Progress in Students' Critical Thinking Skills and Motivation based on the Implementation of Discovery Learning modified with Think Pair Share Learning Model

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Abstract

This study aimed to understand the effect of Discovery Learning modified with Think Pair Share (DL/TPS) learning model for upper secondary school student's critical thinking skills and their motivation in learning the human circulatory system. This study used a quantitative descriptive approach with research design of pre-test/post-test control group. The research instruments were pre-test and post-test questions to evaluate the students' critical thinking skills and a questionnaire to assess the students' motivation in learning. A hypothesis testing of average post-test score about students' critical thinking skills from control and experimental classes was obtained with the value of t_{cal} (4.34) > t_{tab} (1.67).

This result shows that there was a significant difference between the evaluation score for students' critical thinking skills from the control and DL/TPS and control classes. Then, a hypothesis testing of students' motivation score from DL/TPS and control classes was obtained with the value of t_{cal} (8.07) > t_{tab} (1.67) in which the significant difference about the motivation of students from control and experimental classes was validated. Therefore, DL/TPS learning model can enhance the critical thinking skills and motivation of students in science subjects.

Keywords: Discovery Learning, Think Pair Share, Critical Thinking Skills, Motivation, Learning Model, Human Circulatory System.

Introduction

The education has important rules in developing knowledge in a nation. The quality of human resources is correlated to the education quality obtained by learners.[1] One of the problems encountered in the learning process is low awareness and desire of students to develop their potential. [2] This problem has an impact on students' ability to understand a subject. Several efforts to improve the education quality are closely related to the school curriculum, teachers and learning strategies used in the classroom.[3] The teachers must be creative in teaching and use learning models to improve student cognitive abilities, critical thinking skills, or motivation in learning.[4–6]

The teachers can engage the students to be actively involved in learning by giving the opportunity to ask questions and familiarize group discussions among the students.[7] If the students are interested and motivated in the learning process, so they can develop their cognitive potential and critical thinking skills.[8] This effort certainly supports student learning outcomes at the end of the learning activity.

A suitable learning model to be performed is a cooperative learning model in which a student can be used as a learning resource for other students, besides the teachers, books and other learning sources.[9] Discovery Learning (DL) is a type of cooperative learning where the students can build their own knowledge by conducting an experiment and finding a principle from the experimental results.[10] The DL learning model provides the understanding of concepts, meanings and relationships through an intuitive process to finally arrive to a conclusion.[11] The DL learning model is a component of educational practice including a teaching method to promote active learning and process-oriented.[12] An example of research, DL learning model with puzzle media can enhance students' learning outcomes of a colloidal system topic in chemistry subject.[13]

Apart from DL learning model, Think Pair Share (TPS) learning model is also very useful in improving the student ability. TPS learning model provides learning outcomes more satisfying than a conventional learning model.[14] TPS learning model increases student participation in the learning process.[12] TPS learning model gives an opportunity to the students to work individually or in groups and optimizes their participation during the learning process to improve their collaborative skills and cognitive learning outcomes.[15] TPS learning model also gives students enough time to formulate the questions, to answer the questions and communicate them to other students.[16] Therefore, the information of knowledge will spread faster between the students.

Some obstacles often encountered in the classroom are such as a lack of student's enthusiasm for learning and less courageous in expressing their opinions. If so, the learning presented in the classroom is only teacher-centered. Based

on the background above, this study was conducted to enhance students' critical thinking skills and their motivation by using a combination learning model of DL/TPS in learning a natural science concept (human circulatory system) in an upper secondary school in Aceh province, Indonesia. The hypothesis of this study was that there is effects of DL/TPS learning model on critical thinking skills and motivation of students in a natural science subject.

Material and Methods

Population and Samples: The population in this study was 120 students spreading in four classes of 11th grade at public upper secondary school 12 Banda Aceh-Indonesia. The samples in this study were the students in three classes where they were taught by DL, TPS and DL/TPS learning model, while the remaining one class was taught by a conventional learning model.

Research Instruments: The research instruments used in this study were 10 essay questions (pre-test/post-test) to measure the critical thinking skills of students, questionnaires to explore students' motivation in learning and learning tools such as syllabus, lesson plan and student worksheets. A pre-test was used before the learning process. A post-test and a questionnaire were used after learning activity with the learning models. The questionnaire for students' motivation is based on the Attention, Relevance, Confidence and Satisfaction (ACRS) model. ARCS model is one of problem-solving approaches to design the aspects of motivation and/or learning environments to encourage learning motivation.[17] The lesson plan for human circulatory system material was prepared by inserting the learning models of DL, TPS and DL/TPS.

Research Approach and Design: The research approach used in this study was a quantitative descriptive approach. This approach provides all information expressed in numbers and analyzed statistically. The design used in this study was a pre-test/post-test control group as presented in table 1.[18] The steps of DL learning model, TPS learning model and DL/TPS learning model are presented in fig. 1.

Data Collection Techniques: The parameters measured in this study were the progression in critical thinking skills and motivation of students. The type of measured data was the data on the individual score collected through the provision of the tests. Then, the data was tabulated for further analysis.

Data Analysis: Data processing for concept mastery was done by using the t-test calculation. Before performing the t-test, normality and homogeneity tests were carried out by using SPSS software. If the test results show normally distributed data and homogeneous, then it can be continued by a differentiation test with t-test of average scores. To determine the t-table value, a significant level ($\alpha = 0.05$) was used with the degree of freedom, df = N-1. If $t_{cal} > t_{tab}$, the learning model of DL/TPS learning modal can enhance the students' critical thinking skills and motivation for learning of human circulatory system. For the analysis of critical thinking skills, the independent sample t-test formula was used as shown:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{s^2xy\left(\frac{1}{n_x} + \frac{1}{n_y}\right)}}$$

where t = calculated value, x = average value in experimental classes, y = average value in control class, s^2xy = variant, n_x = student numbers in experimental classes, n_y = student numbers in control class.[19]

The scores of student motivation in learning were analyzed by using percentage formula = (Σ respondent score / Σ statement score). The questionnaire with ARCS model was scored by positive responses (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree) and negative responses conversely.[17] The average number of positive and negative response scores was adjusted to the category index (1.00-1.49 = not very good, 1.50-2.49 = not good, 2.50-3.49 = moderate, 3.50-4.49 = good, 4.50-5.00 = very good). Furthermore, the motivation score was analyzed by using the normality and homogeneity formulas and then tested by using the t-test formula.

Results and Discussion

Critical Thinking Skills and Motivation of Students: The data on students' critical thinking skills for the material of human circulatory system were obtained from the calculation of the total scores of the pre-test and post-test questions given in the beginning and at the end of the learning. This calculation aimed to find out the average score of students' critical thinking skills. The average score of critical thinking skills of students from the control class and experimental classes is presented in fig. 2. There were different scores of critical thinking skills between the students from the control class and experimental classes.

The lowest average score of pre-test was obtained from the control class and the highest average score of pre-test was obtained from DL/TPS class as well as for post-test average score. The average score of students' critical thinking skills from DL/TPS class was higher than the control, TPS and DL. Then, a statistical test was conducted to understand the effect of DL/TPS learning model for students' critical thinking skills in the control class and experimental classes.

Furthermore, the data of students' motivation in learning was obtained from the calculation of students' response scores based on the questionnaire given after completion of the learning. This calculation aimed to determine the average score for students' motivation in learning. Based on the data analysis, it was known that the average score of learning motivation of students from experimental classes achieved good category. The average score of students' motivations in the control class and experimental classes can be seen in fig. 3. There were differences in students' motivation between

control class and experimental classes. After learning activity, the learning motivation in control class was achieved in a moderate category with the average score of 2.86. The average scores of motivation in DL and TPS classes were achieved in a moderate category with the score of 2.92 and 2.98 respectively whereas the learning motivation of students from DL/TPS class achieved the average score of 3.52 as a good category.

During the learning proses by using the DL/TPS learning model, the students became more active, creative and confident. This was because the students were given an opportunity to try finding the solutions to the given problems and directly involved in a discussion among the group partners. The teacher provided the stimuli in the form of the problems correlated to the human circulatory system that can help the students to think, ask and give reasons/statements. This learning model can help the students to construct the conceptual knowledge of students so that the students can identify the given problems based on their comprehensions, questions and the solutions.

On each occasion, students proposed several questions correlated to the difficult materials. The implementation of DL/TPS learning model in the learning process can help students and teacher in many aspects. For the students, this learning model can help them in constructing their mindset in order to explore their own ways to learn something. Students also showed their readiness to speak up and propose their statements confidently. As a result, DL/TPS learning model not only generated students with better cognitively learning outcomes but also increased their critical thinking skills with the ability to solve the problems.

DL/TPS learning model can train the students to learn cooperatively and enhance their responses in learning. DL/TPS learning model also supported the interaction among the students. This learning model created the pleasure learning environment so that it can enhance the students' motivation in learning. In learning activity, motivation is an important factor to make students active in learning. The students without learning motivation cannot produce successful learning.

So, the stronger is students' motivation, it is more optimal in conducting learning activities. In other words, the learning intensity is largely determined by students' motivation. DL/TPS learning model can enhance the students' motivation through discussion, asking the questions, proposing the statements and concluding the discussion results.

Statistical Analysis of Students' Achievements: Before testing the hypothesis, normality and homogeneity tests were carried out. Table 2 shows that the normality and homogeneity of pretest and posttest values for students' critical thinking skills from control and experimental classes were tested by using SPPS which normally distributed and derived from homogeneous data. Because all data were normal and homogeny, so the hypothesis testing was continued by using independent sample t-test formula. This testing was conducted to understand the effects of DL/TPS learning model on the critical thinking skills of students. The t-test results of post-test scores of students' critical thinking from control and experimental classes can be seen in table 3.

The t-test result of post-test scores from control and experimental classes has different t_{cal} value. t_{cal} (4.34) was higher than t_{tab} (1.67) so that there was a significant difference of post-test scores of students' critical thinking skills between control and experimental classes. The t-test result of post-test scores of students' critical thinking skills from DL class and DL/TPS class was obtained with the t_{cal} (2.63) > t_{tab} (1.67) which means that there were significantly different achievements among these two classes. Based on the calculation of t-test from post-test scores of students' critical thinking skills between control and experimental classes proved that the hypothesis was accepted.

Furthermore, the statistical testing was performed to understand the differentiation of student motivation in learning between control and experimental classes. Similar to the analysis of post-test scores of students' critical thinking skills, the normality, homogeneity and t-test of the student motivation in learning were also performed with the significant level (α) of 0.05. The normality, homogeneity and t-test of the students' motivation scores from control and experimental classes are shown in table 4.

Normality and homogeneity tests of average scores of students' motivation between DL/TPS and other classes were tested by using SPPS software in which a significant value was higher than 0.05. The data were normally distributed and derived from the homogeneous data. Because all data were normal and homogeny, then the hypothesis testing can be continued by using the independent sample t-test formula. The results of t-test exhibited that $t_{cal} > t_{tab}$. The t-test of the students' motivation from DL/TPS and control classes was obtained with the value of t_{cal} (8.07) > t_{tab} (1.67).

There was a significant difference between the average scores of students' motivation in DL/TPS and control classes. The t-test of the motivation scores from DL/TPS and DL classes has produced the value of t_{cal} (8.45) > t_{tab} (1.67) with a significant difference between the average scores of students' motivation.

In addition, the t-test calculation on the motivation scores from DL/TPS and TPS classes was obtained with the value of t_{cal} (8.51) > t_{tab} (1.67) in which there was a significantly different achievement of the motivation scores in these two classes. Based on the t-test of average scores of learning motivation from different classes can approve the compiled hypothesis was accepted.

Table 1
The design for pre-test/post-test control group. X = learning model implementation, Y = assessment, DL = discovery learning, TPS = think pair share, CON = conventional.

Group	Pre-test	Treatment	Post-test
Exp. 1	$Y_{DL/TPS}$	$X_{DL/TPS}$	$Y_{DL/TPS}$
Exp. 2	Y_{DL}	X_{DL}	Y_{DL}
Exp. 3	Y_{TPS}	X_{TPS}	Y_{TPS}
Control	Y_{CON}	X_{CON}	Y_{CON}

Table 2
The normality and homogeneity tests of the pre-test and post-test values of students' critical thinking skills in the control and experimental classes.

Class	Score	Average	Normality	Homogeneity
Control	Pre-test	27.50	0.081 > 0.05 (Normal)	0.052 > 0.05 (Homogeny)
	Post-test	69.17	0.076 > 0.05 (Normal)	
DL	Pre-test	31.00	0.215 > 0.05 (Normal)	0.241 > 0.05 (Homogeny)
	Post-test	73.33	0.087 > 0.05 (Normal)	
TPS	Pre-test	32.17	0.198 > 0.05 (Normal)	0.162 > 0.05 (Homogeny)
	Post-test	74.67	0.098 > 0.05 (Normal)	
DL/TPS	Pre-test	37.33	0.095 > 0.05 (Normal)	0.512 > 0.05 (Homogeny)
	Post-test	78.00	0.210 > 0.05 (Normal)	

Table 3
The t-test of the post-test scores of students' critical thinking skills from the control and experimental classes.

Class	Average Score	t-test (sig, $t_{hit} > t_{tab}$, $\alpha = 0.05$)	Annotation
DL/TPS	78.00	$t_{cal}(4.34) > t_{tab}(1.67)$	Significantly different
Control	69.17		
DL/TPS	78.00	$t_{cal}(2.63) > t_{tab}(1.67)$	Significantly different
DL	73.33		
DL/TPS	78.00	$t_{cal}(2.10) > t_{tab}(1.67)$	Significantly different
TPS	74.67		
Control	69.17	$t_{cal}(2.10) > t_{tab}(1.67)$	Significantly different
DL	73.33		
Control	69.17	$t_{cal}(2.10) > t_{tab}(1.67)$	Significantly different
TPS	74.67		
DL	73.33	$t_{cal}(2.10) > t_{tab}(1.67)$	Significantly different
TPS	74.67		

Table 4
Normality, homogeneity and t-test analysis of average scores from students' motivation in learning between control and experimental classes.

Class	Average Score	Normality (*Sig* > 0.05)	Homogeneity (*Sig* > 0.05)	t-test (*Sig* >0.05)	Annotation
DL/TPS	3.52	0.20 > 0.05 (Normal)	0.597 > 0.05 (Homogeny)	t_{cal} (8.07) > t_{tab} (1.67)	Significantly different
Control	2.86	0.20 > 0.05 (Normal)			
DL/TPS	3.52	0.20 > 0.05 (Normal)	0.409 > 0.05 (Homogeny)	t_{cal} (8.45) > t_{tab} (1.67)	Significantly different
DL	2.92	0.20 > 0.05 (Normal)			
DL/TPS	3.52	0.20 > 0.05 (Normal)	0.061 > 0.05 (Homogeny)	t_{cal} (8.51) > t_{tab} (1.67)	Significantly different
TPS	2.98	0.20 > 0.05 (Normal)			
Control	2.86	0.20 > 0.05 (Normal)	0.187 > 0.05 (Homogeny)	t_{cal} (0.88) < t_{tab} (1.67)	Not significantly different
DL	2.92	0.20 > 0.05 (Normal)			
Control	2.86	0.20 > 0.05 (Normal)	0.025 > 0.05 (Homogeny)	t_{cal} (1.37) < t_{tab} (1.67)	Not significantly different
TPS	2.98	0.20 > 0.05 (Normal)			
DL	2.92	0.20 > 0.05 (Normal)	0.211 > 0.05 (Homogeny)	t_{cal} (0.54) < t_{tab} (1.67)	Not significantly different
TPS	2.98	0.20 > 0.05 (Normal)			

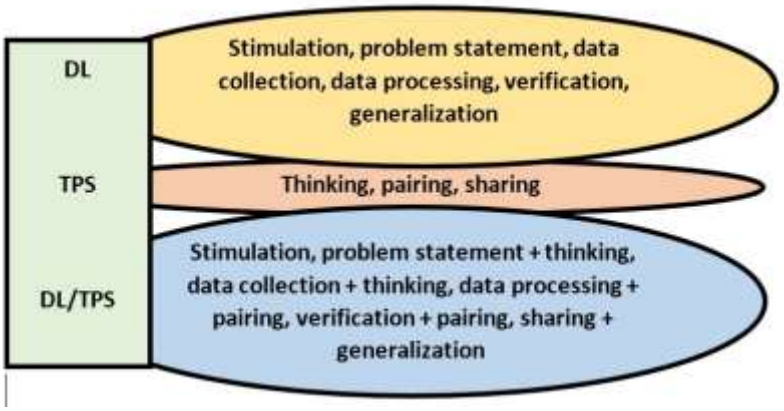

Figure 1: The steps of learning model.

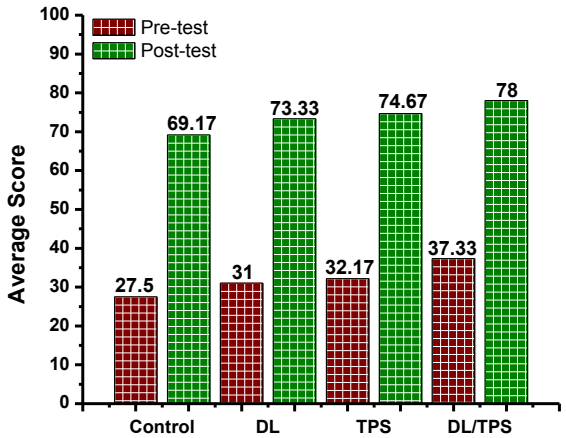

Figure 2: The average of pre-test and post-test score for students' critical thinking skills.

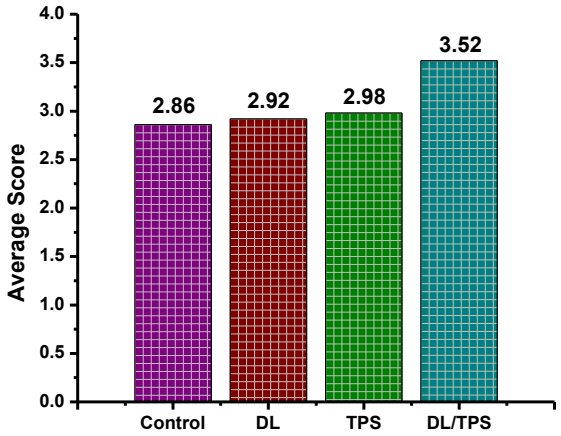

Figure 3: The average score of students' motivation in learning between control, DL, TPS and DL/TPS classes

Conclusion and Suggestions

Based on the findings, DL/TPS learning model can enhance the students' critical thinking skills and motivation in learning. The progress in students' critical thinking skills and motivation was higher than that without DL/TPS learning model. The progress in critical thinking skills and motivation of students can be seen from the statistical data obtained by comparing the average scores of students from control and experimental classes.

Several suggestions are offered based on this study: 1) Teachers can apply DL/TPS learning model as an alternative

learning model to enhance the critical thinking skills and motivation in other learning materials or other lessons; 2) The implementation of DL/TPS learning model needs well-planned preparation in learning steps and also needs the attention of students' characteristics, learning source availability and allocation of learning time; 3) The implementation of this learning model can be developed comprehensively by preparing assessment instruments for learning outcomes to measure all aspects of student ability including cognitive, psychomotor and affective domains.

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References

1. Akareem H.S. and Hossain S.S., Determinants of education quality: what makes students' perception different?, *Open Rev. Educ. Res.*, **3**, 52–67 **(2016)**

2. Al-Sheeb B.A., Abdulwahed M.S. and Hamouda A.M., Impact of first-year seminar on student engagement, awareness and general attitudes toward higher education, *J. Appl. Res. High. Educ.*, **10**, 15–30 **(2018)**

3. Paolini A., Enhancing Teaching Effectiveness and Student Learning Outcomes, *J. Eff. Teach.*, **15**, 20–33 **(2015)**

4. Specht D.M., Probe Method's Impact on Students' Motivation and Critical Thinking Skills, Walden University **(2015)**

5. Safitri D., Irmawanty Bachtiar S. and Rukman W.Y., Students' Cognitive Achievement, Critical Thinking Skills and Metacognitive Awareness in Problem Based Learning, *Eur. J. Educ. Stud.*, **5**, 248–258 **(2018)**

6. Vong S.A. and Kaewurai W., Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province, Cambodia, *Kasetsart J. Soc. Sci.*, **38**, 88–95 **(2017)**

7. DeWaelsche S.A., Critical thinking, questioning and student engagement in Korean university English courses, *Linguist. Educ.*, **32**, 131–147 **(2015)**

8. Kopzhassarova U., Akbayeva G., Eskazinova Z., Belgibayeva G. and Tazhikeyeva A., Enhancement of students' independent learning through their critical thinking skills development, *Int. J. Environ. Sci. Educ.*, **11**, 11585–11592 **(2016)**

9. Wena M., Strategi pembelajaran inovatif kontemporer: Suatu tinjauan konseptual operasional, Bumi Aksara **(2010)**

10. Günay Balım A., The Effects of Discovery Learning on Students' Success and Inquiry Learning Skills, *Eurasian J. Educ. Res.*, **35**, 1–20 **(2009)**

11. Hosnan M., Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21, Kunci Sukses Implementasi Kurikulum 2013, Ghalia Indonesia **(2014)**

12. Suryosubroto B., Proses belajar mengajar di sekolah: wawasan baru, beberapa metode pendukung dan beberapa komponen layanan khusus, Rineka Cipta **(2005)**

13. Zulfajri M. and Amelia R., Pengaruh Model Discovery learning Dengan Media Teka-Teki Silang Terhadap Peningkatan Hasil Belajar Siswa pada Materi Sistem Koloid, *J. Edukasi Kim.*, **1**, 12–18 **(2016)**

14. Syarifah C., Penerapan Model pembelajaran Kooperatif Tipe TPS dalam meningkatkan Prestasi Belajar Siswa Pada Konsep Kingdom Plantae, Universitas Syiah Kuala **(2006)**

15. Yaqin M.A., Indriwati S.E. and Susilo H., Think-pair-square learning: Improving student's collaborative skills and cognitive learning outcome on animal diversity course, *Jurnal Pendidik. Biol. Indones.*, **4**, 135–142 **(2018)**

16. Raba A.A.A., The Influence of Think-Pair-Share (TPS) on Improving Students' Oral Communication Skills in EFL Classrooms, *Creat. Educ.*, **8**, 12–23 **(2017)**

17. Keller J.M., Development and Use of the ARCS Model of Instructional Design, *J. Instr. Dev.*, **10**, 2–10 **(1987)**

18. Sukmadinata N.S., Metode penelitian pendidikan, Remaja Rosdakarya **(2009)**

19. Ruseffendi E.T. and Sanusi A., Dasar-dasar penelitian pendidikan dan bidang non-eksakta lainnya, IKIP Semarang Press **(1994)**.

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