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The Influence of Project-Based Complex Instruction (CI) Collaborative Learning Models and Learning Motivation on Elementary School Students' Problem Solving Skill

Bahriyatin[1], Eges Triwahyuni[1*], Kustiyowati[1]

[1] PGRI Agropuro, Universitas Jember, Jember, Indonesia.

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Corresponding Author:
Eges Triwahyuni
eges.triwahyuni@gmail.com

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Abstract: The problems solving skills of class V students in mathematics learning are still relatively low. One of the things that causes this is the teacher's tendency to carry out learning conventionally through lecture, question and answer and assignment methods. Teachers have a dominant role in finding, processing and explaining the material being taught. Students are not given the freedom to elaborate on the material taught through collaboration with their peers. The objectives of this research are: to describe the influence of the project-based CI Collaborative Learning Model on students' problems solving skills; Describe the interaction between the project-based CI Collaborative Learning Model and learning motivation on students' problems solving skills. The research method used was Quasi Experiment with a Nonequivalent Pretest-Posttest Only Control Group Design. The research instruments used were problem solving skills tests and learning motivation questionnaires. The results of the homogeneity test and normality test of problems solving skill show that the sample variance is homogeneous and normally distributed. After fulfilling the prerequisite tests, a hypothesis test is carried out and it can be concluded that the project-based CI Collaborative Learning Model has a significant effect on students' problems solving skills. Apart from that, there is no interaction between the project-based CI Collaborative Learning Model and learning motivation on students' problems solving skills.

Keywords: Collaborative learning; Complex instructions; Motivation to learn; Project; Solution to problem

Introduction

Problem solving is an important skill that every individual must develop. This will enable individuals to face and resolve various challenges that arise. According to Septian et al. (2022), problem solving is a skill possessed by individuals in finding solutions to the problems they face. With problem solving skills, individuals are directed to think systematically, critically, logically, and have a tenacious spirit and attitude in order to find solutions to problem solving (Tanty et al., 2022). Therefore, problem solving skills must be developed as early as possible and can be started at elementary school level (Windiyani et al., 2023). Problem solving skills are not only relevant in academic contexts, but are also highly valued skills in everyday life and the world of work. The problems solving skills that students will have cannot be underestimated. These skills can be the main foundation in students' intellectual and social development. According to Liu et al. (2022), ability to develop their reasoning power (thinking) can be suggested through problem-solving oriented learning. In the elementary school learning environment, problem solving skills will

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help students understand the concepts of material taught by the teacher, so that students can have independence in their actions.

This is in line with Adeoye et al. (2023), which states that the problems solving skills possessed by students are related to the way they learn, the results of the research show that the independence of students has a very strong influence on problem solving skills. Based on the results of observations made by researchers in class V of SDN Pakusari 02 Jember, teachers tend to carry out learning conventionally through lecture, question and answer and assignment methods. Teachers have a dominant role in finding, processing and explaining the material being taught. Students are not given the freedom to elaborate on the material taught through collaboration with their peers. According to Reinius et al. (2021) collaborative learning is intended to prevent students from being passive and dependent on the teacher as the holder of learning authority. In line with this, Schellekens et al. (2021) stated that traditional (conventional) education is often passive with teachers being the main source of information and students being recipients of information. However, collaborative learning will change the learning paradigm to be more interactive between students and teachers and students. As for what underlies this, researchers explored this through interviews with teachers, namely that teachers had previous negative experiences in implementing collaborative learning, where poor classroom management arrangements caused students to be less actively involved in group collaboration.

This condition also makes students less motivated to learn. Boredom is shown by playing alone with things on the table, disturbing classmates, talking out of context non-stop, etc. In fact, with different enthusiasm among students, teachers have an important role to always foster motivation to learn so that they can make students achieve and develop themselves optimally (Afianti et al., 2022). This is in line with what was stated Christian et al. (2023), that the teacher as the party who teaches students has the urgency to try as much as possible to increase the learning motivation of students who experience difficulties in learning. According to Sauri et al. (2022), students' learning motivation can be seen in several indicators, namely: The existence of passion and desire to succeed; There is encouragement and need for learning; There are hopes and aspirations for the future; There is appreciation for learning; There are interesting activities in learning; and The existence of a conducive environment, thus enabling students to learn well. Apart from the problems above, researchers also know that the problems solving skills of class V students in mathematics learning are still relatively low. From the results of the initial test conducted by researchers on 27 students, fifteen (55.50%) students were in the poor category, seven (25.90%) students were in the sufficient category, and five (18.50%) students are in the good category.

This needs serious attention. According to Nanang et al. (2022) problem solving skills are an important part of mathematics learning and are a process of developing students' mathematical thinking. Students must have problem solving skills because they can be used to solve various problems, both mathematics and everyday life problems (Baidoo & Ali, 2023). According to Fedor et al. (2015), problem solving can be done through several stages, namely Understanding the problem; Problem solving planning; Problem solving based on planning; and Re-examination of procedures and problem solving results. Based on the problems above, researchers recommend the Complex Instruction (CI) Collaborative Learning Model as an alternative learning method. According to Yang (2023), the concept of the Collaborative Learning Model is a philosophy of interaction and lifestyle that positions cooperation as an interaction structure designed in such a way with the aim of facilitating collective efforts in achieving common goals. Further more, Panitzex plains that collaboration is a way of dealing with mutual respect and appreciation for the contribution abilities of each group member, so that the complementary use of the terms collaborative and cooperative is difficult to avoid. CI is a type of Collaborative Learning Model which emphasizes the implementation of discovery-oriented projects, especially in the scope of science, mathematics and social knowledge (Van Leeuwen & Janssen, 2019).

In line with this, Cheng et al. (2021), stated that the CI Collaborative Learning Model is a learning model that emphasizes projects with a discovery orientation with the main focus building confidence in the abilities of all group members. These two opinions are certainly relevant to the Independent Curriculum which is currently widely used in schools, where in implementing the Independent Curriculum there are good practices that can be carried out through projects in learning (Haryono, 2024; Baity et al., 2023). Several relevant research results regarding Collaborative Learning Models are used as a reference in this research, including research Endrawan et al. (2023), which stated that there was a significant influence of the problem-based Collaborative Learning Model on students' problem solving skills, where the control class's completeness was only 43% compared to the experimental class's completeness which reached 89%. Further research from Harianto et al. (2020), shows that collaborative learning can increase self-control, cooperation, respect for friends' opinions, as well as patience and emotional intelligence so that appropriate problem solving can be obtained. Then the research results Le et al. (2018), states that collaborative learning

can be used as an alternative for teachers when carrying out learning to create an active, effective and not boring learning atmosphere.

From the relevant research that the researcher searched for or conveyed above, no application of the Complex Instruction (CI) type of Collaborative Learning Model was found, so its application in this research could be something new. Based on the background above, researchers took the initiative to carry out research with the title "The Effect of Project-Based Complex Instruction (CI) Collaborative Learning Models and Learning Motivation on Elementary School Students' Problems Solving Skills". This is because researchers found a gap, where in learning teachers tend to carry it out conventionally and are too dominating, and do not provide opportunities for students to collaborate. This condition is exacerbated by the low problems solving skills of students. Thus, the objectives of this research are: to describe the influence of the project-based CI Collaborative Learning Model on students' problems solving skills; and describe the interaction between the project-based CI Collaborative Learning Model and learning motivation on students' problems solving skills.

Method

This research uses a Quasi Experiment type, namely a study that looks for a causal relationship between the independent variable and the dependent variable (Gopalan et al., 2020), where the independent variable is controlled with the aim of determining the influence it has on the dependent variable In the context of this research, the independent variables are the project-based CI Collaborative Learning Model and learning motivation, while the dependent variable is problem solving skills. The experimental design used by researchers is Nonequivalent Pretest-Posttest Control Group Design which can be seen in the following table.

Table 1. Non Equivalent Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experiment	0_1	X	0_2
Control	0_1	-	0_2

This research uses a population of SDN Pakusari 02 Jember with a research sample of class V students. The research was carried out in the odd semester of the 2023/2024 academic year in mathematics subjects with the topic Fractions. The data collection techniques that researchers use are tests and questionnaires. Tests are a powerful numerical data collection technique in educational research. In the context of this research, test instruments are given in order to determine students' problem solving skills with the following scoring guidelines.

Table 2. Problem Solving Skills Scoring Guidelines

Rated aspect	Score	Description
Understanding of the problem	0	Doesn't say what is known
	1	Mentions what is known, but does not mention what is asked or vice versa
	2	State what is known and what is asked, but is not precise
	3	State what is known and what is asked appropriately
Problem solving planning	0	Don't plan any problem solving at all
	1	Plan a solution to the problem with an image that is appropriate, but not quite right
	2	Carry out the plan by writing answers completely and precisely
Problem solving based on planning	0	No answer at all
	1	Carry out the plan by writing down the answers, but only a small part is correct
	2	Carry out the plan by writing down the answers, but only half/most of them are correct
	3	Carry out the plan by writing answers completely and precisely
Re-examine procedures and problems solving results	0	Don't write a conclusion
	1	Interpreting the results obtained by making conclusions, but not quite right
	2	Interpret the results obtained by making appropriate conclusions
Total	10	

Table 3. Learnings Motivation Questionnaire Grid

Indicator	Statement	Score 4	3	2	1
There is a desire and desire to succeed	I feel challenged, enthusiastic and motivated in participating in learning.				
There is encouragement and need for learning	I feel that learning can provide satisfaction and be an important part of personal development.				
There are hopes and aspirations for the future	I feel that studying can provide opportunities to realize dreams, goals and aspirations.				

Indicator	Statement	Score 4	3	2	1
There is appreciation in learning	I feel that appreciation, whether in the form of praise from others and feeling proud of achievements, can motivate me.				
There are interesting activities in learning	I feel that interesting learning activities can make you participate and be motivated tocollaborate with classmates.				
The existence of a conducive environment allows students to learn well	I feel that a conducive learning environment supported by adequate facilities can support concentration and quality of learning.				

Information: 4 = Strongly agree; 3 = Agree; 2 = Disagree; 1 = Disagree

Meanwhile, a questionnaire is a data collection technique through submitting a set of written statements that need to be answered by respondents. In the context of this research, a questionnaire instrument was provided to determine students' learning motivation with a grid as in Table 3.

After preparations are complete, experiments and data analysis are carried out to test the research hypothesis. The research hypothesis was tested using the t-test formula and Two Way Anova. The t-test is used to determine the partial significance or each independent variable of the dependent variable. Meanwhile, Two Way Anova is used to analyze group data with more than one independent variable, where each independent variable is divided into several groups. However, before the above hypothesis is tested, it is necessary to carry out prerequisite tests in the form of homogeneity tests and normality tests with the following formula. The formula for the homogeneity test is:

$$F = \frac{S1^2}{S2^2} \quad (1)$$

Information: F = F-test value; S12 = Largest variance; S22 = Smallest variance.

The normality test formula is:

$$x^2 \frac{\sum(f0-fh)^2}{fh} \quad (2)$$

Information: $x2$ = Chi squared; fo = Existing frequency; fh = Expected frequency.

Homogeneity tests are carried out to confirm if the groups to be compared have the same variability. Meanwhile, the normality test is carried out for the purpose of checking whether the normal distribution assumption is acceptable or not.

Result and Discussion

In this research, researchers will describe data on students' problems solving skills and learning motivation. After carrying out the calculations, the following results were obtained.

Table 4. Problems Solving Skills Test Results

Group	N	Ideal Score	Average	Standard Deviation	Maximum Score	Minimum Score
Experiment	27	100	78.03	11.07	100	64.28
Control	27	100	64.67	17.39	85.71	28.57

In the table above, it can be seen that the average score on the problems solving skills test of students taught using the project-based CI Collaborative Learning Model is higher than those taught using conventional learning. In addition, by referring to the standard deviation value of the experimental group which is smaller than that of the control group, it can be interpreted that the problems solving skills test scores of control group students are more spread out compared to the problems solving skills test scores of experimental group students.

Table 5. Problem Solving Skills Test Results Based on Learning Motivation

Group	Motivation to learn	N	Mean	X Minimum	X Maximum	s
Experiment	Tall	15	82.74	64.3	100	11.48
	Low	12	71	64.3	78.6	5.54
Control	Tall	10	70.63	50	85.71	13.45
	Low	17	56.2	28.6	75	18.07

Next, data on students' problems solving skills will be grouped based on high and low learning motivation. Determining groups of students with high and low learning motivation is by adding up the learning motivation scores in the experimental group and the control group and then calculating the average. For students who have a learning motivation score above the average, they are categorized as students with high learning motivation. On the other hand, students who have a learning motivation score below the average are categorized as students with high learning motivation. The problems solving skills of students with high and low learning motivation in the experimental and control groups can be seen in the table 5.

Prerequisite Test

Before the researcher tests the hypothesis, it is necessary to carry out a homogeneity test and normality test as a form of prerequisite test based on data on the problems solving skills of experimental and control group students. The results can be seen in the table 6.

Table 6. Results of the Homogeneity Test of Problems Solving Skills

Motivation to learn	Sig.	Information
Tall	0.15	Homogeneous
Low	0.42	Homogeneous

Based on Table 6, the researcher carried out the homogeneity test using the Bartlett test. The results show that the problems solving skill scores of students with high and low learning motivation have homogeneous variance.

Based on Table 7, the researcher carried out the normality test using the Lilliefors test. The results show that the problems solving skill scores of students with high and low learning motivation in both the experimental and control groups have a normal distribution.

Table 7. Normality Test Results for Problem Solving Skills

Motivation to learn	Experiment	Information	Control	Information
Tall	0.20	Normal	0.13	Normal
Low	0.21	Normal	0.14	Normal

Hypothesis testing

Researchers conducted hypothesis testing with the aim of finding out the significance of the treatment (project-based Collaborative CI Learning Model) given to the research sample. In this research there are four hypotheses, where hypotheses 1-3 are tested using the t-test because the data has homogeneous variance and is normally distributed. Meanwhile, hypothesis 4 was tested using Two Way Anova. The results of hypothesis testing can be seen as follows:

First Hypothesis

H_0= The project-based CI Collaborative Learning Model has no effect on students' problems solving skills; and = The project-based CI Collaborative Learning Model has a significant effect on students' problems solving skills.H_1The results of the first hypothesis testing that the researcher carried out can be seen in the table 8.

Table 8. Firsts Hypothesis Test Results

Group	N	S_{gab}	ɑ	Etc	t_{Count}	t_{table}	Information
Experiment	27	14.58	0.05	54	3.33	2.02	Accept H_1
Control	27						

In the table above, it can be seen that the results of the problems solving skills of students taught using the project-based CI Collaborative Learning Model are higher than those taught using conventional learning. This is because the results of the problems solving skills test of experimental and control group students have a sig value. < real level = 0.05 or can be interpreted as accept table ɑH_1AndrejectH_0.

Second Hypothesis

H_0= High learning motivation has no effect on students' problems solving skills; and = High learning motivation has a significant effect on students' problems solving skills.H_1The results of the second hypothesis testing that the researcher carried out can be seen in the following table.

Table 9. Seconds Hypothesis Test Results

Group	N	S_{gab}	ɑ	Etc	t_{Count}	t_{table}	Information
Experiment	15	12.35	0.05	27	2.27	2.09	Accept H_1
Control	12						

In the table above, it can be seen that the test of problems solving skills of students with high learning motivation in both the experimental and control groups has a sig. < real level = 0.05 or can be interpreted as

accept table ɑH_1 AndrejectH_0. Thus, it can be concluded that the results of students' problems solving skills with high learning motivation are taught using the project-based CI Collaborative Learning Model is higher than those taught using conventional learning.

Third Hypothesis

H_0= Low learning motivation has no effect on students' problems solving skills; and = Low learning motivation has a significant effect on students' problems solving skills.H_1 The results of the third hypothesis testing that the researcher carried out can be seen in the table 10.

In the table 10, it can be seen that the test of problems solving skills of students with low learning motivation in both the experimental and control groups has a sig. < real level = 0.05 or can be interpreted as acceptableɑH_1 AndrejectH_0. Thus, it can be concluded that the results of the problems solving skills of students with low learning motivation are taughtusing the project-based CI Collaborative Learning Model is higher than those taught using conventional learning.

Table 10. Thirdt Hypothesis Test Results

Group	N	S_{gab}	ɑ	Etc	t_{Count}	t_{table}	Information
Experiment	10	14.31	0.05	27	2.24	2.10	Accept H_1
Control	17						

Fourth Hypothesis

H_0= There is no interaction betweenProject-based CI Collaborative Learning Model and learning motivation on students' problems solving skills; and = There is an interaction betweenH_1 Project-based CI Collaborative Learning Model and learning motivation on students' problems solving skills. The fourth hypothesis testing that the researcher carried out can be seen in the table 11.

Table 11. Fourtht Hypothesis Test Results

Variant Source	JK	Etc	RJK	F_{count}	F_{table}
Between	3424.47	1	3424.45	8.90	4.09
Between B	1474.49	1	1474.49	3.83	4.09
A x B interaction	508.50	1	508.50	1.32	4.09
In	14990.80	54	384.37		
Total	19381.37	54	-		

Based on the results of the Two Way Anova calculation, the sig value was obtained. 4.09 or greater = 0.05, so it can be interpreted as acceptableɑH_0 or there is no interaction betweenProject-based CI Collaborative Learning Model and learning motivation on students' problems solving skills.

Discussion

This research was carried out in two meetings on mathematics subjects with the topic Fractions. In the experimental group, students were taught using the project-based CI Collaborative Expansion Model in the form of "Fragment Flowers", while in the control group, students were taught using conventional learning. The Influence of the Project-Based CI Collaborative Learning Model on the Problems Solving Skills of Experimental and Control Group Students. By referring to the posttest results, it can be seen that the average score of the problems solving skills of the experimental group students who were taught using the project-based Collaborative CI Learning Model was higher than the control group who were taught using conventional learning. This can be seen in the average value of problems solving skills of students in the experimental group of 78.03, while the average value of problems solving skills of students in the control group is 62.67. The highest score for students' problems solving skills in the experimental group was 100, while the lowest score was 64.28. The highest score for students' problems solving skills in the control group was 85.71, while the lowest score was 28.57.

This discussion is in line with Liu et al. (2021) and Zach et al. (2023), which states that the application of CI as a type of Cooperative Learning Model has a significant influence on student learning outcomes. Research result Walsh et al. (2014), shows that there is a significant difference between the experimental and control groups with a sig value. amounting to 0.001 < 0.05, so it is concluded that the CI Collaborative Learning Model has a positive impact on student learning outcomes. In addition, this discussion is also relevant to research from Salong (2023) regarding Complex Instruction Team Product (CITP), which is a learning model that combines the Complex Instruction Learning Model and Team Product Learning Method (Darling-Hammond et al., 2020; Sarker, 2021). This learning model emphasizes collaborative activities that produce joint products. Research result Pantiwati et al.

(2023), all shows that the use of the CITP Model has a positive impact on improving creative thinking skills, critical thinking, metacognition, scientific attitudes, cognitive learning outcomes, and student retention, so it is concluded that the application of the CITP Model can improve students' learning experiences and produce creative products (Rahmawati et al., 2020; Eliaumra et al., 2024). Interaction between Project-Based CI Collaborative Learning Model and Learning Motivation on Students' Problems Solving Skills Interaction is the variation of two or more independent variables in influencing the dependent variable (Xu et al., 2023; Mundelsee & Jurkowski, 2021).

Apart from that, interaction also means that the influence of an independent variable on the dependent variable depends on the level or level of other variables (Andersson et al., 2014). Based on the results of hypothesis testing related to interaction in this study, it shows that there is no interaction between the project-based CI Collaborative Learning Model and learning motivation on students' problems solving skills (Andersson et al., 2014; Andriyani & Anam, 2022; Marnola et al., 2024). In other words, the use of the project-based CI Collaborative Learning Model and learning motivation are not interdependent in influencing students' problems solving skills. According to Söderlund (2023) and Hu et al. (2020), the absence of interaction is possible if one or more variables have a significant separate influence. Students with high learning motivation who are taught using the project-based CI Collaborative Learning Model have higher problems solving skills than those taught using conventional learning (Fariasih et al., 2022; Wijnia et al., 2024).

This can be seen based on the average score of problems solving skills for the experimental group of 82.74 and the control group of 62.67. Likewise, students with low learning motivation who are taught using the project-based CI Collaborative Learning Model have higher problems solving skills than those taught using conventional learning. This can be seen based on the average score of problems solving skills for the experimental group of 71.00 and the control group of 56.2. Thus, the project-based CI Collaborative Learning Model can influence the problem-solving skills of students with any level of learning motivation.

Conclusion

By referring to the results and discussion above, the researcher can conclude four things, namely :The problem solving skills of students taught using the project-based CI Collaborative Learning Model are higher than the problem solving skills of students taught using conventional learning; The problem solving skills of students with high learning motivation who are taught using the project-based CI Collaborative Learning Model are higher than the problem solving skills of students with high learning motivation who are taught using conventional learning; The problem solving skills of students with low learning motivation who are taught using the project-based CI Collaborative Learning Model are higher than the problem solving skills of students with low learning motivation who are taught using conventional learning; and There is no interaction between the project-based CI Collaborative Learning Model and learning motivation in influencing students' problem solving skills.

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The authors declare no conflict of interest.

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