

# EFFECTIVENESS OF QUANTUM LEARNING FOR TEACHING LINEAR PROGRAM AT THE MUHAMMADIYAH SENIOR HIGH SCHOOL OF PURWOKERTO IN CENTRAL JAVA, INDONESIA

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**ABSTRACT:** For most Indonesian students, Mathematics is still regarded as a difficult and scaring subject compared to other subjects. Therefore, there should be a learning strategy which can empower all the available potential to achieve the learning objectives as a whole. In relation to the learning process of Mathematics, the choice of learning strategy is also based on the achievement of the learning objectives. One way of realizing that is through the use of quantum learning. The aim of this research is: (1) to find out the effectiveness of quantum learning for teaching Mathematics; and (2) to analyze the difference the result of quantum learning and that of the conventional one. Two classes of grade X were randomly taken as sample out of five available, one class being the experimental group and the other control. This random sampling was due to the fact that students are distributed evenly on ability basis. Data was taken using test and non-test techniques (observation and questionnaire). To find out the effectiveness of this quantum learning, descriptive analysis was used toward: (1) student's activity during the learning process; (2) the teacher's ability in managing the learning process; (3) student's response toward the learning model; and (4) the student's mastery. While ANAKOVA inferential analysis was used to test the difference on the learning achievement. The result of the two analysis were that quantum learning was effective and there was significant difference in which the quantum learning gave a better learning achievement than the conventional one.

**KEY WORDS:** Teaching and learning effectiveness, Mathematics subject, quantum learning concept, and modern and conventional learning.

## INTRODUCTION

For most Indonesian students, Mathematics is still regarded as a difficult and scaring subject compared to other subjects. The result of PISA (Programme of International Student Assessment) and TIMSS (Third International Mathematics and Science Study) over several periods shows that the ability of Indonesian students is below than of the international students. Indonesian students can only

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solve low-category questions, and even there is almost no student can answer high thinking question (Muhaimin, 2001). This shows that the quality of Mathematics learning in Indonesia is still low.

This low quality of Mathematics learning, according to Marpaung (2001), is due to the fact that teachers mostly use the paradigm of uniformity in terms of curriculum, learning process, as well as the test items regardless of students' difference. According to Degeng (2001:1) this is due to centralized, monolithic, and uniformed way of thinking of most Indonesian teachers.

In general, out of the desire to meet the demands of curriculum, teachers tend to pour as much information as possible to students, where concept, principles, and rules of Mathematics are presented as something finished. Students are given test samples and their solution, and then given exercises in which they will use the formula that have been previously given. Concept, principles, and rules of Mathematics seem to be meaningless, and presented as something mechanistic just for the sake of solving test items (Soedjadi, 2001). This has caused the students not to be able to develop their reasoning, communicating, and understanding of Mathematics.

Therefore, there should be a learning strategy which can empower all the available potential to achieve the learning objectives as a whole (Kusno, 2002). In relation to the learning process of Mathematics, the choice of learning strategy is also based on the achievement of the learning objectives. According to R. Soedjadi, the objective of Mathematics learning in the future should pay attention to: (1) the formal objective, the establishing of reasoning system and personal development of the students; and (2) the objective which material in nature, the application of Mathematic and Mathematical skill (Soedjadi, 1994:20). While Davis (in Suryanto, 1987) give more emphasis on the effort to thinking exercise and communication.

To make that a reality students always have to be in ideal condition, knowing what they are going to learn, realizing its importance for their lives, being optimistic that they are going to succeed, even having a plan of what they are going to do. For this, they should be opportunity to express themselves. Teachers only add or reduce what they already have where necessary so as not to deviate from the initial learning objective. One way of realizing that is through the use of quantum learning.

Quantum model of learning is one used as a guide in planning and executing classroom learning which include the strategy called, in Indonesian language, *TANDUR* (*Tumbuhkan* – grow, *Alami* – experience, *Namai* – give a name, *Demonstrasikan* – demonstrate, *Ulangi* – repeat, and *Rayakan* – celebrate), context, content, principle, and main paradigm. Quantum learning is a combination of various interactions which are available in the learning moment. This interaction covers all element which effective in enabling students' success (De Porter, 2000).

In quantum learning, what is meant by *Tumbuhkan* – grow, is to grow students' interest by answering the question of *AMBAK* – an acronym of “*Apakah Manfaat BAgiKu*”, how is it useful for me, and also for the students. Finding the *AMBAK* is

creating interest in the part of the students toward what is being learned and relate it to the real world, and also creating optimism in learning. This is expected to arouse the students' need of learning and strong determination for its success.

What is meant by *Alami* – experience, is providing students with learning experience before a material is taught so that there appears a natural desire to explore (De Porter, 2001). In this phase, teacher gives the students a game to play so that student can understand Mathematics in meaningful way, because Ausubel (in Dahar, 1996) says that new information will be related with cognitive structure which is already present. By playing game, student will also have enjoyable situation so that can occur eliminating mathematics *phobia*.

What is meant by *Namai* – give a name, is an effort to satisfy the natural urge of mind to name, order, and define by giving opportunity to the students to construct knowledge in the form of concept, principle, and thinking skills based on the game the students have played. In this case, teacher can help the students by giving guiding questions, examples, illustration, and so on according to each concept. According to Bruner (in Slavin, 2000) through active participation, students can find the concepts and principles which is the material of the lesson.

What is meant by *Demonstrasikan* – demonstrate, is providing students opportunity to show that they know. Students are given a chance to translate what they know into a case, events, and other learning into their lives. For example, they are given a problem to solve of which the solution is to be demonstrated to their classmates. Here, the teachers give freedom to their students to express their ideas, present their work, and make positive interaction as well as make the use of students difference to support learning. This is important because, according to Bandura (in Slavin, 2000), learning is effective if done through demonstration.

What is meant by *Ulangi* – repeat, is an effort of reiterating, emphasizing, and inferring the learning material. Teacher has to show to the students how to repeat learning material to show that they already know what they are learning. Repetition can reinforce the connection of the nerve. By repeating retention will be stronger.

And finally, what is meant by *Rayakan* – celebrate, is the recognition and appreciation to every accomplishment of participation and the acquisition of knowledge and skill. Celebration can be in the form of giving gift, praising, nodding showing approval, smiling, giving point, thumb up, applause, three times yeah, poster display, and things that can arouse students' positive self perception. According to Lozanov (in De Porter, 2001), this can accelerate learning.

In short, in quantum learning students are required to think, explore, and construct knowledge from their experiences with the guide question given by the teacher. Students should solve a problem through discussion and present their solution. The teacher only facilitates, guide, and encourage enjoyable and cheerful learning.

Meanwhile, it is known that conventional Mathematics learning is mainly teacher centered activity, characterized by memorization instead of understanding

(Russefendi, 1992:74). Lesson usually starts with theory followed by example of problem solving activity and continued with exercise. Daily phenomenon is sometimes included in certain topics, but it is just for the sake of showing an example of how a theory can be applied. There is hardly any interaction among students (Soedjadi, 2001). In other words, students tend to be passive, just listening to and jotting, and only few ask questions.

### **THE AIM, BENEFIT, AND METHOD OF THE RESEARCH**

This research aims at applying quantum learning to teach linear program and seeing the practical implication of the application. There are two purposes of this research:

*First*, finding out the effectiveness of quantum learning for teaching Mathematics by seeing the effectiveness of students' activity, effectiveness of teacher's capability in his/her classroom management using quantum learning, and students' response toward the learning and their classical achievement.

*Second*, analyzing the difference of learning result of students who are taught with quantum learning and those taught using conventional model of learning.

The benefits of this research are: (1) It can be an alternative learning which is suitable with the demand of educational reform in Indonesia; (2) If it is proved effectively, quantum learning can be a means of improving the quality of Mathematics learning process; and (3) The finding can be the basis of further research.

The population of this research is all the grade X students of SMU (*Sekolah Menengah Umum* or Senior High School) Muhammadiyah of Purwokerto in Central Java, Indonesia, which consists five classes. From that population, two classes are then chosen on random basis to be the sample of the research, one as the experiment group, and the other as control. This random selection of sample is due to the fact that, according to the headmaster, students are evenly distributed to the five classes.

Data on students' and teachers' activities are obtained through observation, while questionnaire was used to get data on students' response toward quantum learning. Students' achievement of both experiment and control group was measured using essay test after quantum learning was done.

There were three stages in this research: preparation, action, and concluding stage. *Preparation* stage included: (1) developing learning device and research instrument using 4-D model according to Semmel D.S. Thiagarajan in 1974 which has been modified; and (2) communicating the learning device with the collaborator. The *action* stage included: (1) giving pre-test to both experiment and control groups; (2) forming study group for the experiment group; (3) applying quantum learning to experiment group and conventional learning to the control; and (4) giving post-test to both groups. Finally, the *concluding* stage was the analysis of the data obtained in the second stage.

The design of this research used *two-group pre-test – post-test* by involving (1) the treatment variable, namely the quantum and conventional learning for experiment and control group respectively; (2) the control variable, name the teacher, subject matter, and time; and (3) dependent variable, namely the learning achievement on the topic of linear program.

In this design, descriptively-statistical and inferential analysis was used. Descriptive analysis was used to test the effectiveness of the learning based on the test of learning mastery, learning achievement, teacher's performance in classroom management, students' activity and response. A learning is said to be effective if: (1) mastery is at least 65% with 85% of the students in the class master the topic; (2) the accomplishment of the mastery of the learning objective if  $\geq 85\%$  of the objective can mastered by 65% of the students; (3) effectiveness of students' activity is achieved, and (4) 80% of students give positive response toward the learning (Dahar, 1996; and Slavin, 2000).

Inferential statistic analysis was used to test the research hypothesis and draw conclusion toward population being studied based on the sample of the study. Data analyzed in this research is the score of the pre-test as the accompanying variable or co-variant and the score of the post-test as the dependent variable. The data was analyzed using co-variant analysis (ANACOVA) because co-variant variable was used as the independent variable which is difficult to control but can be measured at the same time with that of the dependent variable (Agung, 1998). ANACOVA has the same principle as that of ANAVA, it having effect to any treatment toward dependent variable of each group (Netter & Wassernmen, 1974).

Besides that, prerequisite test was also done with the following stages: (1) setting the regretion model; (2) independence test/significance test; (3) test of regression model linearity; (4) similarity test of the two regression models; and (5) test of the two regression models parallelism/homogeneity test. If the two regression models sought are not linear or parallel, co-variant analysis cannot be used.

## **RESULT AND DISCUSSION**

The research discussion based on the descriptive-quantitative analysis, included: (1) students' activity during the learning process; (2) teacher's performance in managing the class; (3) students' response toward the learning; and (4) the students' mastery.

Based on the observation to students' activity during the learning process, it was obtained that the mean of students' activity for demonstrating (communicating ideas) was 23.69%. This shows that quantum learning can make students active and thus reducing teacher's dominance. Therefore, there is opportunity for discussion among students and between students and teacher. Based on the students' response, the new (85%) and pleasant classroom atmosphere (90%) can improve enthusiasm so that the silent students had the courage and will to ask questions and present ideas. This was based on the observation and testimony of the Mathematics

teacher who facilitated the learning process. While the students' enjoyment was seen from the questionnaire which shows that they responded positively toward the quantum learning.

Each observation on the teacher's performance in running the learning gave 2.3 to 3.0. This can be categorized as effective based on the criteria previously set. Only that in the first and second meeting the pause belonged to fair category. This might be caused by the teacher's doubtfulness in facilitating pause song.

Based on the questionnaire on the students' response to the learning, 97% of the students were interested in joining the following lesson with the same model. This positive response will surely make students pleased during the learning. They are motivated in individual problem solving activities and constructing knowledge, so that they enlarge their knowledge because they are not dependent on the teacher.

The minimum mastery was achieved in the experiment group but not in control group. Post-test score shows that 35 out of 40 or 88% the student master the topic learned compared to 23 out of 38 or 61% students. This means that students' achievement in quantum group is better that in conventional group. This can also be seen from the increase from the pre-test score to the post-test score. In the experiment group, the mean score of the pre-test was 5.38 (14.16%) and increased in the post-test to 28.83 (75.87% from total score), compared to control group with 4.41 (11.60%) for the mean pre-test score to 24.95 (65.65% from total score) or in other an increase of 54.04%.

Based on the inferential statistic analysis, it was obtained that the simple regression model which showed the relationship between the initial performance and the learning achievement of students taught using quantum learning was  $Y_c = 21.35 + 1.52 X_c$ , while the simple regression model which showed the relationship between the initial performance and the learning achievement of students taught using conventional learning was  $Y_k = 17.87 + 1.51 X_k$ . The analysis on the test result of regression coefficient significance (independence test) for the model, as shown in table 1 and table 2, showed that students' initial performance (X) has significant effect on the students' learning achievement (Y).

**Table 1:**  
 Variant Analysis for Independence Test of Experiment Group

Variant Source	SS	Df	MS	F*
Regression	279.1	1	279.1	
Error	382.2	38	10.06	27.75
<b>Total</b>	<b>661.3</b>	<b>39</b>		

Level of significance  $\alpha = 5\%$  gave  $F(0.95; 1; 38) = 4.15$  which means  $F^* > F$  so that  $H_0$  is rejected or that regression coefficient does not equal zero.

**Table 2:**  
 Variant Analysis for Independence Test of Control Group

Variant Source	SS	Df	MS	F*
Regression	221.6	1	221.6	17.18
Error	464.3	36	12.9	
<b>Total</b>	<b>685.9</b>	<b>37</b>		

Level of significance  $\alpha = 5\%$  gave  $F(0.95; 1; 38) = 4.15$  which means  $F^* > F$  so that  $H_0$  is rejected or that regression coefficient does not equal zero.

From the result of linearity test, as seen in table 3 and table 4, it was found that the two models above was compatible with linear regression model in which the initial performance and learning achievement can be expressed in the form of linear regression.

**Table 3:**  
 Variant Analysis for Linearity Test of the Experiment Group

Variant Source	SS	Df	MS	F*
Regression	279.1	1	279.1	0.646
Error	382.2	38	10.06	
Lack of Fit	338.55	12	28.21	
Pure Error	1134.5	26	43.63	

Level of significance  $\alpha = 5\%$  gave  $F(0.95; 26; 12) = 2.75$  which means  $F^* > F$  so that  $H_0$  is accepted or that the regression model of experiment group is linear.

**Table 4:**  
 Variant Analysis for Linearity Test of Control Class

Variant Source	SS	Df	MS	F*
Regression	221.6	1	221.6	1.967
Error	446.3	38	12.9	
Lack of Fit	445.4	12	37.12	
Pure Error	452.8	24	18.87	

Level of significance  $\alpha = 5\%$  gives  $F(0.95; 24; 12) = 2.27$  which means  $F^* < F$  so that  $H_0$  is accepted or that the regression model of control group is linear. This further means that the higher the initial score (X) the higher the learning achievement (Y).

From the result of similarity test, it was found that the regression model was not the same; and from the result of parallelism test, it was found that the two regression model was parallel. Therefore, it can be concluded that there is difference between students who were taught Mathematics with quantum method and those with conventional method.

The regression line of the experiment group and that of control group is parallel and the constant of the regression line of the experiment group is higher than that of control group, which means that the difference is significant. Geometrically, the regression line of the experiment group is above that of the control group. This means that the learning achievement of the students taught with quantum learning is better than those taught conventional learning. This means that the result of the quantitative descriptive analysis is in line with the result of statistic inferential analysis, showing superiority of quantum learning over conventional one. This also shows that quantum learning used in teaching Mathematics can motivate students, make retention better and longer, because students were required to present their learning, knew how to learn, how to motivate themselves, and how to think.

### CONCLUSION AND SUGGESTION

Based on the data analysis, it can be concluded that: (1) quantum learning is effective to teach Mathematics on the topic of linear program; and (2) the learning achievement of students taught with quantum method is better than that of conventional method.

With this, the researchers recommend that quantum learning be used to teach other topic because the method attract students' interests due to their experiencing and constructing knowledge with their own modes, which in turn improve their achievement.

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