applied model. the appropriate learning model is the inquiry learning model. The inquiry learning model is a series of learning activities with the aim that students can find their concepts so that they can come up with solutions to a problem. The inquiry learning model emphasizes students' thinking processes critically and analytically as a solution to overcoming monotonous student learning boredom because inquiry learning leads to a student center system so that students become active in the learning process [6]. Inquiries are classified into several types: confirmation inquiries, structured inquiries, guided inquiries, and open inquiries [7]. The four types of inquiry learning models each have differences. In the structured inquiry learning model, experiments are conducted with the guidance of teachers, and problem formulations and experimental procedures have also been provided, so students just carry out and make conclusions from their experiments supported by evidence from relevant sources. Structured inquiry is the second level based on the level of the type of inquiry model from the lowest [8]. Jean Piaget's theory divides cognitive development in humans into four stages the sensory stage at the age of 0 to 2 years, the preoperative stage at the age of 2 to 7 years, the concrete surgery stage at the age of 7 to 11 years, and the formal stage of surgery at the age of 11 to 15 years. A person at the age of class VII or about 13 years old is still transitioning from the concrete operational stage to formal operations, then guidance from teachers is still needed by students [9].

This structured inquiry has 4 phases: question identification, conducting experiments, data analysis, and conclusions [10]. In these phases, students acquire critical thinking skills, especially in the data analysis phase, which requires students to

think critically about existing theories. Critical thinking skills become urgent skills to be practiced and must go through a process in learning because it is not attached to the human self from birth. Five indicators measure critical thinking skills: providing simple explanations, building basic skills, concluding, providing advanced explanations, and organizing strategies and tactics [11]. With this inquiry learning model, students are also grouped with their friends so that students can also improve their collaborative skills. Collaborative skills are important to practice to develop sensitivity to the surrounding environment and self-control. Collaborative skills can be interpreted as the ability to work together in teams for a common goal [12]. Collaborative skills include five indicators: working productively with a group of friends, Being responsible for getting work done, Participating respectfully in discussions, debates, and disagreements, Committing to putting group goals first, and Showing flexibility and compromising.

The structured inquiry learning model had a positive effect. However, in the study, collaborative skills were not assessed, even though collaborative skills were also needed. Hence, the research on structured inquiry learning models to improve critical and collaborative thinking skills was conducted [13].

RESEARCH METHODS

This research uses quantitative descriptive methods and research design "one group pretest-posttest design" with the following depictions:

$$O_1 \qquad X \qquad O_2$$
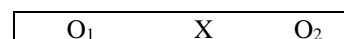
Information:
O_1 : Pretest results before treatment;
X : Treatment in the form of learning using a structured inquiry learning model;
O_2 : Pretest results after treatment

The subjects used were 31 students of class VII-B of Junior High school (JHS) 60 Surabaya. This study was conducted in January-March 2022. The data retrieval method is carried out by two methods, namely the observation method and the writing test method.

Learning implementation is measured by an observation sheet created based on the syntax of the structured inquiry learning model in the Learning Process Plan (LPP). Observation is a way of directly observing and systematically analyzing every behavior [14]. Criteria used to classify learning performance scores according to LPP are listed in the table below [15].

Observers assess by affixing a checklist mark on one of the appropriate criteria. The model is then analyzed with the mode formula. The model itself is the most frequently selected score or the value with the most frequency in a data distribution

[16]. The results of the data analysis will be used to find out the high-frequency answers, namely the scores that most often arise from filling respondents about the implementation of applied learning.

Table 1. Learning Process Plan (LPP) Implementation Assessment Criteria

Score	Criteria
4	Very Good
3	Good
2	Less Good
1	Bad

Students' critical thinking skills are measured by pre-learning and subsequent writing tests called pretests and post-tests. The test given is in the form of 15 description questions. Then the test results are analyzed with the Kolmogorov-sminorv normality test to get information on the distribution of data obtained normally or not. Furthermore, it was analyzed using a paired sample t-test assisted by SPSS 26 to describe whether or not there was an influence on students' critical thinking skills.

Collaborative skills are measured using observation sheets filled out by six observers at each meeting. Collaborative skill observation sheets are created based on predetermined indicators. Furthermore, the observation results are calculated using mode. The data calculation results will be used to determine the classification to be very collaborative, collaborative, quite collaborative, less collaborative, or very less collaborative with the following interpretation of the scale [12].

Table 2. Interpretation of Collaborative Skills Observation Data with Likert Scale

Score	Assessment Criteria
4	Highly Collaborative
3	Collaborative
2	Quite Collaborative
1	Less Collaborative
0	Not Collaborative

RESULT AND DISCUSSION

The effect of a structured inquiry learning model as measured by an observation sheet, namely, meeting 1 reached a score of 4, meeting 2 reached a score of 4. Meeting 3 also reached a score of 4, so it can be stated that the implementation of learning with a structured inquiry model takes place very well by the lesson plans. The results of observations that achieve good criteria indicate that learning has been carried out well [17].

Furthermore, researchers will review students' critical thinking skills that are measured using writing test questions. Shared before learning (pretest) and after learning (post-test). Information from pretest and post-test results is then analyzed descriptively. Descriptive statistical analysis obtained the following results:

Table 3. Descriptive Statistical Analysis Results Data

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	31	16,69	75,01	49,2568	13,24821
Posttest	31	76,66	86,65	81,4623	2,43205
Valid N (listwise)	31				

Table 3 shows that the data has different results between pretest and post-test. The data must be analyzed with parametric statistics using the t-test to describe the influence of the learning model used. There are prerequisites to conducting the t-test, one of which is that the data must be distributed normally. To find out whether the normally distributed data is carried out, the Kolmogorov-Smirnov normality test with the help of SPSS 26. The provision of statistical calculations regarding data normality tests is that if a significance value of more than 0.05 is obtained, then the data is distributed normally. But if the significance value is less than 0.05, then the data is said to be not distributed normally [18]. The data analysis with the normality test produces in the table 4.

Table 4. Tests of Normality

	Kelas	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
hasil tes keterampilan	pretest	,113	31	,200*	,973	31	,599
berpikir kritis	post-test	,144	31	,103	,959	31	,270

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

According to the normality test results above, it was concluded that the critical thinking skills test data was distributed normally both pretest and post-test. H_0 was accepted because the

significance level value was > 0.05. Since the data has been demonstrated to be normally distributed, a t-test using SPSS 26 can be used. The provisions in the paired-sample t-test are that there are two hypotheses, where H_0 is accepted, and Ha is rejected if the signification level is > 0.05. Then the second hypothesis, H_0, was rejected, and Ha was accepted if

the signification level < 0.05. H_0 means no difference between test results before and after learning. In contrast, Ha means to make a difference between the results of the thinking skills test before and after learning [19]. The results of the paired sample t-test are listed in the following table 5:

Table 5. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	49,2568	31	13,24821	2,37945
	Postest	81,4623	31	2,43205	,43681

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pretest & Postest	31	-,155	,407

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest – Postest	-32,20548	13,83429	2,48471	-37,27994	-27,13103	-12,961	30	,000

The results showed that the average pretest was 49.26, and the post-test average was 81.46. Thus the average post-test score is higher than the average pretest score. It can be concluded that students' critical thinking skills increase after applying the structured inquiry model.

The table of the results of the paired samples correlations test shows the degree of significance worth 0.407. If the value of this significance> 0.00, then there is a significant relationship or correlation between the pretest and the post-test.

The table above shows that the significant value that appears is 0.000 < 0.05, then H0 is rejected, and Ha is accepted. Tt means that students' critical thinking skills before and after learning with a structured inquiry model significantly differ.

This fact occurs because syntax in the structured inquiry learning model trains students more actively so that learning can be focused on students. Learning that focuses primarily on students can improve students' critical thinking skills [20]. Students became interested and enthusiastic in undergoing learning with the inquiry model [21]. So between the stages of the structured inquiry learning model with critical thinking skills, there is a linkage whose stages support every indicator of critical thinking skills. Starting from the stage of identifying questions that bring up illustrations in the learner worksheet, this triggers students to estimate and analyze the problems that arise, connected with the formulation of the problems that have been presented to train the indicators to provide a simple explanation in the form of a temporary solution to the problem

given. The illustrations presented are phenomena in life close to students.

The second stage is to conduct experiments; this relates to indicators of building basic skills. The stage of analyzing data makes students practice analyzing the relationship between the results of experiments that have been done and the theory learned so that students can provide advanced explanations. Furthermore, when students make a presentation, they will train students' abilities in managing strategies and tactics. And the last stage is that students can conclude from all the activities carried out; this trains the ability to interpret and interpret a new concept obtained through the results of discussions and presentations of each group. Concluding activities also improve the ability to solve problems so that solving a form of decision-making will also increase critical thinking skills [22].

This structured inquiry learning model has been structured so that it is effective to apply in the learning process whose purpose is to improve students' critical thinking skills. Designing a learning model well can be used to practice critical thinking skills [23]. The phases of inquiry learning can be utilized to improve critical thinking skills, from concepts that are easy to understand to abstract concepts with a curriculum designed clearly and firmly [24]. Good critical thinking skills are demonstrated through patterns in student thinking. Critical thinking is rational, logical, reflective, and independent thinking. Thus critical thinking can also be an intellectual thought process [25]. Critical thinking becomes a cognitive strategy that needs to

be developed to solve existing problems, formulate conclusions from an event, collect various solutions that may be used, and finally make decisions from existing problems effectively and precisely [26]. Students who have good critical thinking skills are said to be able to walk according to the target in solving problems. This statement has been applied to collect critical thinking skills data by providing high-level test questions or HOTS (high order thinking skills) where students practice their rational and logical thinking patterns in determining solutions to each problem. So that the improvement of pretest and post-test results indicates that the better the critical thinking skills that students have.

Table 6. The results indicates that the better the critical thinking skills

| Indicator | Score | | |
	Meeting 1	Meeting 2	Meeting 3
Work productively with a group of friends	2	4	4
Take responsibility together to get the job done	3	4	3
Participate respectfully in discussions, debates, and disagreements	3	3	3
Commit to putting group goals first	3	3	4
Show flexibility and compromise	2	3	4
Modus	3	4	4
Criteria	Very Good		

The observation table shows that at meetings 1 to 3, there is an improvement in students' collaborative skills. This is evidenced by the scores achieved from the five indicators. Meeting 1 reaches a score of 3 means good, meeting 2 reaches a score of 4 means very well, and meeting 3 reaches a score of 4 means very well. Meeting 1 has a lower value than meeting 2 and 3. At the beginning of the meeting, they are still adapting to the applied model, improving the collaboration skills required to process and time. The improvement of collaborative skills achieved by students is, of course, also due to the influence of the structured inquiry model [27]. Stages of structured inquiry learning models focus on learning by walking with small groups. Each group is given one learner worksheet to be discussed together, starting from determining the hypothesis to the concluding stage. Students begin to collaborate with their group of friends by discussing, arguing with each other, and arguing with relevant sources. Thus

the research can be interpreted that learning with a structured inquiry model can improve students' collaborative skills.

Collaborative skills can be practiced through group learning [28]. Learning with small groups involves each other helping each other learn the material [29-30]. It will grow the attitude toward individual and group responsibility and efforts to achieve success together, learn pleasantly with friends, and expand ideas and thoughts from diverse backgrounds.

CONCLUSION

The implementation of a structured inquiry learning model runs with very good criteria. There is a recognized improvement from post-tests and pretests in students' critical thinking skills. The collaborative skills observation sheet scored the final meeting 1 on good criteria, meeting 2 got excellent criteria, and the last meeting got very good criteria. Applying a structured inquiry learning model can improve students' critical and collaborative thinking skills. In the research that has been carried out, several suggestions later can be better, including the need to consider the study's design using several other classes with different models to compare the results obtained.

REFERENCES
[1] Meisaroh, S., Achmadi, H. R., & Prahani, B. K. (2020). Profile of Student s ' Problem-Solving Skills and the Implementation of Free Inquiry Model in Senior High School. *Berkala Ilmiah Pendidikan Fisika*, *8*(2), 59–71. https://doi.org/10.20527/bipf.v8i2.8230
[2] MAGHFIROH, R. A. (2020). Keterampilan Berpikir Kritis Dalam Unit Kegiatan Belajar Mandiri (Ukbm) Pembelajaran Sejarah Indonesia Kelas X Tahun …. *Avatara*, *8*(1). https://core.ac.uk/download/pdf/287305653.pdf
[3] Solikah, M., & Novita, D. (2022). The effectiveness of the guided inquiries learning model on the critical thinking ability of students. *Jurnal Pijar Mipa*, *17*(2), 184-191.
[4] Lestari, A. C., & Annizar, A. M. (2020). Proses Berpikir Kritis Siswa dalam Menyelesaikan Masalah PISA Ditinjau dari Kemampuan Berpikir Komputasi. *Jurnal Kiprah*, *8*(1), 46–55. https://doi.org/10.31629/kiprah.v8i1.2063
[5] Septikasari, R., & Frasandy, R. N. (2018). Keterampilan 4C Abad 21 dalam Pembelajaran Pendidikan Dasar. *Jurnal Taybiyah Al-Awlad*, *8*(2), 112–122.
[6] Wilatika, R. A. S. A., & Yonata, B. (2022). Implementation of guided inquiry learning model to exercise students critical thinking skills on reaction rate material. *Jurnal Pijar Mipa*, *17*(1), 34-40.

[7] Llewellyn, D. (2013). *Teaching High School Science Through Inquiry and Argumentation.* USA: Saga Publication.

[8] Hasanah, J., Jamaludin, J., & Prayitno, G. H. (2019). Bahan Ajar IPA Berbasis Inkuiri Terstruktur Untuk Meningkatkan Literasi Sains Peserta Didik SMP. *Jurnal Pijar MIPA*, *14*(2), 18-24.

[9] Marinda, L. (2020). PIAGET DAN PROBLEMATIKANYA PADA Pendahuluan. *Jurnal An-Nisa :Jurnal Kajian Perempuan & Keislaman*, *13*(1), 116–152.

[10] Foulcorner, E. K. (2016). Investigating The Influence of the Level of Inquiry on Student Engagement. *Journal of Education and Human Development*, *4*(3), 13–19.

[11] Ennis, R. H. (2015). *Critical Thinking : A Streamlined Conception*. Palgrave Macmillan US.

[12] Rahmawati, A. (2019). Analisis Keterampilan Berkolaborasi Siswa SMA Pada Pembelajaran Berbasis Proyek Daur Ulang Minyak Jelantah. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *8*(2), 1–15.

[13] Amijaya, L. S., Ramdani, A., & Merta, I. W. (2018). Pengaruh model pembelajaran inkuiri terbimbing terhadap hasil belajar dan kemampuan berpikir kritis peserta didik. *Jurnal Pijar Mipa*, *13*(2), 94-99.

[14] Kadir, Lucyana, & Satriawati, G. (2017). The implementation of open-inquiry approach to improve students' learning activities, responses, and mathematical creative thinking skills. *Journal on Mathematics Education*, *8*(1), 103–114. https://doi.org/10.22342/jme.8.1.3406.103-114

[15] Setiyadi, M. W., Ismail, & Gani, H. A. (2017). Pengembangan Modul Pembelajaran Biologi Berbasis Pendekatan Saintifik Untuk Meningkatkan Hasil Belajar Siswa. *Journal of Educational Science and Technology*, *3*(2), 102–112.

[16] Sugiyono. (2011). *Metode Penelitian Kuantitatif Kualitatif R&D*. Alfabeta.

[17] Ismail. (2013). Pengembangan Model Pembelajaran IPA Terintegrasi Nilai Karakter di Sekolah. In *Disertasi*. Universitas Negeri Makassar.

[18] Yasmin, N., Ramdani, A., & Azizah, A. (2015). Pengaruh metode inkuiri terbimbing terhadap keterampilan proses sains dan hasil belajar biologi siswa kelas VIII di SMPN 3 Gunungsari tahun ajaran 2013/2014. *Jurnal pijar MIPA*, *10*(2).

[19] Minasari, S. H., & Setiadi, D. (2020). Analisis keterampilan proses sains siswa SMA melalui model pembelajaran penemuan berorientasi sains teknologi masyarakat. *Jurnal Pijar Mipa*, *15*(3), 234-239.

[20] Yuwono, M. R., Udiyono, U., Maarif, D. H., & Sulistiana, S. (2019). Students 'Critical Thinking Profile To Solve The Problem Of Analytical Geometry Viewed From Gender. *Al-Jabar : Jurnal Pendidikan Matematika*, *10*(1), 37–46. https://doi.org/10.24042/ajpm.v10i1.3768

[21] Khalaf, B. K., & Zin, Z. B. (2018). Traditional and inquiry-based learning pedagogy: A systematic critical review. *International Journal of Instruction*. 11(4). 545-564

[22] Arslan, R., Gulveren, H., & Aydin, E. (2014). A Research on Critical Thinking Tendencies and Factors that Affect Critical Thinking of Higher Education Students. *International Journal of Business and Management*, *9*(5), 43–59. https://doi.org/10.5539/ijbm.v9n5p43

[23] Ningsyih, S., Junaidi, E., & Al Idrus, S. W. (2016). Pengaruh Pembelajaran Praktikum Berbasis Inkuiri Terbimbing Terhadap Kemampuan Berpikir Kritis Dan Hasil Belajar Kimia Siswa. *Jurnal Pijar Mipa*, *11*(1).

[24] Suardana, I. N., Redhana, I. W., Sudiatmika, A. A. I. A. R., & Selamat, I. N. (2018). Students' critical thinking skills in chemistry learning using local culture-based 7E learning cycle model. *International Journal of Instruction*, *11*(2), 399–412. https://doi.org/10.12973/iji.2018.11227a

[25] Ahmatika, D. (2017). Peningkatan Kemampuan Berpikir Kritis Siswa Dengan Pendekatan Inquiry/Discovery. *Euclid*, *3*(1). https://doi.org/10.33603/e.v3i1.324

[26] Basri, H., Purwanto, As'ari, A. R., & Sisworo. (2019). Investigating critical thinking skill of junior high school in solving mathematical problem. *International Journal of Instruction*, *12*(3), 745–758. https://doi.org/10.29333/iji.2019.12345a

[27] Herro, D., Quigley, C., Andrew, J., Delacruz,G. (2017). Co-Measure: developing an assessment for student collaboration in STEAM activities.*International Journal of STEM Education.* 4(1).

[28] Arnyana, I. B. P. (2018). Pembelajaran untuk Meningkatkan Kompetensi 4C (Communication, collaboration, critical thinking, creative thinking) untuk Menyongsong Era Abad 21. *Jurnal Universitas Pendidikan Ganesha*, *1*(3), 37–39.

[29] Sari, M. M., & Muchlis, M. (2022). Improving critical thinking skills of high school students through guided inquiry implementation for learning reaction rate concept in chemistry. *Jurnal Pijar Mipa*, *17*(2), 169-174.

[30] Wati, S., Al Idrus, A., & Syukur, A. (2021). Analysis of student scientific literacy: study on learning using ethnoscience integrated science teaching materials based on guided inquiry. *Jurnal Pijar Mipa*, *16*(5), 624-630.