TITLE: Effects of the 21st Century Learning Model and Problem-Based Models on Higher Order

Thinking Skill

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Effects of the 21st Century Learning Model and Problem-Based Models on Higher Order Thinking Skill

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ABSTRACT

The 4.0 industrial revolution is an important topic that is currently being discussed in Indonesia. Industrial revolution 4.0 has an essential influence on education in Indonesia, known as Education 4.0. Instruction 4.0 includes four necessary skills called 4C, namely the ability to communicate, collaborate, think critically, problem-solving, creative, and innovation. The 4C skills are summarised in the form of HOTS (Higher Order Thinking Skill) questions that are currently applied in Indonesia. However, in reality, mathematics learning about the application of HOTS questions made a decline in the national average of student scores. The researcher concluded that students and teachers had not found the right learning model for the HOTS problem. Therefore, the main focus of this research is to apply the 21st-century learning model and problem-based learning models and see how the effects of the 21st-century model and problem-based learning models on HOTS in mathematics. The method of data analysis in this study uses one-way univariate variance analysis.

INTRODUCTION

The Era of Education 4.0 is a big challenge that is hard for teachers and educators in this era. The big problem for teachers in the Education 4.0 era is to prepare students to be able to compete with machine technology. (Whiting, 2018) quote Jack Ma Ceo Alibaba Group statement at the World Economic Forum 2018 annual meeting stated that Education is the toughest challenge of the century, If it does not change the way to educate and teach according to the times, it can be ascertained that in the next 30 years we will experience considerable difficulties.

Challenge Based Learning is a framework for learning while completing real-world challenges (Inc Apple, 2009) This framework is collaborative and direct, involving all participants (students, teachers, families, and community members) to identify big ideas, ask right questions, find and solve challenges, gain in-depth subject knowledge, develop 21st century skills, and share their thoughts with the world. (Nawawi, 2016) Challenge Based Learning learning models include the use of problems in the real world, where students can apply knowledge and problem-solving skills. (Johnson & Adams, 2011) The Challenge Based Learning learning model is a model that combines essential aspects such as problem-based learning, project-based learning, and contextual learning (CTL) that is focused on real problems in the world. (Johnson e. a., 2009) This learning makes problem-solving a significant concern, giving access to 21st-century equipment, requiring students to work collaboratively and manage time under the guidance of the teacher.

PBL learning model is by the purpose of mathematics learning, which focuses on thinking or reasoning, developing creative activities, developing problem-solving skills, and communicating ideas. (Argaw, Haile, Ayalew, & Kuma, 2016) based learning as a learning strategy that simultaneously develops problem-solving strategies, disciplinary knowledge, and skills in placing students in activities to solve problems by confronting structural issues in the form of real problems in everyday life. (Ikman, Hasnawati, & Rezky, 2016) Citing the conclusions of Pierce and Jones in PBL implementation, there is a process that must be raised, such as involvement (involvement), investigation and investigation, performance, general questions and discussion (question and answer). Strengthened by the results of the study, Qomariyah (2018) stated that the PBL learning model had a significant positive impact on the learning outcomes of XI IPS students compared to conventional learning models.

CTL Learning Model is a learning model whose approach can explore student interest and increase activity in the classroom by connecting subject matter content to real-world situations and motivating

students to make connections. In line with the opinion of (Nawas, 2018) which cites the conclusions of Jhonson CTL is a learning model that seeks to associate subject content with real-world situations and motivate students to connect the knowledge, they have with their daily lives. Also, (Nurhadi, Yasin, & Senduk, 2004) concluded that in their study CTL is a learning model that helps students connect substance topics to real conditions and encourages them to make connections between material and that application for their lives. (Surdin, 2018) CTL learning model has advantages such as (1) learning becomes more meaningful and real, meaning students are required to be able to capture the relationship between learning experiences in school and real life. One step of the CTL learning model is an inquiry, where inquiry steps are an essential factor in the learning process. Janah & Subroto (2018) inquiry has a significant influence on students to develop the knowledge they have understood, foster student creativity and stimulate students to learn to express their opinions, provide comprehensive experiences, facilitate students to learn to improve student learning outcomes.

How do we measure that the model is said to be successful in improving the quality of capabilities needed in the 21st century? Before we discuss this, 21st-century capabilities can be measured by seeing how students can communicate, collaborate, think critically, do problem-solving, have creativity and innovation. The ability to communicate, collaborate, think critically, do problem-solving, have creativity, and change can be measured by seeing how the students' high-level thinking skills value in mathematics. By learning mathematics, these abilities can be easily measured because mathematics is learning that needs the ability to think critically. The ability to think higher or commonly known as HOTS is a thought process that requires students to manipulate information and ideas in specific ways that give them new insights and implications (Gunawan, 2012).

HOTS is a process of thinking students in higher cognitive levels developed from various concepts and cognitive methods and taxonomy of learning such as problem-solving methods, bloom taxonomy, and taxonomy of learning, teaching, and assessment (Saputra, 2016). HOTS is a way of thinking that is no longer just verbalistic memorisation but also means the essence of what is contained, among other things, to be able to interpret the meaning that is integralistic thinking by analysing synthesis, associating to conclude the creation of creative ideas and products (Ernawati, 2017). HOTS involves the ability to solve problems, the ability to think creatively, think critically, the ability to argue, and the ability to make decisions guided by truth ideas, each of which has meaning. Therefore, it can be concluded that HOTS in this study is a high-level thinking ability that is not just remembering, restating, or referring without processing, but high-level thinking skills to critically analyze information, transfer one concept to another, creative, creative and able to solve problems based on ideas or ideas constructed from within the students themselves based on real issues.

The most common taxonomy of learning in the cognitive domain is the taxonomy of bloom. In the table. 1. (Anderson, Lorin W; Krathwohl, David R, 2010) classify the dimensions of the thinking process as follows.

Table. 1. Dimensions of the Thinking Process

H OTS	Creative (C6)	• Create your ideas/ideas • Verbs: construct, design, create, develop, write, formulate
	Evaluate (C5)	• Make your own decisions • Verbs evaluate, judge, refute, decide, choose, support
	Analysing (C4)	• Specify aspects / elements • Verbs: compare, examine, criticise, test

High-level thinking skills in this study are at the level of reasoning that includes the dimensions of the thinking process of analysing (C4), evaluating (C5), and creating (C6).

The work steps of the Challenge-Based Learning, (Premsmith, Jakkrit; Wannapiroon, Panita; Nilsook, Prachyanun, 2016) learning model that follow Apple inc as follows:

Big Idea	Guide Sources	Solution
Important Questions	Guide Activities	Evaluation and Assessment
Challenge	Guide Questions	Publication
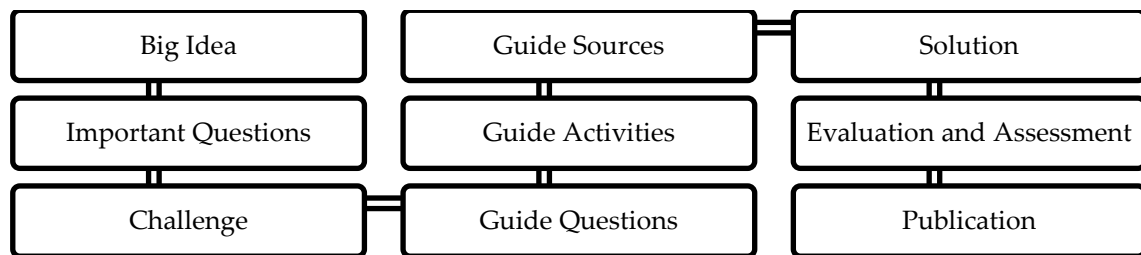
Situation of the Problem

Based on the results of the research and observation of the teacher and students, they still have not found the right way of learning in teaching and learning mathematics that is fun and gives sensations. Dull and rigid learning is very often seen, especially in remote areas. The learning model used only directly without encouragement for students to be able to show their strengths. Therefore, it is essential to research to find ways in which teachers and students find harmonious relationships in the teaching and learning process that are mutually beneficial to each other. The learning model that will be used is a factor that needs to be considered in the teaching and learning process because of that, the relationship between the teacher and students can be formed.

Aim of the Study

The purpose of this study was to find out how the effects of the 21st-century learning model and problem-based learning models on students' high-level thinking abilities. Therefore there will be experimentation on challenge-based learning models, problem-based learning, and contextual teaching and learning.

METHOD

This study is quasi-experimental research (quasi-experimental research), namely research conducted intentionally to try the independent variables to determine the differences in the use of cooperative learning models type CBL, PBL and CTL on HOTS students. Experimentation of challenge-based learning, problem-based learning, and contextual teaching and learning will be conducted to 9 classes with a total of 279 students. The study sample was a grade VIII junior high school student, with an age range of 14-15 years (sample features can be seen in Table 2). Before testing, it is necessary to do a balance test on students 'high-level thinking abilities to see how students' fundamental skills. The balance test was conducted to determine the strength of senior thinking students to use the pretest instrument, which included the student HOTS indicator. After a balance, an analysis is carried out, and the population has the same balance, the initial conditions are met. After that, the challenge-based learning model experiment and other models were carried out for four months in the study sample, at the end of the lesson, HOTS students were tested for the data to be tested. Other test requirements that will be carried out are the normality test, data homogeneity test, variance analysis test, and multiple comparison test, which is a test requirement for univariate one-way variance analysis.

Table 2. Sample Information

School Name	CBL		PBL		CTL		Total
	Class	Total	Class	Total	Class	Total	
SMP N 8 Surakarta	VIIIE	32	VIIIF	30	VIIIG	32	94
SMP N 16 Surakarta	VIIIC	32	VIIID	30	VIIIE	32	91
SMP N 26 Surakarta	VIIIA	30	VIIIB	31	VIIIC	30	94
Total		94		91		94	279

RESULT, DISCUSSION, AND SUGGESTIONS

Research data will be summarised in the table, which will be shown below. The summary analysis of the data is the balance test results, normality test results, homogeneity test results, results of variance analysis, and the results of multiple comparisons.

Table 3. Independent Samples Test Results

| | | HOTS | |
		Equal variances assumed	Equal variances not assumed
Levene's Test of Equality of Variances	F	.017	
	Sig	.898	
t-test for Equality of Means	T	-.032	-.032
	Df	183	182.946
	Sig. (2-tailed)	.975	.975
	Mean Difference	-.04793	-.04793
	Std. Error Difference	1.52073	1.52073
95% Confidence Interval of the Difference	Lower	-3.04835	
	Upper	2.95249	2.95174

Based on table 3, Levene's Test for Equality of Variances value on HOTS variable $Sig > 0.05$, therefore, H0 is not rejected which means because the probability value (significance) HOTS with equal variance assumed is 0.898 greater than 0.05, so it can be concluded that the ability beginning of the same student.

Table 4. Normality Test Results

Tests Of Normality				
		CBL	PBL	CTL
N		94	91	94
Normal Parameters	Mean	77,0213	65,5495	54,6809
	Std. Deviation	9,84610	9,44136	9,94091
Test Statistic/L Max		,083	,088	,083
Liliefors Table		,091	,093	,091

Based on table 4, obtained L Max CBL = 0.083 less than critical area L(0.05; 94) = 0.091 then the decision of the H0 test is accepted, and the CBL population is normally distributed. Obtained L Max PBL = 0.088 less than critical area L(0.05; 91) = 0.093 then the decision of the H0 test is accepted, and the PBL population is normally distributed. Obtained L Max CTL = 0.083 less than critical area L(0.05; 94) = 0.091 then the decision of the H0 test is accepted, and the CTL population is normally distributed.

Table 5. Homogeneity Test Results

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
HOTS	Based on Mean	,332	2	276	,718

Based on table 5, the value of p-value = 0.718 is higher than the cost of α = 0.05 because p> α, it can be concluded that homogeneity of variance is accepted, the variation of data in the CBL model, PBL model, and CTL models are the same.

Table 6. Results of Variance Analysis (ANOVA)

ANOVA					
HOTS					
	Sum of Square	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	24840,650	,332	12420,325	129,125	,000
Within Groups	26538,059	276	96,189		
Total	51388,710	278			

Based on table 6, it can be seen that H0 is rejected at α = 0.05 because p = 0.000 <0.05, it can be concluded that the three learning models have different effects.

Table 7. Multiple Comparison Results

Multiple Comparisons						
Dependent Variable: HOTS						
Scheffe						
(I) Model Pembelajaran	(J) Model Pembelajaran	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CBL	PBL	12,11012[*]	1,44232	,000	8,5604	15,6598
	CTL	22,97872[*]	1,43058	,000	19,4579	26,4995
PBL	CBL	-12,11012[*]	1,44232	,000	-15,6598	-8,5604
	CTL	10,86860[*]	1,44232	,000	7,3189	14,4183
CTL	CBL	-22,97872[*]	1,43058	,000	-26,4995	-19,4579
	PBL	-10,86860[*]	1,44232	,000	-14,4183	-7,3189

*. The mean difference is significant at the 0.05 level.

Based on table 7. It can be concluded that:

(1) Between PBL models and CBL models have a mean difference of -12.11012. Shows that HOTS's ability with the CBL model is more effective than the PBL model.

(2) Between the PBL model and the CTL, the model has a mean difference of 10.86860. Shows that HOTS's capabilities with PBL models are more effective than CTL models.

(3) Between the CBL model and the CTL model, it has a mean difference of 22.97872. Shows that HOTS's capabilities with the CBL model are more effective than the CTL model.

Based on some of the explanations above, the CBL learning model has a positive impact on high-level thinking skills (HOTS) significantly compared to PBL and CTL learning models.

Based on the test results described above the 21st-century learning model is very appropriate to be applied in learning, accurately the challenge-based learning model. Based on this study, the challenge-based learning model gives HOTS students significantly better than other models with an average difference of 12.11012 when compared to the PBL model and a mean difference of 22.97872 when compared to the CTL model. Therefore, educators need to know the application of appropriate learning models is very important in the 21st century because if there is no suitable learning model, future generations will have difficulty facing the development of the 21st century. Researchers suggest applying the challenge-based learning model on mathematics subjects that are used in everyday life, examples of geometry, series, graphs, and systems of linear equations. Because of the limitations of the researcher, it is expected to conduct extensive research again to also pay attention to the student attitude variable towards the challenge-based learning model because it allows there to be other influences from the student attitude variable towards the challenge-based learning model towards HOTS.

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