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The Effect of Instructional Model and Spatial Intelligence Toward Student's Mathematics Learning Outcome Controlled by Prior Competence

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Key words: Integrative model, direct model, spatial intelligency, learning outcome, prior competence

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Abstract: This study aims at investigating the effect of instructional model and spatial intelligency toward mathematics learning outcome controlled by prior competence. It was conducted on SMAN 6 Kendari from August to November in 2017. It uses experiment quasy method with "by level 2×2 design". Sample of this study consists of 40 students who are selected randomly. The data was analyzed by using ANCOVA and ANCOVA t-test in the significance level 0.05. The result of this study shows that: student's mathematics learning outcome who are taught under integrative instruction model is higher than students who are taught under direct instruction model; there is an effect of interaction between instructional model and spatial intelligence toward mathematics learning outcome; student's learning outcome who have high spatial intelligence and taught under integrative instruction model is higher than students who are taught under direct instruction model and student's learning outcome who have low spatial intelligence and taught under integrative instruction model is lower than students who are taught under direct instruction model.

INTRODUCTION

Instruction is a construction and improvement process, namely a process which is pleasant and developed continuously to improve the students' potential and competence. The purpose is to help the students in applying their knowledge in facing and solving the problem to get success in both today and tomorrow. On mathematics instruction, mainly on this time is supposed as difficult subject by most students. They express it in psychology symptoms like "despondent", "stress", "less motivation", "depression", "worried", "tired", "headache" and "queasy". Those expressions show that mathematics learning is not joy full subject and it is sometime not suitable with the real life condition. Substantially, the instructional model has not given yet access for students to develop individually through various findings in their though. They are mostly just listen and note the material given by the teacher, so the students are more passive, not focus and boring. As a result, the mathematics learning outcome is still low and does not achieve the minimum pass criteria as the target from the school.

Based on the result of several studies, like Ishak and Awang (2017), Wahid *et al*. (2014) and Pehlivan and Durgut (2017) show that there are many factors that influence student's learning outcome such as student's internal factors and external factors. Internal factors are motivation to learn, intelligence level and learning style.

External factors are instruction models, instruction strategies, instruction approaches, instruction methods and teacher's competence in teaching and learning process. Besides those factors, the result of study Acharya (2017)'s shows that other factors that affect the student's difficulty in learning mathematics are negative perception and worry to mathematics lesson and low prior knowledge and low concept mastery of mathematics and principle and fact of mathematics to the new material that will be learnt.

According Kline, mathematics is a lesson to explain numbers, geometrics structure and extending of ideas about the numbers and geometrics structure Kline (1962). It shows that the characteristics of mathematics is having abstract object, so, someone is not easy to understand mathematics material that are taught by the teachers. To handle the abstract one, mathematics needs to be visualized in order it can help the students to understand easily mathematics material that are taught by the teachers. To visualize the mathematics object, it needs student's competence, in this case, spatial competence. Spatial competence is ability to understand visual world accurately to do transformation and modification on someone's first perception through visual observation and mental imagination and recreate the visual experience aspect and even without relevant physic stimulus. So, the students who have high spatial competence will be easier and well to understand and learn mathematics and their learning outcome will be better.

One of the mathematics characteristics is hierarchy, meaning the material is arranged based on the previous material. For example, the "division algebra" is arranged based on "multiplication algebra" and room shape material is based on flat shape. It shows that to learn a certain concept in mathematics should be based on the other base concepts, so, the students should master the concepts before moving to the new concept. Besides, the mathematics materials are arranged systematically from elementary school to higher schools, from low level to higher levels and they are related one another. Therefore, the student's prior competence is as the criteria for learning the next materials to better result. Student's prior knowledge or competence is needed by teacher to determine suitable entry behavior line, so the teacher can apply the appropriate ways in the next instruction.

Up till now, instruction model that is used by mathematics teacher in SMAN 6 Kendari is direct instruction model and teacher center without trying other models that can activate the students, so, the student's mathematics learning outcome is not increasing significantly.

Studies of McCormick *et al*. (2015) and Killian and Bastas (2015) shows that learning that can make the students to be more active can increase: motivation and learning behavior, interaction between teacher and students, critic thinking ability in solving the problem and student's performance. Those studies shows that learning that can make the students to be more active will improve thinking ability, scientific attitude and work and good communication as one of the important things in life, so the students can communicate the scientific work results systematically and create more quality learning process.

Integrative instruction is one of appropriate models, namely an instruction model that help the students to develop the knowledge systematically and improve critical thinking ability (Niehaus *et al*., 2017). In this model, the teacher gives combinations of facts, concept and generalization in one matrix, or in the forms of map and hierarchy. Under guiding the teacher, the students try to find out by their selves the pattern and causality relation of the information or knowledge. In the implementation, integrative instruction model does not aims at helping the students to memorize the specific facts, concept, or this generalization but helping the students find out and understand the relationship among them, formulate the relations and consider the addition possibility (hypothesis). It differs to direct instruction model that is dominated by structural or objectives/behavior understanding, in which the students memorize the materials. Integrative instruction model is based on the view that students build the understanding by their selves about the topics that they learn, not just memorize the given systematic materials.

Huber as quoted by Railean *et al*. (2015) state that integrative instruction is improving the competence to make, recognize and evaluate the relationship among different concepts, fields, or context. This definition shows that integrative instruction basically is a learning process to combine various information with experience to create new instruction and meaning. In the process, the students make, recognize and evaluate the relationship among different concepts and make simple connection between their idea and experiences that they get in both class and out of class.

To know further about those instruction models, integrative instruction model and direct instruction model on mathematics lesson and their relationship with spatial intelligence and prior competence in increasing the mathematics learning outcome, it needs a research entitled "The Effect of Instruction Model (Integrative bad direct) and spatial intelligence (High and low) towards student's mathematics learning outcome controlled by the prior competence".

In this study, integrative instruction model is integrative instruction that is developed by Eggen and Kauchak (2012), namely as instruction model with aims at supporting students to develop their learning competence individually by using various thinking skills by Kilbane and Milman (2014). Eggen and Kauchak (2012) define integrative instruction model as instructional model to help students in improving their understanding deeply about the systematic knowledge as well as build their critical thinking skills.

Eggen and Kauchak (2012) integrative instruction model is developed based on Hilda Tab's though that is designed to promote the student's critical thinking and based on constructivism learning theory that state that learning is active process in which the students use sensory input to build meaning of experiences. The essential principles of constructivism like John Dewey, Resnick and Vygotsky is presented in integrative model, such as follow: the students need "do" something or participated in learning actively "active learning" someone learns to learn because they want to learn, the most important thing in building meaning is mental, instruction needs language and learning is social.

Integrative instruction model has steps or phases in instruction that should be done by the teacher and students which is called as syntax. Eggen and Kauchak (2012) divide four phases of integrative instruction model, namely: explain, compare and find out the pattern, explain the similarity and difference, formulate hypothesis, and do generalization to build wide relations.

Direct instruction model is developed based on behaviorist's theory, B.F. Skinner's about learning and instruction process, mainly the effect of operant condition in theory that all behaviors are created from external stimulus. In direct instruction model, someone's responds is related directly to stimulus in class. Based on the result of previous studies, direct instruction model gives positive effect to instruction, mainly if it is applied to learn materials that can be given in smaller details and can be observed and measured (Kilbane and Milman, 2014).

Flores and Kaylor, Leno and Dougherty as quoted by Eggenand Kauchak (2012) state that direct instruction model is a instruction model based on the wide and effective learning outcome and used to teach students who have low pretention motive and who have difficulty in learning. This model is defined as a model that use teacher's practice and explanation and then combined to student's practice and feedback to help them in reaching the needed real knowledge and skill for the next learning's (Eggenand Kauchak, 2012).

As explanation above, the teacher has important role in direct instruction. The instruction arrangement and planning that are made by teacher are very essential for student's mastery of knowledge, attitude and skill. Direct instruction is not only dominated by behaviorism principles but also cognitive psychology principles belong to the importance of long memory save process in instruction, limitations of work memory capacity and base skill learning value. Besides, instruction principles in socio-cultural theory also enrich direct instruction model by emphasizing on that the teacher should give scaffolding (mainly in the first times of learning) and give opportunity to students in small learning groups. Direct instruction model phases based on Eggen and Kauchak's view consists of four phases, namely: introduction, presentation, guided practice and individual practice (Eggen and Kauchak, 2012). Spatial intelligence is one of eight types multiple intelligence that is developed by Howard Gardner. Shortly, spatial competence is ability to know something through visual observation and mental imagination (Williams and Newton, 2007). Comprehensively, Taylor defines spatial intelligence as ability to think in three dimensions, namely spatial analyzing, mental picture, picture manipulation, graphic and art skill and active imaginary by Adekola and Taylor. Further, McKee states that spatial or visual intelligence is ability to think visually in three dimensions McKee, Lex (2014). Shortly, spatial intelligence is ability to visualize concepts and relations among concepts. Based on this definition, spatial intelligence refers to someone's ability to know and think in three dimensions of spatial reasoning, mental image, picture manipulation, graphics and arts skills and active imaginary and visualize concepts and relations among concepts. In other words, spatial intelligence can be stated as ability to do adaptation in looking at the visual forms, equilibrium, color, lines, forms and room shape by Ross (2005).

Students who have spatial intelligence enjoy the activities of arts, reading map, graphic, diagram and analyze the pictures. They be able to visualize picture clearly and can work jigsaw tasks easily. They should pay attention the picture firstly and then understand the meaning of words. The picture gives contextual direction for the words and help students to learn reading, spelling and recognizing the relation among objects. Besides, students who have spatial intelligence commonly take a note the material by making its picture to keep the content. The students learn to spell words by looking at the pictures. The use of picture is very effective because when students hear the words, they then look at the picture and understand it well. Understanding the picture may help them to transfer their understanding into the words.

As the factors or indicators that are explained by Schiltz *et al*. (2012) that several steps need to understand information that students observe in their around environment which is related to spatial intelligence, namely:

Spatial relationships: Ability to understand how the object put in room shape is including in terms of left-right orientation and rotation.

Visual discrimination: Ability to recognize objects based on the familiar characteristics and differ objects, even when they are presented in different scenes.

Figure-ground discrimination: Ability to focus on visual detail with figure-ground interviewing.

Visual integration: Ability to integrate various parts of object or event becomes something meaningful unity.

Visual closure: Ability to recognize known things when the objects are not presented wholly.

Visual memory: Ability to memorize important visual information accurately.

Visual motor integration: Ability to memorize and make replica of a room shape. Visual perceptual ability is ability to see and interpretive information's in around environment.

Based on the statements or opinions above, can be synthesized that spatial intelligence is ability to understand visual world accurately, to do transformation and modification on someone's first perception through visual observation and mental imaginary and to recreate the visual experience aspects, even without relevant physic stimulus that covers eight factors, namely spatial relationships, visual discrimination, figure-ground discrimination, visual integration, visual closure, visual memory, visual motor integration and visual perceptual ability.

The student's prior knowledge or defined in simple way as "the sum of what an individual knows" (Murphy and Alexander, 2012) is the important component that cannot be separated from the learning process. Attention the prior knowledge in the instructions very important because it is a standard reference as the prerequirement to learn. The prior knowledge acts as mental hooks that bring students to the new information. Besides, prior knowledge is a base of skill and knowledge material. According Biemans and Simons as quoted by Campbell and Campbell (2009) prior knowledge is all student's knowledge's which are potential and relevant when they are going to joint with the new material or knowledge. Refers to the statement, prior knowledge is very important as pre-requirement for students to joint to the new lesson to get new knowledge.

Prior knowledge in this study is student's prior knowledge on mathematics subject. Since mathematics is a good organized structure and its material arranged hierarchy which relate one others, the prior knowledge as prerequirements is very important in the learning process of mathematics. It shows that the student's mathematics prior knowledge affects their mathematics learning outcome. Mathematics instruction model should be developed in order can give students opportunity in improving their knowledge continuously, either horizontal or vertical aspect. With considering the prior knowledge, the teacher is hoped be able to arrange more suitable instruction model that involve providing teaching material, arrangement of learning steps and providing appropriate evaluation tools.

The result study of Muthomi and Mbugua (2014)'s shows that there is a significance correlation between teachers's learning strategy and student's mathematics learning outcome. Further, Pollack (2016) and Singer *et al*. (2015) show that integrative instruction model can activate the student's participation in learning process and improve their understanding and individuality in learning. The studies of Andayani and Gilang (2015) and Peet *et al*. (2011) show that integrative instruction model increase not only student's understanding of acquiring the material/knowledge but also give advantages for students in terms of six knowledge dimensions and increase student's ability in: identifying, showing and doing adaptation of knowledge which are obtained in different contexts; doing adaptation in different things (person and situation) finding out the solution; understanding and leading yourselves as learner; being become reflexive, accountable and relational learner; identifying and making differences yourselves perspective and other perspectives and developing professional digital identity.

The result studies of Turgut and Yilmaz (2012) and Yarmohammadian (2014) show that spatial intelligence is very important in mathematics learning and they show that there is a significance correlation between spatial intelligence and the student's learning outcome. Besides, geometry instruction has closed relationship to spatial intelligence (Boaler *et al*., 2016). The students who have high spatial intelligence with effective instruction model will be easier to build their mathematics knowledge than students who have low spatial intelligence. Further, Jones and Ramirez (2013)'s study shows that in direct instruction model, the students really rely upon the teacher in acquiring the knowledge, so the students who have low spatial intelligence will be happier if they are taught in structured and guided ways. The study result lines to Zhang (2017) and Lamber and Tan (2017)'s that the students who have difficulty learning or low spatial intelligence will be more effective if they are taught under guided instruction model and teacher centered.

Based on the description and previous empirics studies, this study aims at finding out: the difference of student's mathematics learning outcome between students who are taught under integrative instruction model and direct instruction model which is controlled by prior competence, interaction between integrative instruction model and direct instruction model towards student's mathematics learning outcome which is controlled by prior competence, the difference of student's mathematics learning outcome between students who are taught under integrative instruction model with high spatial intelligence and students who are taught under direct instruction model which is controlled by prior competence and the difference of student's mathematics learning outcome between students who are taught under integrative instruction model with low spatial intelligence and students who are taught under direct instruction model which is controlled by prior competence.

Table 1: Experiment design by level 2×2

	Experiment variables	
Moderator variables	Integrative instruction model (A_1)	Direct instruction model (A_2)
High spatial intellegence (B_1)	A_1B_1 $[X, Y]_{11k}$ k = 1, 2, ..., n_{11}	A_2B_1 $[X, Y]_{21k}$ k = 1, 2, ..., n_{21}
Low Spatial Intelligence (B_2)	A_1B_2 $[X, Y]_{12k}$ k = 1, 2, ..., n_{12}	A2B2 $[X, Y]_{22k}$ k = 1, 2,..., n_{22}

A_1B_1; a group who are taught under integrative instruction model with high spatial intelligence; A_2B_1; a group who are taught under direct instruction model with high spatial intelligence; A_1B_2; a group who are taught under integrative instruction model with low spatial intelligence; A_2B_2: a group who are taught under direct instruction model with low spatial intelligence; X; student's prior competence score of mathematics lesson; Y: mathematics learning outcome score; K; group (sample for each sell)

MATERIALS AND METHODS

This study was conducted on SMAN 6 Kendari from August to November in 2017. It uses variable experiment method, with two measured variables, namely, free variable and bound variable. Bound variables student's mathematics learning outcome at class XI MIPA of SMAN 6 Kendari. Free variable consists of: experiment variable of instruction model that consists of integrative and direct instruction models and moderator variable: student's spatial intelligence that consists of high and low spatial intelligence. This study also considers affix variable that are not focused on this study but it can influence the study result and it is not manipulated, namely student's prior competence as covariate variable.

It uses experiment quasy method with "by level 2×2 design" and experiment design was presented in Table 1. Data of mathematics learning outcome, spatial intelligence and student's prior competence are obtained through test. The techniques of data analysis covers descriptive analysis which is used to find out mean, median, deviation standard, maximum value and minimum value analysis pracriteria test that covers normality test, homogeneity test, linearity test and regression linear test and Inferential analysis which is done through Covariance Analysis (ANAKOVA) by Kadir (2015). If there is interaction between experiment variable and attribute variable, it uses further test, namely by using t-test ANAKOVA (Huitema and Bradley, 2011).

RESULTS AND DISCUSSION

Descriptive data analysis result is presented in Table 2. Table 2 shows that the score mean of student's learning outcome who are taught under integrative instruction model (72.06) is higher than students who are taught under direct instruction model (67.5). Likewise, the score mean of student's learning outcome who are taught under integrative instruction model on students who have high spatial intelligence is higher than students who are taught under direct instruction model. Differently, the score mean of student's learning outcome who are taught under integrative instruction model on students who have low spatial intelligence is lower than students who are taught under direct instruction model.

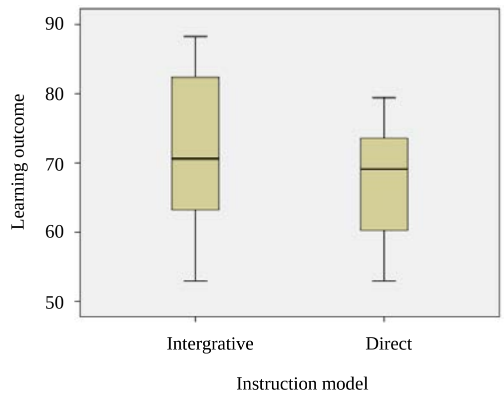

Fig. 1: Box plot graphics student's mathematics learning outcome who are taught under integrative instruction model and direct instruction model

Table 3 shows that student's learning outcome who are taught under integrative instruction model is higher than students who are taught under direct instruction model which is controlled by prior competence. It can be observed on Fig. 1.

The result of ANKOVA test on Table 3, variants source between A which obtain F_{count} = 6.717 with sig. = 0.014 is lower than α = 0.05. It means that there is a significance difference between student's mathematics learning outcome who are taught under integrative instruction model (A_1) and students who are taught under direct instruction model (A_2) which is controlled by prior competence. The result of ANKOVA t-test shows that $t_{count} = T_{0(A1XA2)} = 2.592$ is higher than $t_{table} = t_{(0,05;37)} = 1.684$. It means that the score of student's mathematics learning outcome who are taught under integrative instruction model is higher than students who are taught under direct instruction model controlled by prior competence.

The mean score of descriptive analysis of student's mathematic learning outcome who are taught under integrative instruction model on students who have high spatial competence after being controlled by prior competence is 81.76 while the mean score of mathematic learning outcome who are taught under direct instruction model after being controlled by prior competence is 68.24. The mean score of student's mathematics learning outcome who are taught under integrative instruction

Table 2: Descriptive analysis of study result data

Statistic data Spatial Intelligence (B)	Instruction model (A) Integrative instruction model(A1) X	Y	Direct instruction model (A2) X	Y
B1 n	10	10	10	10
Mean	59.6	81.76	60	68.24
Minimum	48	73.53	48	55.88
Maximum	68	88.24	68	79.41
Median	60	82.35	60	67.65
Deviation Standard	5.48	4.56	6.53	8.18
B2 n	10	10	10	10
Mean	58.4	62.35	57.6	66.77
Minimum	52	52.94	48	52.94
Maximum	64	67.65	68	76.47
Median	58	63.24	58	69.12
Deviation Standard	4.7	5.15	6.85	7.73
	20	20	20	20
Mean	59	72.06	58.8	67.5
Minimum	48	52.94	48	52.94
Maximum	68	88.24	68	79.41
Median	60	70.59	60	69.12
Deviation Standard	5	11.03	6.63	7.78

Table 3: Tests of between-subjects effects; Dependent Variable: Y

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	2646.518a	4	661.630	22.678	0.000
Intercept	356.853	1	356.853	12.232	0.001
X	544.220	1	544.220	18.654	0.000
A	195.952	1	195.952	6.717	0.014
B	836.970	1	836.970	28.688	0.000
A× B	873.997	1	873.997	29.958	0.000
Error	1021.108	35	29.175		
Total	198431.980	40			
Corrected total	3667.626	39			

a.R^2 = 0.722 (Adjusted R^2 = 0.690)

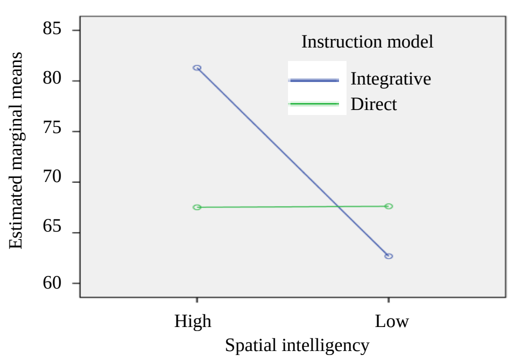

Fig. 2: Graphics of interaction between instruction mode land spatial intelligence towards mathematics learning outcome after being controlled by the prior competence

model on students who have low spatial competence after being controlled by prior is 63.35 while the mean score of mathematic 'learning outcome who are taught under direct instruction model after being controlled by prior competence is 66.77. It indicates that it descriptively shows that there is an effect of interaction between integrative instruction model and direct instruction model towards student's mathematics learning outcome after being controlled by prior competence. Visually, the interaction can be observed on Fig. 2.

The result of ANKOVA counting as presented on Table 3 line of interaction is obtained $F_{count} = F_0(A\times B)$ = 29.958 with significance value = 0.00 and it is lower than α = 0.05. It means that there is a significance effect between instruction model and spatial competence towards student's mathematics learning outcome after being controlled by prior competence. In other words, student's mathematic learning outcome that are taught under integrative instruction model on students who have high spatial competence (A_1B_1) is higher than students who are taught under direct instruction model (A_2B_1) after being controlled by prior competence. Visually, it can be seen on Fig. 3. The result is supported by ANKOVA t-test, in which, $t_{count} = t_{0(A1B1\times A2B2)}$ = 5.708 is higher than t_{table} = 1.74.

Likewise, the student's mathematics learning outcome that are taught under integrative instruction model on students who have low spatial competence (A_1B_2) is lower than students who are taught under direct instruction model (A_2B_1) after being controlled by prior

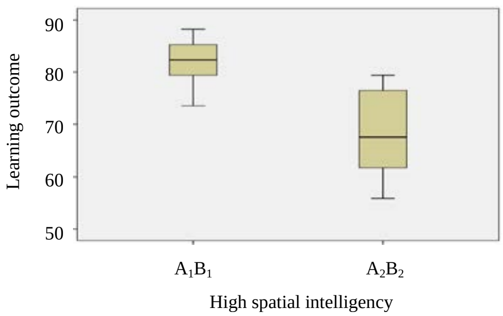

Fig. 3: Student’s mathematics learning outcome who are taught under integrative instruction model on high spatial intelligence and student’s mathematics learning outcome who are taught under direct instruction model after being controlled by prior competence

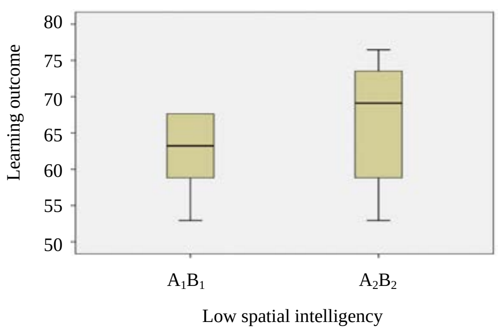

Fig. 4: Student’s mathematics learning outcome who are taught under integrative instruction model on low spatial intelligence and student’s mathematics learning outcome who are taught under direct instruction model on low spatial intelligence after being controlled by prior competence

competence. Visually, it can be observed on Fig. 4. The result of the next test by using ANKOVA t-test is obtained $t_{count} = t_{0(A1B2 \times A2B2)} = 2.041$ is higher than $t_{table} = 1.74$. It indicates that the student’s mathematics learning outcome that are taught under integrative instruction model on students who have low spatial competencies lower significantly than students who are taught under direct instruction model after being controlled by prior competence.

CONCLUSION

Based on the result of study and discussion, it can be concluded as follow: there is significance effect difference of student’s mathematics learning outcome between students who are taught under integrative instruction model and who are taught under direct instruction model, after being controlled by prior competence. Student’s mathematics learning outcome who are taught under integrative instruction model is higher than students who are taught under direct instruction model; there is an effect of interaction between instruction model and spatial intelligence toward mathematics learning outcome after being controlled by prior competence; student’s learning outcome with high spatial intelligence who are taught under integrative instruction model is higher than students who are taught under direct instruction model after being controlled by prior competence and student’s learning outcome with low spatial intelligence who are taught under integrative instruction model is lower than students who are taught under direct instruction model after being controlled by prior competence.

SUGGESTION

This study has several limitations because it just investigates the effect of instructional model and spatial intelligence towards student’s mathematics learning outcome. It needs next researches, mainly studying the factors influencing the student’s mathematics learning outcome, like: using covariate variable that differs to the present study, using moderator variable that differs to the present study and applying other instructional models based on the student’s characteristics.

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