Interaction of Demonstration Learning Model with Learning Motivation in The Development of Critical Thinking Skills in Elementary School Mathematics Learning in Ngrampal-Sragen

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Abstract
The development of critical thinking skills requires selecting appropriate learning models to effectively achieve learning objectives. This study aims to examine the interaction between the demonstration learning model and learning motivation in developing critical thinking skills in mathematics. The research used a quasi-experimental design with quantitative data analysis. The population consisted of third-grade elementary students in Ngrampal District, Sragen Regency, selected using cluster random sampling. Data were collected through tests and analyzed using two-way ANOVA with unequal cells and follow-up variance tests. The results showed Fcount (11.844) > Ftable (3.91), indicating a significant interaction between the demonstration model and learning motivation. Further analysis revealed average scores of 85.37 (high motivation), 84.77 (medium), and 83.77 (low), showing that learning motivation significantly affects the effectiveness of the demonstration model in enhancing critical thinking. The study concludes that the demonstration learning model and learning motivation interact positively to improve students' critical thinking skills.
Keywords: Critical thinking, learning motivation, demonstration model.

Abstrak
The development of critical thinking skills requires selecting an appropriate learning model to achieve learning objectives effectively. This study aims to prove the interaction between the demonstration learning model and learning motivation in developing critical thinking skills in mathematics. The research used a quasi-experimental design with quantitative data analysis. The population consisted of third-grade elementary students in Ngrampal District, Sragen Regency, with samples selected through cluster random sampling. Data were collected using tests and analyzed using two-way ANOVA with unequal cells and follow-up variance tests. Results showed Fcount (11.844) > Ftable (3.91), indicating a significant interaction between the demonstration model and learning motivation. Further analysis revealed that students with high (85.37), medium (84.77), and low (83.77) motivation achieved improved critical thinking skills. Therefore, learning motivation significantly influences the effectiveness of the demonstration learning model in enhancing students' critical thinking. The study concludes that both factors interact positively in developing critical thinking skills.

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INTRODUCTION

Critical thinking skills are a focus in learning mathematics. The purpose of learning mathematics in the Merdeka Curriculum is to develop students' abilities in understanding concepts, reasoning, problem solving, and mathematical applications in everyday life. This curriculum emphasizes meaningful, student-centered learning, and encourages students to think critically and creatively in solving problems. Al Fanny and Roesdiana (2020) critical thinking skills are needed to analyze a problem to the stage of finding a solution to solve the problem. Erlistiani, Syachruroji, & Andriana (2020) explain that critical thinking skills are the ability to analyze arguments through aspects of finding basic similarities and differences in the material or learning topics studied. Larasati and Syamsurizal (2022) explained that critical thinking skills are the ability to correctly conclude a problem, review and thoroughly examine the decisions taken. Meanwhile, Septiany (2024) explains that: critical thinking is thinking that uses reason to solve a problem by first understanding the problem, expressing opinions or arguments clearly and being able to draw conclusions from existing problems. Based on the descriptions above, researchers can synthesize that critical thinking skills are an ability to analyze, conclude or find solutions, appropriately review a problem or learning topic by looking for basic similarities and differences in the material or learning topics studied.

Learning mathematics class III in elementary school (SD) in the district Nuncjal Sragen, obtained data, namely: learning conducted by teachers is to use direct learning models, print media worksheets learners (LKPD), and Handbook learners. Supartini (2021) explains that direct learning (Direct Instruction) is a learning model in which teachers transform information or skills directly to learners, goal-oriented learning and structured by teachers. understanding the learning model, mathematics learning in Grade III leads to teacher-centered learning, mathematical formulas are built based on memorization, and to strengthen the understanding of formulas, exercises are repeated and continuous. This condition is certainly less favorable for students, because: students do not get an understanding of the meaning of the mathematical symbols studied. The lack of understanding of the meaning caused by the development of the concept of mathematical formulas that provide less space for reasoning in the exploration of knowledge and learners are given stages of completion with the nature of imitating the answers from the teacher.

The argument for the need to develop thinking skills starting from elementary school is in accordance with the concept of Hwang, Hand, & French (2023) who explained that: the reason why critical thinking skills are important for elementary school students is to face and respond to the explosion of information in the digital era, build the quality of thinking, accuracy and rational thinking in students, develop students' ability to think logically, organizing problems, and solving various types of problems. The statement explains that there are benefits if critical thinking skills are developed and owned by students since childhood. Benefits in developing critical thinking skills. Meanwhile, Lau (2011: 175) explains that several characteristics that support the thinking process, namely: 1) the ability to understand logical relationships between ideas; 2) the ability to formulate ideas concisely and precisely; 3) the ability to identify, build, and evaluate arguments; 4) the ability to evaluate decisions; 5) the ability to evaluate evidence and be able to prove hypotheses; 6) the ability to detect inconsistencies and common errors in reasoning; 7) the ability to analyze problems systematically; 8) the ability to identify the relevance and importance of ideas; 9) the ability to assess one's beliefs and values; and 10) the ability to evaluate one's thinking skills.

Mathematics learning in elementary schools (SD) is a basic medium in developing critical thinking skills. Sihotang (2018) suggests that the criteria for students to have critical thinking include: 1) raise important questions and problems, formulating

clearly and thoroughly; 2) collect and assess relevant information, using abstract ideas to interpret it effectively; 3) draw conclusions and solutions with strong reasons, strong evidence and test them using relevant criteria and standards; 4) think openly by using various alternative systems of thought, while recognizing, assessing, and looking for relationships between all assumptions of practical implications; and 5) able to overcome confusion, able to distinguish between facts, theories, opinions, and beliefs.

The development of critical thinking skills needs to pay attention to the aspects that are developed. Aspects of critical thinking skills according to Fecione (1990: 3) are critical thinking skills, including: interpretation, analysis, inference, evaluation, explanation, and self-regulation, but someone who has critical thinking skills does not have to fulfill all aspects of critical thinking as a cognitive ability: The interpretation aspect is one's ability to understand and express the meaning of a situation, data, judgment, rule, procedure, or varied criteria; The analysis aspect is one's ability to clarify conclusions based on the relationship between information and concepts, and the question at hand; The inference aspect is one's ability to identify the elements needed to make a rational conclusion, by considering information relevant to a problem and its consequences based on existing data; The evaluation aspect is one's ability to assess the credibility of a statement or other representation of one's opinion or assess a conclusion based on the relationship between information and concepts, and the question at hand; and The explanation aspect is one's ability to express one's reasoning when providing justification for logical evidence, concepts, methodologies, and criteria based on existing information or data, where this reasoning is presented in the form of an argument.

Developing critical thinking needs to be related to the learning motivation of students. Muhibbin Syah (2003: 158) asserts that learning motivation is the overall driving force within students that gives rise to learning activities and ensures the continuity of learning activities, so that the goals desired by the learning subject can be achieved. Winkel (2004: 526) learning motivation is the overall driving force within students that causes learning. Meanwhile, Uno (2017: 23) explains that learning motivation is an internal and external drive in students who are learning. Based on the above understanding, it can be concluded that learning motivation is the totality of the power possessed by students to bring about learning, so that the desired goals are achieved.

Sukor, Mohd Ayub, Norhasnida, & Khaizura (2017) explain that the definition of learning motivation is the overall driving force within the student which gives rise to learning activities, which ensures the continuity of learning activities and provides direction to learning activities, so that the goals desired by the learning subject can be achieved. This statement can be interpreted that the definition of learning motivation is the overall driving force within the student that gives rise to learning activities, which ensures the continuity of learning activities and provides direction to learning activities, so that the goals desired by the learning subject can be achieved. Based on the description above, the researcher can conclude that learning motivation is the power possessed by students who encourage learning to occur, so that they can launch learning and be able to build the concept of knowledge learned.

Individuals who have motivation can be noticed from their attitudes and behavior when interacting. Yulianto, Sisworo, and Hidayanto (2022) explained that the characteristics of motivated individuals are: 1) the tendency to work on challenging tasks but not above their abilities, 2) the desire to try and work alone and find their own solutions, 3) a strong desire to progress and achieve a level of success that is slightly above the level previously achieved, 4) orientation to the future, learning activities are seen as a path to the realization of ideals, and 5) tenacity in work.

The urgency of the need for research on the development of critical thinking skills in terms of learning motivation is based on the results of test analysis. Mathematics

learning that is often carried out in elementary school is direct learning with teachers as the center of learning. The results of the end of semester test (UAS) odd academic year 2024/2025 in Class III, 35 elementary schools (SD) in Sragen district with criteria for many students more than or equal to 20 and less than 20, data obtained that the average value range is at 47.21 to 73.35, range 30 to 40, and the standard deviation is 9.67 to 12.36; so it can be interpreted that learning with direct learning models and utilizing printed books and LKPD media, has not yet given the correct value results optimal. This leads to the understanding that learning needs to reveal the meaning of the symbol, not the method of memorizing formulas or memorizing the pattern of solving a problem. Low learning outcomes above, it can be suspected that the development of critical thinking skills are poorly developed. This is because, the syntax of direct learning, teachers tend to give lectures in planting mathematical concepts, provide examples of problems, and end up giving exercises. How to build concepts like this should be used for learning that is directly related to the object or movement of a skill. Wintarti and Abadi (2021) explain that the Direct Instruction learning model is a good learning model to teach about rules, procedures, basic skills. Supartini (2021) explained that direct learning is a learning model in which teachers transform information or skills directly to learners, learning is goal-oriented and structured by teachers. meanwhile, Yanti (2019) explained that the direct learning model is specifically designed to develop student learning about procedural knowledge and declarative knowledge that is well structured and can be learned step by step.

The low mastery of mathematical concepts in elementary school, teachers need a demonstration learning model in building these concepts. Kinait et al. (2022) explain that the demonstration learning model is a teaching model that uses demonstrations to clarify an understanding or to show how to do something to students. Demonstration model is one method that is quite effective because it helps students to find answers with their own efforts based on correct data (Nonik et al., 2013). According to Siniakon et al., (2021), the demonstration model is a teaching model by demonstrating goods, events, and sequences either directly or through the use of teaching media relevant to the subject matter being presented. Yusrida and Siregar (2019) explain that the demonstration learning model is teaching by demonstrating items, events, rules and the sequence of carrying out an activity, either directly or using teaching media that is relevant to the subject matter or material being presented. This explanation can be interpreted that the demonstration learning model is teaching by demonstrating items, events, rules, and the sequence of carrying out an activity, either directly or using teaching media that is relevant to the subject matter or material being presented.

Some of the above opinions we can know that the demonstration learning model is a learning method that is quite effective because it helps students to find answers with their own efforts by demonstrating using items, events, and sequences either directly or through the use of media.

The application of the demonstration learning model needs to be interacted with learning motivation. Ginting, Ramadhan, Ramadhani. (2024) explained that students gave positive responses to the demonstration method, found it easier to understand difficult concepts and were more interested in following the next lesson. Teachers involved felt positive changes in the classroom atmosphere, the demonstration model was more effective in attracting students' attention, and there was an increase in learning motivation which had a direct impact on academic achievement.

Based on the description above, this research focuses on the interaction of demonstration learning model with learning motivation in developing critical thinking skills. Therefore, the title of this research is Interaction of Demonstration Learning Model with Learning Motivation in the Development of Critical Thinking Skills in Mathematics Learning at Elementary School in Ngrampal-Sragen. The purpose of the

research is to prove the interaction between demonstration learning model and learning motivation on the development of critical thinking skills in mathematics learning.

RESEARCH METHODS

This research is quantitative with Pretest-Posttest Control Group Design. Characteristic of the study is that all groups were pretested before being given treatment / treatment and then observed the results. This experimental study is to investigate the effect of two independent variables simultaneously, namely demonstration learning model and learning motivation as a moderator variable against one dependent variable, namely critical thinking skills. The study population is the third grade elementary school students in the district Ngrampal, Sragen. The sampling technique used is cluster random sampling, with 91 students as the experimental group and 92 students as the control group.

The data collection technique used tests. The incoming data were tested for prerequisites, including tests: normality, homogeneity, analysis of variance (Anava) two-way with unequal cells, using the formula:

$$X_{ijk} = \mu + \alpha_i + \beta_i + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$ (Budiyono, 2016:229)

and further test of two-way analysis of variance, using the Scheffe method, which is formulated:

$$F_{i,j} = \frac{(\bar{X}_i - \bar{X}_j)^2}{RKG\left(\frac{1}{n_i} + \frac{1}{n_j}\right)}$$ (Budiyono, 2016: 215)

Notes:

$F_{i,j}$ = the value of F_{obs} on the comparison of the i-th row and the j-th row

$\bar{X}_i$ = mean at row i

$\bar{X}_j$ = mean at row j

RKG = mean square error obtained from the calculation of analysis of variance

n_i = i-th sample size

n_j = j-th sample size

RESULTS AND DISCUSSION

The results of hypothesis testing using analysis of variance (Anava) two-way unequal cells. Analysis of variance is carried out with the following procedure:

a) H_{0B} : $\alpha_i = 0$ for each $i = 1,2$; there is no effect of learning model in developing critical thinking skills.
   H_{1B} : there is at least $\alpha_i \neq 0$ for each $i = 1,2$; there is an effect of learning model in developing critical thinking skills.
   H_{0A} : $\beta_j = 0$ for each $j = 1,2$; there is no effect of learning motivation in the development of critical thinking skills.
   H_{1A} : there is at least $\beta_i \neq 0$ for each $i = 1,2$; there is an effect of learning motivation in the development of critical thinking skills.
   H_{0BA} : $(\alpha\beta)_{ij} = 0$ for each $i = 1,2$ dan $j = 1,2$; there is no interaction between learning model and learning motivation in the development of critical thinking skills.
   H_{1BA} : there is at least one $(\alpha\beta)_{ij}$ that is not zero; there is an interaction between learning model and learning motivation in the development of critical thinking skills.
b) Significance level $\alpha = 0.05$
c) The critical region for F_b is $DK = \{F\ I\ F > F_{(0.05,1,177)}\} = \{F\ I\ F > 3.91\}$
   The critical region for F_a is $DK = \{F\ I\ F > F_{(0.05,2,177)}\} = \{F\ I\ F > 3.91\}$
   The critical region for F_{ba} is $DK = \{F\ I\ F > F_{(0.05,2,177)}\} = \{F\ I\ F > 3.91\}$
d) Test decision: H0B is rejected; H0A is accepted; and H0BA is rejected.

The summary of hypothesis testing of two-way variance analysis of unequal cells is arranged as follows:

Table 1. Summary of Analysis of Variance Two-Way Unequal Cells

	JK	dk	RK	F_{count}	F_{table}	Decision
Learning Model (B)	4.724,70	1	4.724,70	84,98	3,91	Reject H_{0B}
Learning Motivation (A)	77,01	2	38,51	0,693	3,91	Accept H_{0A}
Interaction (BA)	13.170,82	2	6.585,41	11,844	3,91	Reject H_{0BA}
Error	9.896,80	178	5.560	--	--	--
Total	27.869,33	183,00		--	--	--

Jk = sum of squares
dk = degree of freedom
RK = mean square

The Anava summary table of two-way unequal cells above, can be interpreted, namely: there is an interaction between the demonstration learning model with learning motivation and Direct Instruction (DI) with learning motivation in developing critical thinking skills in mathematics learning.

The data results in the table above are followed up with the Anava further test as follows:

Table 2. Mean of Each Cell

Learning Model (B)	Learning Motivation (A)			Marginal error
	High (A1)	Medium (A2)	Low (A3)	
Demonstration Model (B1)	90,58	90,00	88,13	89,57
Direct Instruction (B2)	80,12	79,55	79,41	79,69
Marginal error	85,35	84,77	83,77	

Based on the table above, the marginal mean in row B1 (89.57) > the marginal mean of row B2 (79.69). This comparison can be interpreted that students who are given a demonstration learning model have an effect in developing critical thinking skills better than students who are given learning with the Direct Instruction (DI) learning model.

The next Anava follow-up is to determine multiple comparisons between cells. The results of the comparison are arranged in the table as follows:

Table 3. Summary of Multiple Comparisons Between Cells

H_0	F_{obs}	(pq-1) F Table	P
$\mu_{11} = \mu_{21}$	11981,6	(5)(3.04)=15.20	Reject H0
$\mu_{12} = \mu_{22}$	11945,9	(5)(3.04)=15.20	Reject H0
$\mu_{13} - \mu_{23}$	5763,92	(5)(3.04)=15.20	Reject H0

Based on the table above, students who are given a demonstration learning model have different results from the Direct Instruction (DI) learning model in developing critical thinking skills in mathematics learning with learning motivation that has High, Medium, and Low criteria. Taking into account the respective averages, it can be concluded that the demonstration learning model is more effective than the Direct Instruction (DI) learning model, in terms of learning motivation for all criteria.

DISCUSSION

The results of the hypothesis test calculations with Anava cells are not the same, obtained the value Fhitung (11.844) > Ftable (3.91) which means there is or there is an interaction between the demonstration learning model and learning motivation to critical thinking skills in mathematics learning class III in SD Negeri Nencjal district Sragen. These results are also reinforced from further tests obtained Anava data, namely the results of the calculation of double comparison between cells obtained by comparison of demonstration models and high criteria of learning motivation with direct instruction models and high criteria of learning motivation obtained Fhitung (11981.6) > Ftable

(15.20). Comparison of demonstration model and learning motivation medium criteria with direct instruction model and learning motivation medium criteria obtained Fcount (11945.9) > Ftable (15.20). Meanwhile, the comparison of demonstration model and low criterion learning motivation with direct instruction model and low criterion learning motivation obtained Fcount (5763.92) > Ftable (15.20). These results are also supported by the results of marginal averaging. For the marginal mean of demonstration model is 89.57. While the direct instruction model the marginal mean is 79.69. Based on the marginal mean, the demonstration learning model and learning motivation are all greater than the direct instruction model. Thus, the above description can be concluded that the influence of the demonstration model is better than the direct instruction model for learning motivation with all the criteria in the development of critical thinking skills.

The findings of this study indicate that learning mathematics needs to pay attention to the learning motivation possessed by learners before being taught further mathematical material, and utilize motor skills in the demonstration learning model. The application of demonstration models has led to learning motivation for learners. This is because in the syntax of the learning model there is room for interaction between learners which is the basis for generating learning motivation for learners. the learning model factor that supports the emergence of learning motivation is that learners perform independently in building concepts. This is in accordance with the concept of Riyadi, A., & Sudiyatno, S. (2023) which explains that motivation provides an internal drive that makes learners become enthusiastic and passionate when doing learning activities. This explanation provides an understanding that the demonstration learning model provides space for interaction between learners and through this interaction can occur the development of mathematical concepts. This is also supported by the results of research from Ghorbanzadeh and Aghdasi (2020) which show that demonstration learning models by utilizing fine and gross motor skills, emotional intelligence, and academic achievement, are positively correlated with each other. Structural Equation Modeling (SEM) analysis shows that demonstration models utilizing fine and gross motor skills have a positive effect on academic achievement through an indirect pathway, namely through emotional intelligence.

Learning by utilizing motoric skills is a form of learning that provides stimulus (S) to appear response (R) of learners. The demonstration Model given in this study was able to increase attention, guide learners to try movements, and provide an overview of mathematical concepts through observation. This is consistent with the concept of Basheer, A., Hugerat, M., Kortam, N., & Hofstein, A. (2017) which explains that the demonstration model is able to increase the attention of learners in learning; directing learners to try and correct; and develop in building the concept of knowledge through observation and movement.

Learning with gross motor skills in learning mathematical concepts in line with the theory of Pavlov Rita L. Atkinson, et.al, (Radiusman, 2020). Pavlov's theory describes that the formation of responses can be seen by the existence of two basic procedures in conceptual learning, namely: reception paradigm (acceptance paradigm) and selection paradigm (selection paradigm). In the acceptance paradigm, the stimulus is presented randomly through forward and backward activities in stepping, as the meaning of addition and subtraction operations. Meanwhile, the selection paradigm, students are given the opportunity to realize the meaning of the symbols of mathematical calculation operations, through repeated experiments and feedback.

The learning approach with motor skills approach is better than the direct instruction model approach. This is because learning is utilizing motor skills as the ability in physical form that does not need a teacher to teach. That is, learning through skills motoric has been owned pesrta didik before the occurrence of learning in elementary school (SD), so that it can provide penginterprestasian of meaning to the

symbols of the operation count of mathematics. This is in line with the concept from Rahmawati, Yuni, Nurfalah, (2021) which states that the learning motivation of a student in the teaching and learning process is very necessary, especially to equip students in learning higher material. Learners who have the motivation to learn for all the criteria will easily understand and understand the subject matter presented by the teacher and allow will get a better learning achievement.

Demonstration learning with motoric skills approach in terms of learning motivation has been able to build interactive learning. This is in accordance with the concept of Alkhateeb and Milhem (2020) about the Seven Principles of carrying out active learning, namely: attention and motivation (Gaining Attention), shown by active learners to try motoric movements and interpret movements with mathematical symbols. This shows that the approach to learning with gross motoric skills has led to the motivation of learners; activeness, shown by doing physical movement and the emergence of interaction between learners; direct involvement or experience (Eliciting Performance), learners demonstrate by trying the movement and formulating the meaning of the movement into a mathematical symbol; repetition (Stimulating Recall), learners are able to show ease in repeating the movement and prove the relationship of movement with the symbol of counting operations; Challenge (Presenting the Stimulus), learners in building mathematical concepts need to go through the concrete stages to the abstract through gross motoric skills; feedback and reinforcement (Providing Feedback), a learning approach with the skills to direct the meaning of the symbols of calculation operations through concrete stages; Individual Differences (Assessing Performance), a learning approach with gross motor skills to accommodate the differences in learners who have learning styles and levels of understanding the symbols of mathematical operations.

Based on the above description, the hypothesis test with Anava cells is not the same, obtained Fhitung value (11,844) > Ftable (3.91) which means there is or there is an interaction between the demonstration learning model and learning motivation to critical thinking skills in mathematics learning class III in SD Negeri Ngrampal district Sragen. These results are also reinforced from further tests obtained Anava data, the calculation results of double comparison between different cells obtained comparison demonstration model and learning motivation is better than direct instruction model and learning motivation for all criteria; the average margin, the demonstration model is 89.57 better than direct instruction model. This proves that there is an interaction between the demonstration learning model and the motivation to learn together towards understanding the development of critical thinking skills in mathematics learning in elementary school Ngrampal Sragen Regency. The interaction of the two learning models is because the two models provide space to build mathematical concepts. Demonstration models provide space for learners to try and build concepts through testing and observation. Meanwhile, the direct learning model provides space to build concepts through Group Exercises and mansiri, Kastur, A., Mustaji, M., & Riyanto, Y. (2020) explained that the direct learning model provides understanding to learners directly for observation, trying and discussing with other learners. penejelasn provide understanding that both learning models in this study both provide space to try. Observe, and build knowledge through interaction.

CONCLUSION

The results of the Anava hypothesis test, the results of the calculation of multiple comparisons between unequal cells, and the results of the marginal mean, which all show that the demonstration model and learning motivation are better than the direct instruction model and learning motivation. this proves that there is an interaction between the demonstration learning model and learning motivation in the development of critical thinking skills. The implication of the results of this study is the selection of learning models need to pay attention to the space for interaction between learners, so

as to bring up the motivation to learn and build mathematical knowledge. This research needs to be followed up with further research to be able to build mathematical learning that starts from concrete stages

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