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The Effectiveness of Deep Dialogue/Critical Thinking (DD/CT) Instruction on Scientific Reasoning Ability

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Abstract: *Science inherently involves a process of reasoning, fostering honest, objective, critical, systematic, and creative attitudes, and shaping one's character and thought patterns to support informed conclusion-making. The Deep Dialogue/Critical Thinking (DD/CT) learning model is considered innovative as it encourages student activeness in the learning process by prompting them to seek knowledge and discover concepts, often leveraging technology to maximize interaction. This study investigated the impact of the DD/CT learning model on the mathematical reasoning ability of tenth-grade students at FKIP Universitas HKBP Nommensen. This research employed a quantitative approach, utilizing a quasi-experimental pretest-posttest control group design that involved both experimental and control classes. The research instruments underwent validity, reliability, discrimination, and difficulty testing, and the data met the prerequisites for normality and homogeneity. An independent t-test (α = 0.05) yielded a p-value of 0.004, indicating a statistically significant difference between the groups. Therefore, the DD/CT model has a positive effect on students' mathematical reasoning skills.*

Keywords: *influence; learning model; deep dialogue / critical thinking (DD/CT); saintic reasoning ability; opportunities*

INTRODUCTION

Science is a field of study that plays a crucial role in the development of human life. Science is a process of reasoning, building an honest, objective, critical, systematic, and creative attitude, shaping a mindset and character, and also a field of knowledge that can support concluding (Putri, et al., 2019). In Indonesia, the development of science education aligns with the global progress of science education. However, the advancement of science learning in Indonesia is not in line with the improved capabilities of students in science subjects. This can be seen from the students' lack of ability to find patterns, relationships, and properties when learning scientific material. In fact, when they can do this, they can understand scientific problems by properly examining evidence from a scientific solution. This ability is what is known as scientific reasoning ability (Abidah et al., 2021).

According to Sriwahyuni Latif (in Maulidiyah, 2021), the objective of science subjects is for students to have the following abilities: (a) to understand science concepts, explain the connections between concepts, and apply concepts or algorithms flexibly, accurately, efficiently, and appropriately in problem-solving; (b) to use reasoning on patterns and properties, perform manipulations to make generalizations, construct evidence, or explain ideas and statements; (c) to solve problems; (d) to communicate ideas using symbols, tables, diagrams, or other media to clarify situations or problems; and (e) to have an attitude of appreciating the usefulness of science in life, a sense of curiosity, attention, and interest in studying science, as well as a persistent and confident attitude in problem-solving.

The low level of science reasoning ability is evident from the ranking of Indonesian students in the PISA (*Programme for International Students Assessment*) in 2018, which showed that the science score for Indonesian students was 379. This score is still very far from the OECD average score of 490. One of the aspects assessed in the PISA test is reasoning, so it can be concluded that the science reasoning of Indonesian students is still low (Adit & Raekha, 2022). Compared to PISA in 2022, Indonesia's score was 366, a decrease from the 2018 PISA assessment results. Furthermore, the report from The Trends In International Mathematics And Science Study (TIMSS) in 2015 showed that Indonesia was ranked 44th out of 49 participants with an average score of 397. This score is far below the international average of 500. Based on these results, Indonesia is classified as having a low category (Nur, et al., 2024).

Reasoning ability is not something that can grow and develop on its own without the presence of an educator; instead, an educator can enhance students' reasoning ability by implementing various learning strategies. One way is to use an active learning approach, where students are involved in discussions and problem-solving activities that encourage the development of reasoning skills. In addition, educators should have the competence to develop teaching materials, which they ideally should have mastered well. However, in reality, many educators have not yet mastered this, resulting in many teaching processes that are still conventional. The impacts of this conventional learning include the educator being more dominant, while students are less active because they tend to be listeners. Additionally, the learning itself is less engaging because the teaching methods are not varied enough.

The Deep Dialogue/Critical Thinking (DD/CT) learning model is designed as an innovative approach that encourages students to be active in the learning process. This model promotes active inquiry and discovery of concepts by leveraging technology to maximize interaction. Consequently, this type of instruction is expected to enhance students' understanding of spatial dimension layout and improve their reasoning abilities. This method is crucial because recent studies predominantly indicate that interactive, collaborative, challenging, and surprising learning experiences significantly improve learning outcomes, particularly for complex topics such as buffer solutions.

LITERATURE REVIEW

Deep dialogue / critical thinking (DD/CT) learning model

Deep dialogue / critical thinking (DD/CT) is a philosophy used as a learning approach that prioritizes in-depth discussion and critical thinking skills in classroom learning activities. The discussion can be seen during the learning process, whether it's a discussion between the teacher and students, between students and students, or between the teacher, students, and the environment (Hendri Pratama, et al., 2015).

According to Swidler (2000), Deep Dialogue / Critical Thinking (DD/CT) is a form of self-transformation that occurs by opening oneself up to anyone with a different way of thinking. It is a global awareness of the world and perspectives that will influence the process of how one sees, perceives, and knows in every aspect of life. Furthermore, according to Lau, DD/CT is the ability to think carefully and reasonably, which includes the ability to synthesize, reflect, and think freely.

Based on the definitions from the experts above, it can be concluded that Deep Dialogue / Critical Thinking (DD/CT) is a learning approach that emphasizes in-depth discussion and critical thinking skills. This approach involves interaction between teachers and students as well as between students themselves, and it encourages openness to different perspectives.

Critical thinking helps students discover and test their own attitudes. Deep Dialogue / Critical Thinking (DD/CT)-based learning accesses a constructivist understanding by emphasizing deep dialogue and critical thinking. The dialogue conducted by students will take place throughout the learning process, whether it's a dialogue between the teacher and students or between students themselves, to solve a problem (Nurliana et al., 2023; Widiawati, et al., 2020).

Scientific Reasoning Ability

Scientific reasoning ability is the capacity to draw conclusions based on existing or known facts. Due to the importance of reasoning skills for students, it is necessary to analyze the types of errors students make when solving problems (Atika, 2018). Mathematical reasoning ability is a form of thinking. Hardjosatoto states that reasoning is one event in the thought process. The scope of thinking is a set of varied mental activities, such as recalling something, imagining, memorizing, connecting different meanings, creating concepts, or guessing certain possibilities (H. Ahmad, 2016).

Reasoning ability is one of the goals of mathematics education in schools, which is to train thinking and reasoning skills to draw conclusions, develop problem-solving abilities, and develop the ability to convey information or communicate ideas through speech, writing, images, graphs, maps, diagrams, and so on (Sumartini, 2015).

Based on the definitions from several experts above, it can be concluded that mathematical reasoning ability is the capacity to draw conclusions and solve problems based on known facts, which involves a critical thinking process and mental activities, and aims to train students to convey information and ideas through various media.

There are two types of reasoning in science education: 1) Inductive reasoning is a thought process that seeks to connect known facts or specific events to a general conclusion. Inductive reasoning is empirical, based on facts. In general, the steps of inductive reasoning used in science are as follows: a) Observing patterns that occur, b) Making conjectures about a general pattern that might be valid, c) Making a generalization, and d) Proving the generalization deductively. 2) Deductive reasoning is a thought process for drawing conclusions about specific things based on general principles or things that have been previously proven (or assumed) to be true. Deductive reasoning is related to rationalism and is based on reason. Based on the assumption of innovation-based research, the hypothesis of this study posits that the DD/CT model is significantly more effective than conventional learning.

Buffer Solutions

A buffer solution is a solution that can maintain a relatively constant pH despite the addition of small amounts of acid (H^+) or base (OH^-), or upon dilution. Buffers are widely used in biological systems, analytical chemistry, and industry because pH stability is crucial.

There are two types of buffer solutions: a) Acidic buffer: Made from a mixture of a weak acid and its salt derived from a strong base. An example is a mixture of acetic acid (CH_3COOH) with sodium acetate (CH_3COONa), and it has a pH < 7. b) Basic buffer: Made from a mixture of a weak base and its salt derived from a strong acid, such as a mixture of ammonia (NH_3) with ammonium chloride (NH_4Cl), and it has a pH > 7 (Petrucci, et al., 2017).

METHODS

This study uses a quantitative research method with a quasi-experimental approach to examine the effectiveness of the Deep Dialogue / Critical Thinking (DD/CT) learning model on scientific reasoning ability. A quasi-experiment is defined as an experiment that has a treatment, a measure of impact, and experimental units but does not use random assignment to create a comparison to conclude changes caused by the treatment (Cook, 1979; Abraham & Supriyati, 2022).

The research design used is a pre-test post-test control group design. The pre-test was used to determine the level of students' scientific reasoning ability before the treatment was given. The post-test was used to determine the level of students' scientific reasoning ability after the treatment was given. The implementation of this study began by first conducting a pre-test on two classes. Then, the experimental class was given a treatment in the form of learning using the Deep Dialogue / Critical Thinking (DD/CT) learning model, while the control class learned as usual using a conventional learning model. After the treatment was given, a post-test was conducted on each group to determine the level of students' understanding of science concepts.

A population is a generalization area consisting of objects/subjects that have certain qualities and characteristics determined by the researcher to be studied and from which conclusions are then drawn (Sugiyono, 2019; Muslimin, 2021). The population in this study is all students of the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University, Medan.

N−Gain is the difference value between the pretest and posttest that shows the extent of a student's knowledge development or mastery of a concept after the learning process. N−Gain is used to assess how much change has occurred, whether the result is good, moderate, or low (Herlanti, 2014) with the formula used:

$$N - Gain = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \qquad (1)$$

RESULTS AND DISCUSSION

Before conducting the Normality and Homogeneity tests, the researcher first calculated the mean and standard deviation of the pretest and posttest data from both the control and experimental classes. These mean values were then used to test whether each data set was normally distributed or not. The results of the mean and standard deviation calculations can be seen in the following table:

Table 1. Mean and Standard Deviation Values

Value	Pretest Control	Pretest Experimental	Posttest Control	Posttest Experimental
$\bar{X}$ (mean)	68.71	73.65	68.96	79.92
Standard Deviation	6.67	5.83	9.31	13.08

A normality test was conducted on four data sets: the pretest and posttest data from both the control class and the experimental class. The results of the normality test can be seen in the following table:

Table 2. Normality Test

Kelas	Jumlah sampel (n)	Hasil uji	t tabel 0.05%	Keterangan
Pretest k.kontrol	28 siswa	1.11	0.92	Normal
Pretest k.eksperimen	26 siswa	1.11	0.92	Normal
Posttest k.kontrol	28 siswa	1.01	0.92	Normal
Posttest k.eksperimen	26 siswa	0.97	0.92	Normal

A homogeneity test is performed after the data is normally distributed, using an independent t-test. The results are as follows:

Table 3. Homogeneity Test

F-Test Two-Sample for Variances		
	Variable 1	*Variable 2*
Mean	80,30769231	69,96428571
Variance	167,0215385	99,36904762
Observations	26	28
df	25	27
F	1,680820562	
P(F<=f) one-tail	0,094687852	
F Critical one-tail	1,920973673	

Based on these results, it was found that the data is homogeneous.

The N-Gain calculation was performed to determine whether the deep dialogue/critical thinking learning model is effective in improving the scientific reasoning ability of students in the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University, Medan. Based on the calculation, the following was obtained:

Table 4. N-Gain Results

No.	Group	N-Gain Score	Criteria
1	Experimental	0.72	High
2	Control	0.577	Moderate

Therefore, it can be concluded that the deep dialogue / critical thinking learning model is effective in improving the scientific reasoning ability of students in the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University.

To determine the effect of the deep dialogue / critical thinking learning model on the scientific reasoning ability of students in the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University, a t-test was conducted with the following results:

Table 5. T-test Results

t-Test: Two-Sample Assuming Equal Variances		
Mean	70,037	79,760
Variance	103,037	165,857
Observations	27	25
Pooled Variance	133,1904593	
Hypothesized Mean Difference	0	
df	50	
t Stat	3,035	
P(T<=t) one-tail	0,002	
t Critical one-tail	1,676	
P(T<=t) two-tail	0,004	
t Critical two-tail	2,009	

Based on the findings, it is concluded that the deep dialogue/critical thinking learning model has a significant effect on the scientific reasoning ability of students in the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University.

Based on the research conducted by the author, it can be concluded that the implementation of the deep dialogue/critical thinking learning model has a significant influence on the reasoning ability of students in the Science Education study program at the Faculty of Teacher Training and Education, HKBP Nommensen University, Medan, specifically regarding the topic of buffer solutions. This is evident from the higher average posttest scores in the experimental class compared to the control class, the t-test results, which showed a significant effect, and the N-Gain test results, which indicated a higher increase in the experimental class.

CONCLUSION

This study demonstrably indicates that the implementation of the Deep Dialogue / Critical Thinking learning model has a positive and measurable impact on students' scientific reasoning ability. This outcome is substantiated by the statistical test results, which registered a significant effect differentiating the experimental group from the control group following the intervention.

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REFERENCES

Abidah, N., Hidaayatullaah, H. N., Simamora, R. M., Fehabutar, D., Mutakinati, L. (2020). The impact of COVID-19 on Indonesian education and its relation to the philosophy of “Merdeka Belajar”. Studies in Philosophy of Science and Education, 1(1), 38-39.

Abidin, Z. (2020). Efektivitas pembelajaran berbasis masalah, pembelajaran berbasis proyek literasi, dan pembelajaran inkuiri dalam meningkatkan kemampuan koneksi matematis. Profesi Pendidikan Dasar, 7(1), 37-52.

Abraham, I., & Supriyati, Y. (2022). Desain kuasi eksperimen dalam pendidikan: Literatur review. Jurnal Ilmiah Mandala Education, 8(3)

Adit Saputra, & Azka, R. (2020). Pengembangan komik matematika untuk memfasilitasi kemampuan pemahaman konsep dan motivasi belajar siswa SMP. Jurnal Pengembangan Pembelajaran Matematika (JPPM), 2(2), 89–97.

Ahmad, H. (2016). Desain pembelajaran matematika yang memanfaatkan model kooperatif dengan pendekatan kontekstual pada kelas XA SMK Bina Generasi Polewali. Pepatudzu: Media Pendidikan dan Sosial Kemasyarakatan, 7(1), 39–55.

Atika, P. M. (2018). RETRACTED: Model pembelajaran langsung berbasis media pasir berwarna terhadap kemampuan pemahaman konsep angka 1-10. JPI (Jurnal Pendidikan Inklusi), 1(2), 129–145.

Mauliddiyah, L. & Wulandari, S. S. (2022). Pengaruh media pembelajaran daring, fasilitas belajar dan motivasi belajar terhadap hasil belajar siswa selama pandemi Covid-19 di SMKN 1 Surabaya. EDUKATIF: Jurnal Ilmu Pendidikan, 4(2).

Nani, N., Samiun, Z., & Nur, M. P. (2024). Exclusive Breastfeeding with the Incidence of Stunting. Jurnal Ilmiah Kesehatan (JIKA), 6(1), 114–121.

Nur, F. A., Permatasari, N. S., & Nurliana, M. (2023). Pemanfaatan ekosistem mangrove untuk keberlangsungan hidup masyarakat pesisir di Desa Tanjung Rejo Kecamatan Percut Sei Tuan Kabupaten Deli Serdang Sumatera Utara. Jurnal Pendidikan dan Konseling (JPDK), 5(1), 2175–2186.

Petrucci, R. H., Herring, F. G., Madura, J. D., & Bissonnette, C. (2017). General Chemistry: Principles and Modern Applications (11th ed.). Pearson.

Putri, D. K., Sulianto, J., & Azizah, M. (2019). Kemampuan Penalaran Matematis Ditinjau dari Kemampuan Pemecahan Masalah. International Journal of Elementary Education, 3(3), 351–357.

Pratama, H., Azman, M. N. A., Mustapha, R., Ab Rahman, A., & Che Rus, R. (2015). Keberkesanan kaedah pembelajaran berasaskan DD/CT terhadap kecerdasan emosi pelajar sekolah menengah di Banda Aceh. Sains Humanika, 7(1).

Pratama, H., Azman, M. N. A., Mustapha, R., Ab Rahman, A., & Che Rus, R. (2015). Keberkesanan Kaedah Pembelajaran Berasaskan DD/CT Terhadap Kecerdasan Emosi Pelajar Sekolah Menengah di Banda Aceh. Sains Humanika, 7(1).

Sumartini, T. S. (2015). Peningkatan kemampuan penalaran matematis siswa melalui pembelajaran berbasis masalah. Mosharafa: Jurnal Pendidikan Matematika, 4(1), 1–10.

Swidler, A. (2000). Cultural power and social movements. In Culture and Politics (pp. 269–283). Springer.

Widiawati, H., Budiawan, A., Thahir, M., Ulum, S., & Vebrianto, R. (2020). Pengembangan Program REWARD (Reading, Writing, and Art Development) melalui pelatihan desain grafis untuk mewujudkan sekolah berbasis IT pada SMPN 1 Kerinci Kanan Tahun 2020. Instructional Development Journal.