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The Effect of Creative Problem Solving Learning Strategy on Conceptual and Procedural Understanding Moderated by Social Skills

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The paper examines the effect of learning strategy on learning outcomes moderated by social skills. Our research was conducted by employing quasi-experimental techniques, specifically two-times-two factorial design. Learning strategy in terms of creative problem solving was treated for the experiment group, and in contrast direct instruction was treated for the control group. Learning outcomes as criterion variables were measured by students' conceptual and procedural understanding, based on their social skills. The subjects of this study were selected by using cluster sampling and involved 72 students from a private vocational high school at *Lamongan* City, East Java Province. The data was analyzed by implementing multivariate analysis of variance, since the intention was to seek main and interactional effects.

Key words: *creative problem solving, social skills, understanding, and procedural understanding.*

Introduction

Creative problem solving is a problem-based learning strategy created for creative problem solving. Creativity expresses the problem given, discussed, and the discovery of ideas. Creative problem solving can be determined as a skill to achieve the goals needed through the creative process to find new and creative solutions. Research in this area has found that creative problem solving can provide students with skills to solve routine problems (Abdulla & Cramond, 2018; Basadur, Gelade, & Basadur, 2014; Carver & Scheier, 2000; Chowdhry, 2016; Wang, Chang, & Li, 2008a). This skill requires practice that consists of a creative process. Such an activity is important in the development of social skills in the field of creativity. It evaluates ideas and involves many people who make decisions by thinking creatively in everyday life.

Creative problem solving strategy

The implementation of the Creative problem solving strategy is done in several stages:
1) *Objective Finding* . This is where students are divided into groups. They discuss the problems raised by the teacher and convey goals that can be used for their creative work
2) *Fact Finding* – students construct all the facts that may be related to these goals. The teacher provides opportunities for students to reflect on the facts that are most relevant to the goals and solutions to problems.
3) *Problem Finding* is where the teacher guides students to redefine the problem so that students can find clearer solutions.
4) *Finding* Ideas: Student ideas are listed and those ideas are selected which are potential ideas as a solution to the problem.
5) *Solution Finding* - students colloboratively evaluate the ideas that have the greatest potential by constructing criteria, criteria that can determine the solution of a problem (William E., Mitchell. & Thomas F., 1999). Keunggulan kinerja kreativitas ketika instruksi menjadi kreatif harus standar yang jelas. Beberapa intruksi digunakan misalkan bersikap fleksibel, menjadi cerdas (Morris & Leung, 2010; Thomson, Hall, & Jones, 2012).

Direct learning strategy

Direct learning is learning that emphasizes activities that include lecturing, explaining and demonstrating. Students are asked to absorb information provided by the teacher based on an explanation and demonstration conducted by the teacher or teachers. Direct learning has the following characteristics:

1. The occurrence of domination and self pocket on the group by the students who were left by the teacher.
2. Tasks done by only one student make individual student accountability minimal.
3. The existence of homogeneity in the study group.
4. The selection of group leaders is done by the group chosen by the teacher.
5. Learning groups are monitored by the teacher through observation and intervention.
6. The learning process in the group lacks the teacher's attention.
7. Task completion is the goal of implementing learning (Stolp et al., 2017).

This type of learning is done in stages with the aim of mastering procedural knowledge and structured declarative knowledge so that students are able to master the material quickly. Arends (2012) has argued that direct instruction is a teacher-centered model that has five steps, including: an establishing set; an explanation and/or demonstration; a guide practice; feedback; and extending practice. A direct instruction lesson requires careful orchestration by the teacher and learning environment that is businesslike and task oriented.

Social skills

Social skills are one's ability to manage interactions with others effectively and not regress into anti-social behavior (Merrell, 2001). In this regard, characteristics of students are important in their learning process. Metacognition is an important student characteristic because it involves the process of 'thinking about thinking' (Carver & Scheier, 2000; Flavell, 1979; Isari, Pontiggia, & Virili, 2016; Schult, Stadler, Becker, Greiff, & Sparfeldt, 2017). Identifying factors that support the social skills group involvement can be done by knowingly contributing to improving the quality of interaction by asking a question or giving an explanation (Salavera, Usán, & Jarie, 2017). Some experts claim that creative ways to solve problems can be solved through complex and evolving processes. Without good metacognition, students will have difficulty learning complex topics in their learning environment, including difficulties in planning, setting goals and choosing effective strategies (Ames & Archer, 1988; Azevedo, Cromley, & Seibert, 2004). There are gaps in the application of creative problem solving without seeing internal and external social skills interventions. Social skills are an important factor in shaping the creative process to solve problems creatively (Gillies, 2017). Involving social skills of students with low metacognitive abilities cannot facilitate their abilities. How students learn to solve problems, locate problems and convey ideas requires social skills. In addition, the level of student understanding of the problem given in implementing creative problem solving strategies during the problem solving process is important (F. Paas, Camp, & Rikers, 2001; F. G. W. C. Paas & Van Merriënboer, 1994; Schmidt, Loyens, Van Gog, & Paas, 2007; Schult et al., 2017; Sternberg, 1985).

Merrell (2001) divides school skills into three categories: (1) *Teacher-Preferred Social Behaviour*, which is a social skill that supports the learning process. In this category, social skills include: contact and communication, sympathy and empathy, compromise and cooperation, and overcoming problems. (2) *Peer-Preferred Social Behaviour,* is the ability to interact outside of learning. In this category, social skills include: adaptation, helping behavior, friend interaction, initiative, and positive talent shown. (3) *School Adjustment Behaviour,* is a social skill to adjust to learning activities, consisting of: time management ability, response to learning, the ability to work, and the ability to follow the direction of learning.

Research about the importance of social skills becomes a significant question in terms of learning strategies, with skills training and their interactions affecting students' ability to understand concepts and procedures in computer manufacturing courses. The big questions that require these solutions become new references on how to manage creative problem solving strategies and different social background skills for the creative process in the classroom. One of those questions is whether there is a real interaction between the implementation of the strategy with the intervention of social skills with how students understand concepts and procedures?

Method

Research Design

The research's quasi-experimental design was implemented in the Department of Computer and Network Engineering, specifically in Computer Assembly Course. Subjects of research were ninth graders at a private senior vocational high school at *Lamongan* City in East Java Province, Indonesia. Subjects were selected by using the cluster sampling technique. Two classes were chosen, each consisting of 36 students. The first class was preserved as an 'experiment group', and the second class was preserved as a 'control group'. This quasi experimental design was shown as follow.

Table 1: Research Design

Group of students	Pre Test	Treatment	Post Test
Experiment Group (36 students)	Students' Conceptual and Procedural Understanding	Creative Problem Solving Learning Strategy	Students' Conceptual and Procedural Understanding
Control Group (36 students)	Students' Conceptual and Procedural Understanding	Direct Instruction Learning Strategy	Students' Conceptual and Procedural Understanding

Test of Homogeneity

The test of homogeneity of variances by using the Levene Statistic was employed to ensure that both experiment and control groups were homogeny. The result is reflected in following table and exposes a non-significant coefficient, meaning that both of the two groups are homogenous.

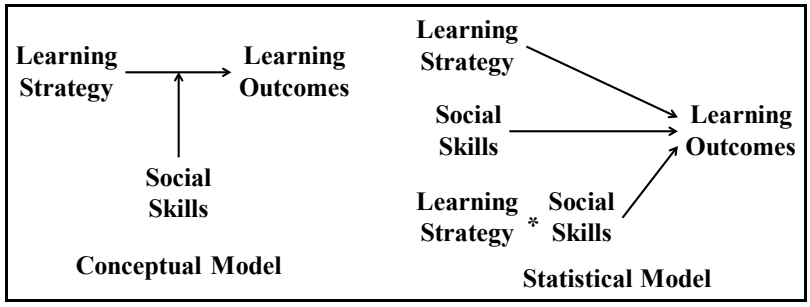
Table 2: Test of Homogeneity of Variances

Test of Homogeneity of Variances			
Levene Statistic	df1	df2	Sig.
1.418	1	142	.236

Relationship among Variables

The creative problem solving learning strategy was treated for experimental group, and the direct instruction learning strategy that was treated for the control group. The moderating variable was students' social skills, and the criterion variables were learning outcomes in terms of students' conceptual and procedural understanding. The relationship among variables is figured out as follows:

Figure 1: Relationship among Variables



This experimental research design applied two times two factorial design, as presented in following table.

Table 3: Two Times Two Factorial Design

		Predictor Variable: Learning Strategies	
		Creative Problem Solving (for Experiment Group)	Direct Instruction (for Control Group)
Moderating Variable: Students' Social Skills	High	Criterion Variable: Students' Conceptual and Procedural Understanding	Criterion Variable: Students' Conceptual and Procedural Understanding
	Low	Criterion Variable: Students' Conceptual and Procedural Understanding	Criterion Variable: Students' Conceptual and Procedural Understanding

Research Hypothesis

The experiment group was treated by using creative problem solving learning strategy, while the control group was treated by using direct instruction learning strategy, and the impact of those treatments were on Students' Conceptual and Procedural Understanding. Moreover, it was also aimed at finding the different impact of students' social skills on Students' Conceptual and Procedural Understanding, and also to find the interactional effect of learning strategies and students' social skills on Students' Conceptual and Procedural Understanding. The research hypothesis that was examined is described as follows:

H_{1a}: there were significant differences in students' conceptual understanding between groups of students treated by using creative problem solving learning strategy and those treated by using direct instruction learning strategy.
H_{1b}: there were significant differences in students' procedural understanding between groups of students treated by using creative problem solving learning strategy and those treated by using direct instruction learning strategy.
H_{2a}: there were significant differences in students' conceptual understanding between groups of students who have high and low social skills.
H_{2b}: there were significant differences in students' procedural understanding between groups of students who have high and low social skills.
H_{3a}: there were significant differences in students' conceptual understanding between groups of students as a consequence of interactional effect between learning strategies used and students' social skills.
H_{3b}: there were significant differences in students' procedural understanding between groups of students as a consequence of interactional effect between learning strategies used and students' social skills.

Research Variables

Variables of this research involved the learning strategy as a predictor or independent variable, the social skills as a moderating variable, and learning outcomes as a criterion variable. Detailed description of each variable is highlighted in following table.

Table 4: Description of Research Variables

No.	Variables	Description	Carried out as
1.	Learning Strategy	Its involves two learning strategies described as follow. 1. Creative problem solving learning strategy treated for experiment group procedurally implemented as mentioned by its learning syntax. The syntax consists of objective finding, fact finding, problem finding, idea finding, and solution finding. 2. Direct instruction learning strategy treated for control group procedurally implemented as mentioned by its learning syntax. The syntax consists of telling learning objective, presenting knowledge, providing opportunity for practice, evaluating knowledge and feedback, and providing tasks.	Predictor variable implemented for experimental treatment
2.	Social Skills	This involves three dimensions described as follow. 1. Dimension 1: teacher-preferred social behavior. Its indicators consisted of relationship and communication, sympathy and empathy, compromise and cooperation, and solving problems. 2. Dimension 2: peer-preferred social behavior. Its indicators consisted of adaptation, stewardship behavior, friendship interaction, initiative, and positive talent showed. 3. Dimension 3: school adjustment behavior. Its indicators consisted of time management capability, response on learning, industriousness, and ability to go along with learning direction.	Moderating variable measured by using inventory
3.	Learning Outcomes	Conceptual understanding as the first criterion variable. This conceptual understanding includes the following aspects of learning achievement regarding knowledge in the field of computer hardware.	Criterion variable measured by using instrument

		1. Identifying parts/modules of computer hardware 2. Describing function of parts/modules of computer hardware 3. Explaining technical computer specification matched with fields of works 4. Describing bios components 5. Explaining work safety regarding computer assembly	test
		Procedural understanding as the second criterion variable. This procedural understanding includes the following aspects of learning achievement regarding flow process of works. 1. Determining stages of computer assembly based on industrial standard 2. Assembling process of computer hardware by implementing work safety 3. Implementing bios setting configuration 4. Testing bios configuration 5. Reporting results of assembling process and bios configuration	Criterion variable measured by using performance test and observation

Data analysis

Data collected was analyzed by using multivariate analysis of variance at 0.05 alpha level run in IBM SPSS Statistics version 24 for windows. By using this technique of analysis, it is workable to include all data in once analysis process intended to examine all null hypotheses by putting data of conceptual understanding and procedural understanding as criterion variables in the cell of dependent variables, then putting data of learning strategy as a predictor in cell of a fixed factor, and finally putting data of social skills as a moderating variable in a cell of covariate.

Results and Discussion

Descriptive Data

Once treatment was completed,, a test was given to both groups by implementing creative problem solving for the experiment group, and the direct instruction given for the control group.

The learning outcomes measured in terms of the conceptual and procedural understanding of the students' social skills is described in following table.

Table 5: Learning Outcomes after Treatment

Learning Strategy and Social Skills						
Dependent Variable: Learning Outcomes	Predictor Variable: Learning Strategy	Moderating Variable: Social Skills	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Students' Conceptual Understanding	Creative Problem Solving	High	90.222	.911	88.404	92.040
		Low	77.333	1.578	74.185	80.482
	Direct Instruction	High	85.179	.895	83.394	86.964
		Low	72.875	1.674	69.535	76.215
Students' Procedural Understanding	Creative Problem Solving	High	89.778	1.027	87.729	91.827
		Low	77.778	1.779	74.228	81.327
	Direct Instruction	High	85.000	1.008	82.988	87.012
		Low	76.500	1.887	72.735	80.265

From the above table, according to the mean score obtained, it can be deducted that students who have high social skills achieved higher learning outcomes compared to students who have low social skills, whether the students were treated by using direct instruction or creative problem solving. Moreover, it is also can be concluded that the group of students treated by creative problem solving achieved higher learning outcomes compared to students treated by direct instruction either for high or low social skills. In another words, this research revealed that the group of students treated by using creative problem solving learning strategy had a better learning achievement compared to those treated by using direct instruction, either for high or low social skills.

Hypothesis Testing

To examine hypotheses, and considering the relationship among variables as mentioned previously, data was analyzed by using multivariate analysis of variance. The result of the analysis is presented in following table.

Table 6. Results of Multivariate Analysis of Variance

Tests of Between-Subjects Effects							
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Conceptual Understanding	2436.796[a]	3	812.265	36.251	.000	.615
	Procedural Understanding	1663.556[b]	3	554.519	19.475	.000	.462
Intercept	Conceptual Understanding	343263.835	1	343263.835	15319.764	.000	.996
	Procedural Understanding	350568.884	1	350568.884	12311.957	.000	.995
Learning Strategy	Conceptual Understanding	292.323	1	292.323	13.046	.001	.161
	Procedural Understanding	118.725	1	118.725	4.170	.045	.058
Social Skills	Conceptual Understanding	2054.831	1	2054.831	91.706	.000	.574
	Procedural Understanding	1360.638	1	1360.638	47.786	.000	.413
Learning Strategy * Social Skills	Conceptual Understanding	1.109	1	1.109	.050	.825	.001
	Procedural Understanding	39.662	1	39.662	1.393	.242	.020
Error	Conceptual Understanding	1523.649	68	22.407			
	Procedural Understanding	1936.222	68	28.474			
Total	Conceptual Understanding	520766.000	72				
	Procedural Understanding	523120.000	72				
Corrected Total	Conceptual Understanding	3960.444	71				
	Procedural Understanding	3599.778	71				
a. R Squared = .615 (Adjusted R Squared = .598)							
b. R Squared = .462 (Adjusted R Squared = .438)							

The above table was used to examine null hypothesis by mentioning column F and Significance, and a decision made for either the rejection or not of the null hypothesis. The decision was taken for null hypothesis testing as presented in the following table.

Table 7. Hypothesis Testing

No.	Null Hypothesis (H_0)	F	Sig.	Decision
1.	There were no significant differences of students' conceptual understanding between groups of students treated by using creative problem solving learning strategy and treated by using direct instruction learning strategy.	13.046	.001	H_0 Rejected
2.	There were no significant differences of students' procedural understanding between groups of students treated by using creative problem solving learning strategy and treated by using the direct instruction learning strategy.	4.170	.045	H_0 Rejected
3.	There were no significant differences of students' conceptual understanding between groups of students who have high and low social skills.	91.706	.000	H_0 Rejected
4.	There were no significant differences of students' procedural understanding between groups of students who have high and low social skills.	47.786	.000	H_0 Rejected
5.	There were no significant differences of students' conceptual understanding between groups of students as a consequence of interactional effects between the learning strategies used and students' social skills.	.050	.825	H_0 Not Rejected
6.	There were no significant difference of students' procedural understanding between groups of students as a consequence of interactional effect between the learning strategies used and students' social skills.	1.393	.242	H_0 Not Rejected

Research Findings

Our research revealed findings as pointed out in following list:

1. From results of descriptive statistics analysis, in general, it is found that group of students treated by using creative problem solving learning strategy results in a better learning

achievement in terms of students' conceptual and procedural understanding, compared to those treated by using direct instruction either for high or low social skills.

2. The null hypothesis stating that there was no significant difference of students' conceptual understanding between groups of students treated by using creative problem solving learning strategy, and those treated by using direct instruction learning strategy was rejected. This means that there is the effect of creative problem solving learning strategy on students' conceptual understanding.
3. The null hypothesis stating that there was no significant difference of students' procedural understanding between groups of students treated by using creative problem solving learning strategy and those treated by using direct instruction learning strategy is rejected. It means that there is the effect of creative problem solving learning strategy on students' procedural understanding.
4. The null hypothesis stating that there was no significant difference of students' conceptual understanding between groups of students who have high and low social skills is rejected. It means that there is an effect of students' social skills on students' conceptual understanding. The higher students' social skills, the higher its effect on students' conceptual understanding.
5. The null hypothesis stating that there was no significant difference of students' procedural understanding between groups of students who have high and low social skills is rejected. This means that there is the effect of students' social skills on students' procedural understanding. The higher students' social skills, the higher its effect on students' procedural understanding.
6. The null hypothesis stating that there was no significant difference of students' conceptual understanding between groups of students as a consequence of interactional effect between learning strategies used and students' social skills is not rejected. This means that there is no interactional effect between learning strategy and students' social skills on students' conceptual understanding.
7. The null hypothesis stating that there was no significant difference of students' procedural understanding between groups of students as a consequence of interactional effect between learning strategies used and students' social skills is not rejected. It means that there is no interactional effect between learning strategies and students' social skills on students' procedural understanding.

Discussion

The learning process that takes place in the classroom is dominated by social skills; how they can manage their learning time, understand their own learning style, understand their learning needs and take responsibility for the tasks given.

This experimental research exposed that there is the effect of a learning strategy used on students' learning outcomes. Groups of students treated by utilizing creative problem solving learning strategy reached higher learning outcomes compared to those treated by direct instruction learning strategy. Students' learning outcomes in terms of conceptual and procedural understanding is better achieved by implementing a creative problem solving learning strategy. Creative learning process skills development is necessary for students to be able to maintain learning achievement retention. Students' cognitive involvement in the process of creative learning 'collaboratively' generates long-term memory intensification, and all information obtained will be conserved. Through collaborative learning, students' previous knowledge cognition is amplified and sharpened by a process of discussion and analyzing thoughts with their classmates intended for advancing the capability of information processing. It reflects the progress of knowledge transformation caused by the learning process (F. G. W. C. Paas & Van Merriënboer, 1994; F. Paas, Tuovinen, Van Merriënboer, & Darabi, 2005; Sweller et al., 2019).

Delivering a creative problem solving learning strategy in class requires additional social environmental factors to be considered that includes forming groups and creating and encouraging social interaction amongst the group members. Creative learning process activity conducted in class needs groups of students endeavouring to carry out learning syntax in terms of defining objectives, collecting information and the constructing of empirical facts obtained, arguing and proposing several kinds of alternatives as possible solutions, comparing and evaluating alternatives of solutions, and determining and deciding solution. This learning strategy affects students' cognitive development and students' social skills involvement by manipulating variability of learning assignments, learning environment, group forming, and learning motivation that stimulate cognitive schemata development, knowledge transformation, and creative process skills that are beneficial as a process of reflection for further creative problem solving learning experiences (Foster & Yaoyuneyong, 2016; Huang, 2019; F. Paas, Tuovinen, Tabbers, & Van Gerven, 2003; F. Paas et al., 2005; Schmitt, Buisine, Chaboissier, Aoussat, & Vernier, 2012; Wang, Chang, & Li, 2008b).

Our research has shown that the higher students' social skills, the higher its effect on students' conceptual and procedural understanding. Students' experience developed by interaction within their circumstances is the main factor that determines how they respond to incoming stimuli, and how they deal with their social environment. Each individual needs an ability to understand their own level of social skills. In the learning process, students' behaviour in class is more effective if they have an expectation that appropriate social skills may accomplish targeted learning outcomes. In contrary, performing inappropriate social skills can affect the achievement of solving problems at an unexpected level (Buisine, Besacier, Aoussat, & Vernier, 2012; Estrada, Isen, & Young, 1994; Muis, Chevrier, & Singh, 2018; F. Paas et al., 2005; Vidal, 2005). The

success of the learning process in class in terms of students' learning outcomes is also influenced by level of students' social skills. This success depends on the students' ability to control their learning timetable, to understand their learning style, to realize their learning needs and take responsibility of the process of learning assignment accomplishment.

It was discovered that there is no interactional effect between learning strategy and students' social skills on learning outcomes. Students who have high social skills achieved high learning outcomes, and groups of students treated by using creative problem solving achieved higher learning outcomes than those treated by using direct instruction. Students' social skills are not associated with the learning strategy used, and both of the two variables take action as main variables that have an effect on students' learning outcomes. The implementation of the learning strategy has to consider students' characteristics and social skills background to optimize their learning outcomes achievement. Students' social skills such as time management capability, response to learning and the ability to go along with learning direction support the learning process and affect learning activity creatively. Learning that activates students' social skills means it's possible for them to be able to arrange their learning schedule, to understand their learning style and needs, and to be responsible for accomplishing a learning assignment.

Conclusion

Selecting an appropriate learning strategy to drive students' initiative and become problem solvers and creative thinkers is essential. This experimental research that had been implemented in a computer assembly course at a private vocational high school has revealed that learners are able to reach higher learning outcomes in terms of conceptual and procedural understanding by the use of creative problem solving learning strategy compared to direct instruction. Empirically, the delivery of learning by using creative problem solving is able to affect students' conceptual and procedural understanding. It was also discovered that higher students' social skills contribute to higher learning outcomes. Students' social capabilities are able to be improved by examining preferred students' social behavior for carrying out social interaction with teachers, classmates, and in the school environment. This research has found that there is no interactional effect between the learning strategy used and the social skills that inform the students' conceptual and procedural understanding. It is recommended that the 'teacher as facilitator' and learning organizer is able to take into consideration the use of a creative problem solving learning strategy to activate and to stimulate learners to work enthusiastically and collaboratively in terms of how they investigate and explore empirical facts, argue and analyze possible alternatives, as well as deciding on suitable solutions. It is also recommended that the teacher facilitates the development of students' social skills since these preferred social behaviors are effective in

supporting learning that requires them to take part in group work. This will also be able to develop the students' responsibility to study in real world circumstances.

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