

THE EFFECT OF LEARNING MODELS AND CRITICAL THINKING SKILLS TOWARD MATHEMATICS ACHIEVEMENT BY CONTROLLING STUDENTS' NUMERIC APTITUDE

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ABSTRACT

This research is to determine the effect of learning model and critical thinking skills toward mathematics learning achievement of class XI IPA students in senior high school in Gianyar by controlling students' numeric aptitude. This research used treatment by level 2x2 design and analysis of covariance. The sample was 80 people using multistage random sampling. The results by controlling numeric aptitude are: students learning achievement taught using PAIKEM model is higher than those taught in conventional model. There is an interaction effect between learning model and critical thinking skills toward students' mathematics achievement. Given high critical thinking skills, students taught using PAIKEM models displayed higher results compared to those in conventional learning who were best in a lower critical thinking skills. Finally, based on the results, it can be recommended to SMA Mathematics teachers to increase students' Mathematics achievement by using PAIKEM model accurately and to see of students critical thinking skills.

Keywords: *learning models, critical thinking skills, numeric aptitude mathematic achievement.*

Mathematic is one of subjects taught from Elementary school until higher learning. It is expected to be one of means to increase student's intelligent so that they are able to uplift their capability to apply mathematic in solving problem. There are many reason why student need learning mathematic, such as: (1) to train the way of thinking and reasoning to summarize, (2) to develop creative activity which involve imagination and curiosity, (3) to develop the capability in solving problem, and (4) to develop the capacity of communicating idea, by oral, graphical, map, or diagram.

Having a lot of beneficiaries from learning mathematic, it should be a favourite subject among the students. In fact, there are frequent complain and discontentment on the student learning mathematic until now. The student commonly say that mathematic is difficult, uninteresting, boring, greatly misterious, evenmore supposed to be separated from daily life. Many of them do not comprehend the benefit of mathematic. Therefore, many students do not like mathematic, moreover hate it. The impact is the student's achievement of learning mathematic have not maximum yet.

This matter is also evident among the students of Senior High School in Bali, included at State Senior High School in Gianyar Regency. The average preliminary examination remarks of mathematic in Bali which is the barometer the student's rate for the further national test, indicate unoptimum mathematical marks. Shown in table 1 below:

Tabel 1. The average Preliminary-Exam Remark of Mathematic by Senior High School in Bali Province.

Department	Year of study	2010/2011	2011/2012
Language Class		3,77	4,24
Science Class		7,27	6,15
Social Class		2,94	3,40

In Gianyar itself, as the population of this research target, for the year learning period of 2012/2013, indicate the preliminary exam on mathematics is still low. Based on the data from Education Youth and Sports Department of Gianyar, for Language Department has average marks of 3,42, IPA department of 4,62, and IPS department of 2,70.

The non-optimum student's achievement on mathematics caused by many factors, one of them is supposed to be the insufficient learning process. The class orientation of learning is often led to quantity of learning matter. Teacher's point of view is that his main job is to complete subject matter noted in the textbook without seeing student's comprehension on the matter they learned. Related with this condition, Arends noticed by Trianto say that "in teaching process the teacher always insists the student to learn and rarely teach them on how to learn. The teacher asks the student to solve problem, but never teach them on how to solve the problem." Then, the student often comprehend the matter merely as much as they got from the teacher without being able to further improve it. This situation often made them experience difficulty in learning process.

From the above description, it seems any significant gap between the hopes of learning mathematics and the reality achieved. As at one side, mathematics is greatly needed to improve reasoning and could train student to be able to think logically, critical, systematic, and creative, but on the other hand, there are still so many student does not like mathematics which made their achievement is not maximum. Thereby, it is very important to create innovation in learning to make it meaningful, so that student have more ability to solve the problem put on their head.

Seeing the importance of mathematics in the school, an exact strategy is greatly needed in learning mathematics to meet the targeted purpose. The government has made many efforts for innovation in education, such as: to improve teacher quality through trainings, education seminar, upgrading education, as well as mathematics learning innovation. This innovation made mathematics learning is more highlights. Meaningful learning is learning process by connecting new information or knowledge with the structure already owned by someone being learn. Hence, meaningful learning done when the concept or the matter presented in the form of contextual problems and completed by contextual approach too. A contextual problem is a matter that related with a real world of the student or at least close the real condition. Correlated with this terms, Narohita, in his research of mathematics learning, indicated that contextual approach will bring a natural learning process in the form of working activity, and a meaningful learning is not knowledge transfer from teacher to student. By this process, give

possibility for student to do a variety learning activity to develop skill, attitude, and understanding the material received from various sources and helping tools to make a more interesting, enjoyable, and effective learning. This process put the student as the center stage performance. This process is stressing more on the student as a human beings with awareness, understand their importance of interaction with the environment.

Together with the development of constructivism philosophy in education, appears a critical opinion to apply learning innovation in order to bring active, innovative, creative, effective, and comfortable learning process. Active is learning being able to create such a situation so that student is actively ask, exam, and express his idea. Innovative is a meaningful learning happens if the process could facilitate student's chance to innovate something through learning activity being done. Creative is a process that could develop critical thinking as it enable him to develop creativity. Effective is the process refers to an effective and efficient learning for all components organized to achieve the goal. Enjoyable is a process that make student not feels suffer doing it, whereas it is a grateful grace. Enjoyable learning make student go through the process sincerely. Later on, this learning process frequently named as a learning process with PAIKEM nuance, namely active, innovative creative, effective, and enjoyable learning. The essence of PAIKEM is competency-based learning that is learning with orientation on student competency achievement. The tip point of this learning process is to develop student's competency which could be measured from attitude, knowledge, and skill.

This terms correlate with Permendiknas Number 41, year 2007 about process standard for Elementary and Secondary Education, which state that the core activity is a learning process to achieved KD. The learning activity is done in the way of interactive, inspirative, enjoyable, chalanging, and motivate student to be actively invloved, and give an enough space for initiative personal, creativity, and self-reliance in accordance with student's interest, aptitude, physical and psychological growth. This activity run in a systematical and systemic way, through explorative, elaborative, and conffirmative process.

Seeing from philosophical aspect of school function as a media to prepare student so that he could live in the society, the PAIKEM nuance of learning is an important learning to apply. In the context of education quality improvement, this method is one of learning models that could be used to improve the learning system. By this method, student also will learn to evaluate problem, identify problem he needs to know, collecting information and make collaboration to evaluate a hypothesis based on the data they collected. Therefore, student will be fully trained to use his thinking capacity to solve problem scientifically. It makes learning process more meaningful. The meaningful learning will impact on memory power and student understands for a higher concepts. It will be saved in a long run memory and it surely gives positive effect on learning result.

The success in learning mathematic depends also on student's critical thinking skill. Critical thinking skill is a mental activity to formulate or solve problem, efforts of making decision, understanding something, finding an

answere for some matters, and take a central point of anything. This thinking pattern develop a logic thought, believable, brief frame of mind and make sure which terms needed in solving problem. Anybody will be successful in whatever subject matter if he has a critical mind. This skill of mind commonly recognized as an important and inseparable education goal, and supposed to be an intended result of human activity.

Other than all factors stated above, there is internal factor of student for his success in learning mathematic called numeric aptitude. It is one of student's aptitude, being able to operate mathematical counting, such as plus, minus, divide, and multiple. If a student has aptitude in number counting operation, then he will be quicker mastering, understanding, and operate mathematic. Number domination is so strong term. It means the student will be able to achieve a better mathematic learning result. This is supported by research by Samiati, it indicated that numeric aptitude give important effect in learning process, and learning result. In this research numeric aptitude roles as a controlling variable (covariable).

The purpose of this research is to recognaize the influence of PAIKEM learning model and critical thinking skill on the result of student's learning mathematic of class XI IPA SMA Negeri in Gianyar regency by controlling numeric aptitude.

METHOD

This research run at SMA Negeri in Gianyar regency, Bali Province. It is done at two places of SMA Negeri, namely: SMA Negeri 1 Ubud and SMA Negeri 1 Payangan, two of them located in Gianyar regency.

Sample is taken as many as eighty students by multistage random sampling. This research is a kuasi eksperiment with treatment by level 2x2 and use two terms covarian analysis. Analysis design shown as Picture 1, as below.

Learning Model (A) Critical Thinking Skill (B)	PAIKEM (A ₁)	Conventional (A ₂)
High (B ₁)	(X, Y) _{11k} k= 1,2..... n ₁₁ (A ₁ B ₁)	(X,Y) _{21k} k= 1,2..... n ₂₁ (A ₂ B ₁)
Low (B ₂)	(X, Y) _{12k} k= 1,2..... n ₁₂ (A ₁ B ₂)	(X, Y) _{22k} k= 1,2..... n ₂₂ (A ₂ B ₂)

Picture 1. Research Design Chart

The data collected use the mathematic learning result test, critical thinking skill test, and standard Differential Aptitude Tests (DAT). Mathematic learning result test developed as many as 32 terms, critical thinking skill as many as 31 terms. This test have been through content validation evaluation by eight panelists with content validity ratio/CVR $\geq$

0,75, empirical validation exam and each reliability are 0,771 and 0,915. The data analysis technique used in this research is involving descriptive analysis, analysis on requirements test, and inferencial analysis. All of these three analysis based on the data numeric aptitude score and mathematic learning result score after the learning model and critical thinking skill applied.

RESULTS AND DISCUSSION

Research hypothesis is examined with inferencial analysis through SPSS 16.0 application program. Analysis model used in this research is covariance analysis (Ankova), by applying the procedure of GLM Univariate for testing the main effect factor and interaction effect factor on mathematic learning result after controlling student's numeric aptitude. The further test apply t-test to see the differences of average parameter on mathematic learning result for all group formed by learning model factor (A) with critical thinking skill factor (B) by controlling student numeric aptitude as consequence of factor effect and significant interaction factor. Based on the result of Ankova count using SPSS 16.0 program, lead the result shown by table 2 below.

Table 2. Statistic F-test about A,B, A*B on Mathematic Learning Result by Controlling Numeric Aptitude

Source	Type III Sum of Squares	d f	Mean Squar e	F _{hitu ng}	F _{tabel} ($\alpha=0.05$)
Corrected Model	600,540 ^a	4	150,135	31,440	3,968
Intercept	2884,877	1	2884,877	604,124	
X	122,302	1	122,302	25,611	
A	20,138	1	20,138	4,217	
B	20,436	1	20,436	4,280	
A * B	198,376	1	198,376	41,542	
Error	358,148	75	4,775		
Total	47279,000	80			
Corrected Total	958,687	79			

Table 3. Average uncorrected or Average Corrected Mathematic Learning Result in Each Group Formed by Learning Model Factor and Formative Test Form

Learning Model (A)	PAIKE M (A ₁)	Conventional (A ₂)	Total
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Critical Thinking Skill (B)			
High (B ₁)	26,783	22,549	24,666
Low (B ₂)	22,388	24,529	23,459
Total	24,586	23,539	-

1. Mathematic Learning Result in Group Experience PAIKEM Learning Model is Higher than The Group with Conventional Learning Model by Controlling Numeric aptitude

The statistic Hypothesis is:

$$H_0 : \mu * A_1 \leq \mu * A_2$$

$$H_1 : \mu * A_1 > \mu * A_2$$

Symbol $\mu * A_i$, state average corrected of Y variable. Statistic value F-test on table 2, got value $F_{count} = 4,217$, more than $F_{table} = 3,968$ so H_0 is refused or H_1 is accepted, it means that any difference of mathematic learning result between the group of PAIKEM learning model and the group of conventional model, by controlling numeric aptitude. It is evident on the different result of mathematic learning between student experience PAIKEM learning model and conventional learning model by controlling numeric aptitude, furthermore the comparison of corrected average value of mathematic learning on both group.

Based on Table 2, shown corrected average score of mathematic learning result on the group experience PAIKEM learning model is 24,586, while the corrected average score of mathematic learning on the group of conventional learning model is 23,539. Thus, we can summarize that mathematic learning result on the group apply PAIKEM learning model is higher than the group with conventional learning model by controlling numeric aptitude.

PAIKEM learning method actively involve student in learning process, start from planning, application until valuation process. PAIKEM method applied by seeing student's ability, so that it enable student motivated for continuously study and contained much with real problem correlation. The learning process centre on vision and examination over daily phenomena or events, in order to enable student to understand learning entities from all sides. Next, it will create a more active and wise student facing the existed reality.

Whereas, conventional learning model is a *teacher centered* method. In Mathematic learning using conventional model emphasize more on teacher function as information feeder. The teacher tightly manage the learning process either on theme, quality, or strategy. In this method the teacher stress more on his job as a model. The goal will be completely achieved if the teacher could exactly demonstrate knowledge and skill so that the student could imitate. The student will passively listens to his teacher's explanation without actively involved. The description of mathematic concept or principle have been designed in such a way by the

teacher, start from theory or definition or theorem, examples and exercise. The job is tightly managed according to the time set.

Compare to conventional model, then PAIKEM model seem focus more on student's involvement in learning, so that student actively involve in the learning process and value in making decision. It is coincidence with curriculum which stated that student's learning experience take an important place for the efforts of improving graduation quality.

Based on the above description it clearly seen that PAIKEM method is better applied for the student than conventional one. PAIKEM method make all senses involved along the learning process. That is why, the learning result is higher on PAIKEM method than conventional one.

2. There are Interaction Effect Learning Model and Critical Thinking Skill on Mathematic Learning Achievement by Controlling Numeric Aptitude

Based on hypothesis test result both of these research indicate interaction effect between learning model and critical thinking skill on mathematic learning achievement by controlling numeric aptitude. This research shown the interconnecting effect between learning model and critical thinking aptitude on the mathematic learning achievement. It is shown by the analysis result by the value $F_{\text{count}} = 41,542$ and value $F_{\text{table}} = 3,968$. This finding informs that this research data support the truth of hypothesis proposed. The conclusion is supported the result of corrected average score in which found reverse connection effect.

Table 3 shown that student whose high critical thinking skill, the corrected average score of mathematic learning achievement for student experience .PAIKEM model is = 26,783 and student with conventional model is = 22,549. It leads to conclusion that student with high critical thinking skill, the mathematic learning achievement with PAIKEM model is higher than student with conventional learning model.

Moreover, student with low critical learning skill, corrected average score of mathematic learning achievement with PAIKEM model is = 22,388 and corrected average score of mathematic learning achievement with conventional model is = 24,529. It shown that mathematic learning achievement of student with conventional model is higher than student with PAIKEM model.

This hypothesis test is supported by the theory that in learning process there is important thing the teacher should be care of. It is the material subject presented to student should be creatively explained, like using an exact learning model relate with the subject. Student's critical thinking skill is also need to be considered for choosing an exact learning model. The contribution of critical thinking skill on learning achievement is shown by research by Samiati. It is said that there is a significant contribution of critical thinking capacity on learning achievement. Therefore, Teacher should pay attention on student's critical thinking skill in applying learning model.

The above description shown that for student with high critical thinking skill, PIKEM learning model is better than conventional model to improve mathematic learning achievement. While, for student with low critical thinking skill, conventional learning model is better than PAIKEM model in improving mathematic learning achievement.

The reason of this result is in PAIKEM model, the prominent activity is the student's freedom to express his informal knowledge through some contextual problems as the initial learning process. The student is fully involved in the process of refinding and reformulating concepts with the teacher's guide. PAIKEM model perform real context as the opening of learning process. Student has freedom to express his idea for learning and solving problem. Besides, it emphasizes more on real world. By stressing on real world, student clearly sees the benefit in daily life. The questions are more open, it means having many ways out in accordance with the existed contexts. PAIKEM Model is greatly good applied for student high critical thinking skill because he tends to use reasoning, logic, and his ideas in solving problem and has a chance to give open answers which is not focus on one manner of solving problem.

While for mathematic learning applying conventional model, the learning process is more stressing on teacher function as an information feeder. Conventional learning is a *teacher centered* process of learning. The teacher tightly manages the process either about the theme, quality, or strategy. The goal is optimally achieved if the teacher enable to demonstrate the knowledge and skill before the student in a right way. On the other side, the student passively listen to the teacher's explanation without actively involved in the learning process. The explanation of mathematic concept/principle has been designed in such a way by the teacher, start from theory/definition/theorem, with some examples, and exercise. The job is tightly prepare as per time setted. This model fits for student with low critical thinking skill, as such a student tend to be not creative and receive the subject limited merely on the teacher's explanation, without any efforts to meet another choice in solving the problem.

From the above description, each model has the same direction that is to achieve the learning purpose. The goal will be met if teacher and student feel a meaningful learning process. It happens when the learning process follows learning steps connect to the characteristic of model applied. So that the optimum achievement could be met.

Seeing the above description, we found that there are some strength and weakness of each model depends on the level of student's critical thinking skill. In the learning process, the teacher had better to consider the student condition. The student with high critical thinking skill is better with PAIKEM model, while student with low critical thinking skill is better with conventional model.

As the truth of interaction hypothesis is significantly proved, then need to do further test or simple effect hypothesis test. For the result of simple effect hypothesis is shown in table 4 below.

Table 4. Parameter Estimation for Simple Effect Hypothesis Test

Parameter	B	Std. Error	T _{count}	t _{table} ($\alpha=0,05$)
Intercept	20,578	0,764	26,933	
X	0,228	0,045	5,061	
[B=1,00]	-1,980	0,733	-2,703	
[B=2,00]	0 ^a	-	-	
[A=1,00] [B=1,00]	4,234	0,725	5,837	1,725
[A=1,00] [B=2,00]	-2,142	0,694	-3,085	
[A=2,00] [B=1,00]	0 ^a	-	-	
[A=2,00] [B=2,00]	0 ^a	-	-	

3. For The Group of Student with High Critical Thinking Skill, Mathematic Learning Achievement of The Student with PAIKEM Model is Higher than Student with Conventional Model by Controlling Numeric Aptitude

The Statistic Hypothesis is as follows: $H_0 : \mu^*_{A1B1} \leq \mu^*_{A2B1}$; $H_1 : \mu^*_{A1B1} > \mu^*_{A2B1}$; symbol μ^*_{AiB1} , $i = 1$ and 2 , state Y variable corrected average. Analysis result in table 4, state that statistic value –test got from value $t_{count} = 5,837$ is more than $t_{table} = 1,725$ on the signficancy level $\alpha = 0,05$. So, H_0 is refused and H_1 is accepted, means that for student with high critical thinking skill, the mathematic learning achievement of student with PAIKEM model is higher than student with conventional model by controlling numeric aptitude. The statement is empirically tested by the data and supported by the result of corrected average statistic score shown in table 3. Specific for the group with high critical thinking skill, the corrected average of mathematic learning achievement with PAIKEM model is = 26,783 higher than with conventional model is = 22,549.

The application of PAIKEM model for student with higher critical thinking skill give a chance to student to be able to explore his ability so he could optimally develop his capacity as student with PAIKEM model is actively involved to find and understand the concepts of the subject learned and have a chance to examine what he have done. It would be more meaningful felt as the student get involved for the whole process.

While student with high critical thinking skill would be bored and feel blocked with conventional model as he could merely receive the subject explained by the teacher. Student has no chance to completely explore himself so the learning achievement is not maximum.

Seeing the above explanation it seems that PAIKEM learning model give student a chance to develop his ideas which involve all five senses. Conventional model stress more on teacher ability in providing extrinsic motivation to the student. Student seems passive, as all has been managed by the teacher. It could be concluded that student with high critical thinking skill, has higher value with PAIKEM model than student with conventional model by controlling numeric aptitude.

4. For Student with Low Critical Thinking Skill, Mathematic Learning Achievement for the Group with PAIKEM model is lower than the The Group with Conventional Model by Controlling Numeric Aptitude

Statistic Hypothesis is as follows: $H_0 : \mu^*_{A1B2} \geq \mu^*_{A2B2}$; $H_1 : \mu^*_{A1B2} < \mu^*_{A2B2}$; Symbol μ^*_{AiBj} , $i = 1$ and 2 , state Y variable corrected average. Analysis result in table 4, shown that statistic value t-test got value $t_{count} = -3,085$ less than $t_{table} = 1,725$ on the signfinacy level $\alpha = 0,05$. So that, H_0 is refused and H_1 is accepted, it means that for student with low critical thinking skill, mathematic learning achievement with PAIKEM model is lower than student with conventional model by controlling numeric aptitude. The statement is empirically tested by the data and supported by the result of corrected average statistic score shown in Table 3. Specific for the group with low critical thinking skill, corrected average of mathematic learning achievement with PAIKEM model is = 22,388. It is lower than the group with conventional model by = 24,529. It indicate that for student with low critical thinking skill, the mathematic learning achievement with conventional model is higher than the group with PAIKEM model.

The application of PAIKEM model on student with low critical thinking skill make student feels stress, because PAIKEM model insists student to optimally develop his ability. Student is directed to every day life problem, and he is expected to develop concepts connected to the problem being faced. Student is forced to be actively involved to find and understand the concept of subject matter, and enable to judge what he has done. Hence, the learning process centres to the student. For the student with low critical thinking skill it is a difficult things to do as he tends to just accept the subject matter given by the teacher without any intention to criticize the problem.

While, when student with low critical thinking skill will feel happy with conventional model as he used to be with guided learning process. If student feels happy with what he is doing it will drive him to be knowledgeable. So, conventional model fits more with student by low critical thinking skill.

It could be concluded that student with low critical thinking skill, the mathematic learning achievement is lower by PAIKEM model than student with conventional model by controlling numeric aptitude.

CONCLUSION

After research data collected by using parameter instrument composed by researcher, test is done on the four research hypothesis. From the

hypothesis test result by using covariance analysis followed by difference test, it could be concluded as follows: (1) Mathematic learning achievement of student group apply PAIKEM model is higher than the group with conventional learning model by controlling student's numeric aptitude; (2) There is interaction effect between learning model and critical thinking skill on mathematic learning achievement by controlling student's numeric aptitude; (3) For the student with high critical thinking skill, the mathematic learning achievement of student apply PAIKEM model is higher than student with conventional model by controlling student's numeric aptitude; (4) For student with low critical thinking skill, the mathematic learning achievement of student with PAIKEM model is lower than student with conventional model by controlling student's numeric aptitude.

This research show that mathematic learning achievement of student apply PAIKEM model is higher compare to the group with conventional model, so learning model is one of rulling factors to improve mathematic learning achievement. Besides, the level of student's critical thinking skill could influence the learning achievement, especially on student of class XI IPA SMA Negeri in Gianyar regency. The success of learning process so much depends on the teacher's capability in applying the learning model which could be adjusted with the characteristic of the mathematic subject matter and with consideration of student's critical thinking skill.

Remembering that mathematic learning achievement is affected by the model and critical thinking skill, so the application of mathematic learning should be oriented on the matter characteristic, need, and the student's critical thinking skill. Hence, teacher is expected to be able to identify on matter characteristic and student's critical thinking skill, so that the applied learning process refers to that need.

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