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THE INFLUENCE OF NOVICK CONSTRUCTIVISM LEARNING MODEL ON CRITICAL THINKING SKILLS AND MOTIVATION IN ONLINE LEARNING

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ABSTRACT

This study aims to determine the influence of the Novick constructivism learning model on 1) critical thinking skills and motivation, 2) the extent of influence of the Novick constructivism model on the aspects of critical thinking skills, 3) the extent of influence of the Novick constructivism model on learning motivation, and 4) the effectiveness of the model on critical thinking skills. The method used was quasi-experimental with a non-equivalent pretest-posttest control group design. The population was the tenth-grade science students. The critical thinking skills were assessed using a cognitive test, and the motivation was assessed using questionnaires. The MANOVA analysis was used to determine the model's influence. The regression analysis was used to determine the extent of the model's influence. The N-gain was used to determine the model's effectiveness. The MANOVA analysis obtained a significant value of 0.02, which was lower than 0. 05. Thus, H_0 was rejected. The regression analysis showed the values of critical thinking skills ranged from high to low. The values consisted of strategies and tactics (46.49%), advance clarification (14.02%), basic support (13.96%), elementary clarification (13.62), and inference (11.88%). The motivation aspects ranging from high to low: relevance (26.35%), attention (25.98%), confidence (25.40%), and satisfaction (22.25%). The N-Gain score obtained by the experimental class was 0.437 in the moderate category. Based on the results, it can be concluded that 1) there was an influence of Novick constructivism model on critical thinking skills and motivation on online learning, 2) there was an unequal influence of the model on critical thinking aspects, and 3) motivation aspects, and 4) Novick constructivism model was relatively effective to be used in online learning.

Pengaruh Model Pembelajaran Konstruktivisme Tipe Novick terhadap Kemampuan Berpikir Kritis dan Motivasi pada Pembelajaran Online

ABSTRAK: *Penelitian ini bertujuan untuk mengetahui pengaruh model konstruktivisme tipe Novick terhadap: 1) kemampuan berpikir kritis dan motivasi, 2) sejauh mana pengaruh model konstruktivisme tipe Novick terhadap aspek-aspek kemampuan berpikir kritis 3) sejauh mana pengaruh*

model konstruktivisme tipe Novick terhadap aspek-aspek motivasi, serta untuk 4) mengetahui efektivitas model terhadap kemampuan berpikir kritis. Metode yang digunakan adalah Quasi-Eksperimental dengan desain penelitian Pretest-Posttest Nonequivalent Control Group Design. Subjek penelitian ini adalah siswa kelas X MIPA. Pengambilan data berpikir kritis dengan soal tes dan motivasi dengan angket. Uji hipotesis menggunakan uji Manova untuk mengetahui pengaruh, uji Regresi untuk mengetahui sejauh mana pengaruh, dan Uji N-Gain untuk mengetahui efektivitas model. Hasil penelitian menunjukkan bahwa pada uji Manova memiliki nilai sig.=0,02 < 0,05 sehingga H_0 ditolak. Hasil uji Regresi menunjukkan nilai sumbangan efektif pada aspek kemampuan berpikir kritis mulai dari yang tinggi ke rendah adalah strategies and tactics (46,49%), advance clarification (14,02%), basic support (13,96%), elementary clarification (13,62), inference (11,88%) dan terhadap aspek-aspek motivasi mulai dari yang tinggi ke rendah adalah aspek relevance (26,35%), attention (25,98%), convidence (25,40%), satisfication (22,25%). Hasil N-Gain score pada kelas eksperimen adalah 0,437 yaitu pada kategori sedang. Berdasarkan hasil penelitian, dapat disimpulkan bahwa 1) ada pengaruh model konstruktivisme tipe Novick terhadap kemampuan berpikir kritis dan motivasi pada pembelajaran daring, 2) ada pengaruh yang tidak sama pada pemberian model terhadap aspek berpikir kritis dan 3) aspek motivasi, serta 4) model konstruktivisme tipe Novick cukup efektif (kategori sedang) digunakan dalam pembelajaran daring.

INTRODUCTION

The 2013 curriculum intends to enable the students to master the skills needed in the 21st-century and become competent human resources in facing challenges. These skills consist of critical thinking, creative thinking, and communicative and collaborative thinking. Critical thinking is one of the skills that need to be developed in learning (Pertiwi & Fitrihidajati, 2019). Critical thinking is the ability to think neutrally with logical reasons (Hermayani et al., 2015; Yasin et al., 2020). According to Ennis (1996) in Sekti (2020), the indicator of critical thinking skills consists of five aspects, namely providing a simple explanation (elementary clarification), building basic skills (basic support), concluding (inference), making further explanations (advance clarification), and strategies and tactics (strategies and tactics).

Rosidah & Fitrihidajati (2014) discover that students' critical thinking skills test results are still inadequate. Hermayani et al. (2015) also state that students' critical thinking skills test results are still relatively low. The low critical thinking skills were because biology learning tends to hone the remembering and understanding (Artini et al., 2019).

Efforts to train critical thinking skills need to be initiated by instilling motivation in online learning. Therefore, students' learning motivation needs to be trained continuously to have strong learning motivation (Daud, 2012).

Keller in Adi (2015) compiled a set of motivational principles applied in the learning process called the ARCS model consisting of attention, relevance, confidence, and satisfaction. However, based on the motivation questionnaire distributed to students, students' learning motivation was still low. It was supported by research by (Angraini et al., 2019; Damopolii et al., 2017) that students' motivation is still very low because they are less active during learning. According to Azis et al. (2010), students' learning motivation is still relatively low, affecting their learning outcomes. Motivation needs to be increased so that students are interested in actively participating in learning (Ribawati, 2015). Students will study hard because they are motivated and can solve problems (Pramitasari et al., 2011).

Prayitno & Sugiharto (2017) Prayitno & Sugiharto (2017) say that the root of the low critical thinking skills lies in the learning model that could not facilitate students' critical thinking. Teachers can train critical thinking skills through special learning scenarios that integrate knowledge (Al Ayub et al., 2015).

One solution to solve this problem is to apply the learning model developed by Nussbaum and Novick, known as the Novick Constructivism learning model. The Novick Constructivism learning model contains a constructivist view in shaping students' knowledge (Rezeki, 2017). According to Masruroh et al., (2014), the Novick Constructivism model can foster students' deeper thinking skills. Andriani et al. (2014) states that applying this learning model makes students active and critical in the learning process. In each stage, the Novick Constructivism model can facilitate teachers and students to carry out learning with a conceptual change system (Solehat, 2013).

Alatubir et al. (2020), explained that the Novick constructivism model consists of three stages of learning as follows:

1.) Exposing Alternative Framework (Revealing Early Conceptions)

Students' initial conceptions can be revealed through presenting a model of an event or an actual event. Furthermore, students are asked about their views and opinions to examine the event. The teacher can ask students to describe their opinions by writing descriptions.

2.) Creating Conceptual Conflict

At this stage, the teacher creates a conceptual conflict by inviting students to discuss in the learning process, small or large groups, and providing activities to students.

3.) Encouraging Cognitive Accommodation

The teacher provides a learning experience through explanations and questions to explore students' conceptions.

Several previous studies have examined the Novick constructivism model, namely determining the level of biological misconceptions (Yuliana et al., 2013), improving mathematical concept understanding (Alatubir et al., 2020), (Ayuningsih, 2018), (Marlina, 2014), and (Mutmainnah et al., 2019), physics concept understanding (Risah, 2019) and (Solehat, 2013), physics cognitive ability (Nurhayati et al., 2019), mathematical representation (Rezeki, 2017), and natural science learning activities (Andriani et al., 2014). The novelty of this research is to determine the effect Novick constructivism model on students' critical thinking skills and motivation simultaneously on biology materials. Mathematics dominated previous research and only a few studies in the field of biology.

Based on the description, this research aimed to determine the effect of the Novick constructivism model on students' critical thinking skills and motivation.

METHOD

This research was quantitative research with a quasi-experimental design. This research was conducted at SMA Negeri 6 Surakarta from April to June 2021. The research design of this research was the pretest-posttest non-equivalent control group design. The sampling technique used in this research was the purposive sampling technique. The population was the tenth-grade science students, which consisted of 143 students. The research samples were 36 students of class X MIPA 4 as the experimental class teated by the Novick constructivism model and 36 students of class X MIPA 5 as the control class treated by a conventional learning model. The research instrument consisted of pretest and posttest on critical thinking skills and ARCS motivation questionnaire. The instrument used had been tested for its validity using the Product Moment formula, reliability using Alpha Cronbach, discriminating index, and difficulty level. The researchers also performed the prerequisite tests, which consisted of the normality test using Kolmogorov-Smirnov and

the homogeneity test using Levene's statistics with a significance value of 0.05.

The hypothesis testing was performed using the MANOVA test to determine the effect of the Novick constructivism model on students' critical thinking skills and motivation. H_0 is rejected if the significance value is lower than 0.05, which means a significant difference between the experimental class and the control class. The hypothesis test was processed with the help of the SPSS 22 application. To determine the extent of the effect, the regression test was performed by looking at the percentage of the effective contribution value. Effective contribution formula (SE) according to Hadi, (2004) is:

$$SE = Beta\ value\ (x) x\ Coef.correlation(r)\ x\ 100\%$$

The N-Gain test was performed to determine the effectiveness of the Novick constructivism model on students' critical thinking skills by calculating the difference between the posttest and pretest scores. The N-Gain formula, according to Hake & Richard. R, (1999) is as follows:

$$g = \frac{Sposttest - Spretest}{Smax - Spretest}$$

Information:

g : Normalized gain (N-gain)
Smax : Maximum pretest and posttest scores
Spre : Pretest score
Spost : Posttest score

The gain value criteria used in this research were (Suherman et al., 2018):

$g > 0.7$: High
$0.7 \leq g \leq 0,3$: Moderate
$g < 0,3$: Low.

RESULTS AND DISCUSSION

The validity test on the critical thinking skills test performed on the SPSS 22 program affirmed that 30 questions had met the valid criteria. Furthermore, the ARCS motivation questionnaire found that 32 questions had met the valid criteria.

The reliability test on critical thinking skills items obtained a reliability index of 0.903. On the other hand, the motivation questionnaire obtained a reliability index of 0.930. Both instruments were categorized as reliable.

The item difficulty level test for critical thinking skills test using SPSS 22 show that the test instrument was divided into three categories, namely easy, medium, and difficult questions. Items in the difficult category consisted of items number 7, 8, 11, 13, 14, 21, and 23. Items in the moderate category consisted of items number 1, 2, 3, 6, 9, 10, 12, 15, 16, 17, 18, 22, 24, 27, 28, and 29. Items in the easy category consisted of items number 4, 5, 19, 20, 25, 26, and 30.

The results of the item discriminating index test using SPSS 22 showed by the Corrected item-total Correlation value that eight questions were in the moderate category, twenty-one items in the high category, and 1 item in the excellent category.

The normality test using the Kolmogorov-Smirnov formula showed that the significant value obtained was 0.20, higher than 0.05. Thus, the data were normally distributed. The data used in the normality test were the pretest and posttest scores on critical thinking skills and motivation questionnaires. Levene's homogeneity test showed a significant value of 0.286, which was higher than 0.05. Thus, the data was homogeneous. The data used in the homogeneity test were pretest and posttest scores on critical thinking skills and motivation questionnaires.

a. The Scores of Students' Critical Thinking Skills and Motivation

The score of students' critical thinking skills was taken from the pretest and posttest scores on Environmental Pollution material. There were 30 multiple-choice items with aspects of critical thinking skills, according to Ennis. The results of the descriptive analysis can be seen in Table 1.

Table 1. Descriptive Analysis of Pretest and Posttest Data

Statistical Results	Critical Thinking Skills			
	Experimental Class Frequency		Control Class Frequency	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Average	59.8	76.6	59.7	69.9
Standard deviation	12.2	12.10	10.02	11.6
Variance	147.9	146.4	100.5	136.1
Minimum	44.3	53.3	43.3	50.0
Maximum	80.0	96.7	83.3	93.3
median	60.0	76.7	60.0	68.3
N	36	36	36	36

Table 1 shows the average score of students' critical thinking skills where the experimental class ranked higher than the control class. The score difference was 16.8, while the average score difference was 10.2. Therefore, the Novick constructivism model significantly experimental class students' scores compared to the control class that applied the conventional model. The standard deviation and variance values indicated that the experimental class was higher than the control class. The level of diversity of the experimental class was higher than the control class.

The value of student motivation was obtained from the motivation questionnaire that contained the ARCS motivation aspect. The results of the descriptive analysis can be seen in Table 2.

Table 2. Descriptive Data of Students' Motivation

Statistical Results	Learning Motivation	
	Experimental Class Frequency	Control Class Frequency
Average	78.7	70.3
Standard deviation	7.7	8.8
Variance	59.9	78.4
Minimum	61.7	51.6
Maximum	90.6	85.9
median	78.1	72.3
N	36	36

Table 2 shows that the average value of students' motivation in the experimental class was higher than the control class, with a difference of 8.4. The values of the standard deviation and variance in the experimental class were higher than the control class. They showed that the experimental class had a higher diversity.

b. Hypothesis Testing

Based on the hypothesis test, the significant value of the MANOVA test for critical thinking skills was 0.02, which was higher than 0.05. Therefore, H_0 was rejected, and H_1 was accepted. It can be concluded that the Novick Constructivism model influenced students' critical thinking skills. The significant value of the Manova test on students' motivation was 0.00, which was higher than 0.05. Therefore, H_0 was rejected, and H_1 was accepted. It can be concluded that the Novick constructivism model influenced students' motivation.

c. The Influence of Novick Constructivism Learning Model on Students' Critical Thinking Skills

This research showed that the Novick constructivism model influenced students' critical thinking skills. This result is supported by Masruroh et al. (2014) who state that the constructivism learning model emphasizes the students' activeness in building ideas towards scientific concepts to improve critical thinking skills. Critical thinking skills are reasons and reflective thinking that emphasize reliable decision-making (Wakhidah & Indana, 2021). Learning activities were carried out online using Google Meet within three meetings. Also, the students worked on the pretest and posttest that had been integrated with the critical thinking skills aspects. Each aspect of critical thinking skills can be trained into three stages of the Novick constructivism model.

The first stage is exposing an alternative framework (uncovering the initial conception). At this stage, the teacher gave the experimental class phenomena in the form of videos about problems caused by environmental pollution. The teacher asked the students to present their opinion and then wrote them down on the Slidoo link. The

students responded splendidly at this stage. They wrote complete comments about what they saw and were motivated to share their ideas. In this stage, the teacher's role was as a facilitator by providing feedback about the appropriate or scientific concepts. This stage can train students' critical thinking skills in elementary aspects (giving simple explanations) by clarifying activities that focus on questions and answers. Another aspect trained at this stage is advanced clarification (making further explanations) by defining terms and identifying assumptions. These activities can be carried elementary clarification, and advanced clarification aspects can be well trained as well.

The second stage is creating conceptual conflict. This stage was done by inviting students to discuss together in the process of an experiment. In online learning activities, the experiments were contained in the demonstration videos on Google Meet. The demonstration videos contained the activities of experimenting with water pollution on fish (meeting 1), air pollution on animals and plants (meeting 2), and experimenting with soil pollution on worms (meeting 3). At this stage, the learning runs smoothly. The students paid close attention and constructed their knowledge based on the demonstration videos. The teacher described the video briefly and guided students to hold discussions. The discussions were held by filling out discussion sheets in Microsoft Word document format. The obstacle found at this stage was the limited time allocation that caused students to be less flexible in discussing and writing down the results of their analysis. This stage can train critical thinking skills in basic support aspects (building basic skills) by observing and considering the results and the credibility (criteria for a source). Another aspect that is trained at this stage is the strategies and tactics by deciding actions from the environmental problems.

The third stage is encouraging cognitive accommodation. At this stage, the students were given questions related to the topics. Some questions were related to the phenomena of everyday life. The students were also asked to solve the problem. Students with critical thinking skills are more skilled in solving problems (Kono et al., 2016). The questions also explored the reasons why these responses appeared in the demonstration videos. Then, the teacher asked the students to conclude the concepts that they had successfully understood at each meeting. The teacher helped students to complete the incomplete concepts. The teacher also provided a brief explanation of the discussion points at each meeting. At this stage, the students were trained in inference (conclusion) by making inductions and considering induction. Another aspect that is trained at this stage is strategies and tactics by deciding an action. The activities at this stage were carried out well so that the inference, strategies, and tactics aspects could be well trained.

According to Ennis, critical thinking is divided into five aspects: elementary clarification, basic support, inference, advance clarification, and strategies and tactics. A regression test was conducted to determine the extent of the model's influence on the five aspects of critical thinking skills. The results of the regression test can be seen in Table 3.

Table 3. The Regression Test Results on Every Aspect of Students' Critical Thinking Skills

Aspects of Critical Thinking Skills	*R2*	Sig.	Beta	Coef. Correlation	Effective Donation
Elementary clarification	1	0.00	0.2	0.681	13.62%
Basic support		0.00	0.2	0.698	13.96%
Inference		0.00	0.2	0.594	11.88%
Advance clarification		0.00	0.2	0.701	14.02 %
Strategies and tactics		0.038	1.34	0.347	46.49%

Table 3. shows that there was an effect of the Novick constructivism model on

critical thinking skills. Masruroh et al. (2014) reveal that the constructivism learning model can improve critical thinking skills by emphasizing students' activeness in building scientific ideas. Based on the score of the effective contribution, the most affected aspects from high to low are strategies and tactics (46.49%), advance clarification (14.02%), basic support (13.96%), elementary clarification (13.62), and inference (11.88%).

d. The Influence of Novick Constructivism Learning Model on Students' Learning Motivation

This research shows that the Novick Constructivism model influenced students' motivation. This result is in line with the research conducted by Sulaiman (2012), that based on the analysis of questionnaires; the Novick constructivism learning model encourages students to be motivated and active in learning. Therefore, the Novick constructivism learning model needs to be applied in learning to increase students' motivation.

Learning motivation questionnaires were distributed to students after three meetings had been completed. The motivation questionnaire consisted of 32 questions that contained the motivational aspects of the ARCS model (Attention, Relevance, Confidence, and Satisfaction).

The experimental and control classes obtained quite good results in attention, relevance, confidence, and satisfaction. Each aspect of ARCS motivation can be trained into three stages of the Novick constructivism model.

The first stage is exposing an alternative framework (uncovering the initial conception). At this stage, the experimental class (X MIPA 4) was given a phenomenon through a video about the problems caused by environmental pollution. Then, the teacher asked the students to present their opinion about the video through the Slidoo link. The motivation aspect of attention can be trained at this stage. Some students showed interest in the material because the teacher presented phenomena about environmental problems quoted from news on TV. The students were motivated to present their ideas, although some students acted passively.

The second stage is creating conceptual conflict. This stage was conducted by inviting students to discuss together a demonstrated experiment video on Google Meet. This stage ran smoothly, and the students paid close attention. This stage motivated students to pay attention to the aspects of attention and relevance because the videos can attract students' attention, and the content of the videos was related to their daily lives. Activities at this stage were performed properly so that the attention and relevance aspects could be trained properly.

The third stage is encouraging cognitive accommodation. The teacher asked questions related to the topics discussed, while some other questions were related to phenomena in everyday life. At this stage, the students were trained in the aspect of confidence to express their opinions. Some students were quite brave and confident in answering questions from the teacher. Another aspect trained at this stage was satisfaction through praises from the teachers to students who answered the questions. Activities at this stage were carried out well so that the confidence and satisfaction aspects could be well trained.

According to Keller, motivation aspects are divided into four aspects, namely attention, relevance, confidence, and satisfaction. A regression test was conducted to determine the extent of the influence of the model on the four aspects of students' motivation. The results of the regression test can be seen in Table 4.

Table 4. Regression Test Results on Every Aspect of Students' Learning Motivation

Motivational Aspect	*R2*	Sig.	Beta	Coef. Correlation	Effective Donation
Attention	1	0.00	0.364	0.714	25.98 %
Relevance		0.00	0.359	0.734	26.35%
Confidence		0.00	0.348	0.73	25.40%
Satisfaction		0.00	0.323	0.689	22.25%

Table 4 shows the effect of the Novick constructivism model on the aspects of student motivation. Based on the score of the effective contribution, the most affected aspects from high to low were relevance (26.35%), attention (25.98%), confidence (25.40%), and satisfaction (22.25%).

e. The Effectiveness of the Novick Constructivism Model

The N-gain calculation of the difference between the posttest and pretest scores on the value of critical thinking skills can be seen in Table 5.

Table 5. N-Gain Results of Critical Thinking Skills and Students' Motivation

Indicator	Class	N-Gain Score	Category
Critical thinking	Experimental	0.437	Moderate
	Control	0.254	Low

Based on the indicators of critical thinking skills in Table 5, the experimental class obtained an N-gain score of 0.437. The experimental class experienced an increase in critical thinking skills in the medium category. The control class obtained an N-gain score of 0.254, so that the control class has increased critical thinking skills in the low category. Based on the N-gain score, the Novick constructivism learning model improved students' critical thinking skills compared to the conventional model. This result is also supported by Prayitno & Sugiharto (2017) who state that the Novick constructivism model is better at raising students' critical thinking skills than the conventional model.

The Novick constructivism model could improve students' critical thinking skills in the medium category because of several shortcomings in online learning activities. In online learning, the teacher cannot fully control students' understanding. Teachers cannot directly see the students' attitudes and responses during the learning activities. A problem that often occurs during online learning is weak internet signals, so that some students cannot participate in learning optimally.

CONCLUSIONS AND SUGGESTIONS

Based on the analysis and discussion results, the conclusion in this research is that (1) there was an effect of the Novick constructivism learning model on students' critical thinking skills and motivation in online learning. (2) There was an unequal effect of the Novick constructivism learning model toward the aspects of critical thinking skills from high to low, namely aspects of strategies and tactics (46.49%), advance clarification (14.02%), basic support (13.96%), elementary clarification (13.62), and inference (11.88%). (3) There was an unequal effect of the Novick constructivism learning model toward the aspects of students' motivation in online learning ranging from high to low, namely aspects of relevance (26.35%), attention (25.98%), confidence (25,40%), and satisfaction (22.25%).

The research results can be implemented theoretically as a reference material for similar research that discusses the Novick constructivism model.

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