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Slope and Intercept of Regression Equations of The Correlation between Metacognitive Skill and Concept Gaining of The Students having Different Academic Capabilities In Biology Learning at Senior High Schools In Malang, Indonesia

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***Abstract* – Regression analysis is a tool used to study the functional correlation between variables presented in the form of regression equations and regression lines. In this study, regression analysis was performed to investigate the correlation between students' metacognitive skills and their Biology concept gaining. Regression analyses performed on different learning models will generate several regression equations. Those regression equations can be analyzed further to determine whether the regression lines formed are parallel and coincide, parallel but do not coincide or intersect. This study aims to reveal the regression lines of seven learning models implemented on students having different academic abilities in class XI of Senior High School. The study was conducted for one semester in 2013/2014 academic year with a total sample of 350 students. The results of the data analysis showed that regression lines of the correlation between metacognitive skills and concept gaining being compared, both on the students of low academic ability and on those of high academic ability, on the same or different learning models, tended to be parallel. The regression lines which were parallel and coincide were 53.07%, parallel but did not coincide were 26.53%, and those which were intersected were 20.40%. The tendency of the parallelism of the regression lines of the correlation between students' metacognitive skills and concept gaining at various or all conditions, still needs to be studied further.**

***Keywords* – Concept Gaining, Intercept, Metacognitive Skills, Regression Equation, Slope.**

I. INTRODUCTION

The regression analysis is a type of statistics evaluation describing predictor variable and criterion variable [1]. Regression analysis is an analysis related to the predictor variable and criterion variable of a regression equation. Based on a regression equation, a regression line can be constructed. A regression line can be described as a representation of an equation called regression equation [2]. The regression line might be a straight line (linear), or even a curved line (parabolic, hyperbolic, or others). This study particularly discusses the simple linear regression line. The equation of the linear regression line with a predictor variable is $y = ax + b$, where "y" is the criterion, "x" is the predictor, "a" is predictor coefficient number (slope), and "b" (intercept) is a constant number [1].

Slope is the steepness of a line and intercept is the intersection of the regression line on the Y-axis [3]. Operationally the slope refers to the increase rate of a variable due to the influence of the other variables, while the intercept refers to the increase size of a variable due to the influence of other variables.

Only few previous researches about the correlation between students' metacognitive skills and their cognitive learning results investigated too the differences of regression equations among the regression lines formed related to the correlation. Some examples of such researches have been conducted [4] – [7]. Those previous researches only discussed whether or not there was a correlation, and contribution value of the correlation.

The differences/similarities of regression equations can be studied. The analysis of variance related to correlation equations can be done by comparing two or more regression equations. The results of analysis of variance related to regression equation can vary [8]. The results might show that the regression lines could be parallel and coincide, parallel, or even intersect.

If the slope coefficient values of the regression lines being compared do not differ from one another, and the intercept coefficient values of the regression lines compared do not differ either, the lines are parallel and coincide. If the slope coefficient values of the regression lines being the regression lines being compared do not differ from one another, but the intercept coefficient values of the regression lines compared differed, the lines compared are parallel but are not coincide. On the other hand, if the slope coefficient values of the regression lines being compared are different from one another, and the intercept coefficient values of the regression lines compared are also different, the lines compared are not parallel or intersect with each other.

Related to a regression analysis study, it is very important to remember that each of the regression coefficient is influenced by other variables [9]. This means that the value of a (the slope coefficient) and the value of b (intercept coefficient) related to the regression equation $y = ax + b$ can be affected by other variables. The variables can be interpreted as factors that influence the slope coefficient and intercept coefficients that are formed. If the regression lines being compared are parallel and coincide (slope coefficients are equal, so are the intercept coefficients), of course it happens because the factors influencing the slope coefficients, and the factors influencing intercept coefficients are also the same. In this case, if the regression lines are parallel, of course, the factors influencing the slope coefficients are the same, but the factors influencing the intercept coefficients are

different. On the other hand if the regression lines intersect, the factors influencing the slope coefficients are not the same same, and the factors influencing the intercept coefficients are not the same either.

It is very important to be mentioned that the regression slope, the determination coefficient as well as the correlation coefficient can be influenced by several factors [10] as follow.

1. Errors of measurement, which may be related to various factors.
2. There are some effects of common variable on the X and Y.
3. There are forced or unexpecteds variations on the X or Y, or both, related to the case instrument error used. This forced variation may be related to measurement instruments that do not cover all the range, or because the range is too narrow on the experimental conditions used.
4. There is a continuous correlation of the data.

Reference [11] stated that the parameters a and b can not be observed. Therefore, the factors affecting the a and b need to be sought. Moreover, it is also stated that the work on estimating a and b is equivalent with the work on estimating the position of the regression line.

There have been many researches in the field of biology learning examining the correlation between one variable and the other variable, such as between metacognitive skill variable and concept gaining variable. The researches examining the correlation were limited to different academic abilities, and at different levels of education, such as at elementary schools, at junior high schools, as well as at senior high school [4], [5], [6], [7], [12].

Related to Problem Based Learning (PBL), reference [4] reported that regression equation of the correlation between metacognitive skills and concept gaining was Y = 0.8402X + 6.8127 having contribution value of 43.7%. The researcher also revealed the regression equation of correlation between the two variables on inquiry learning as Y = 0.9009X + 10 318 having contribution value of 69%. Related to Jigsaw learning, reference [5] reported that the regression equation of the correlation between the two variables was Y = 1.277X - 0488 and had contribution value of 66.6%. The researcher also revealed the correlation between the two variables on the TPS learning, which had the regression equation Y = 0.956X - 1,146 with contribution value of 82.4%. In reciprocal teaching learning, reference [7] reported a regression equation of the correlation between the two variables as Y = 0.667X + 26 225 having contribution value of 31.9%. In TPS learning, reference [6] reported that the regression equation of the correlation between the two variables was Y = 0.816X + 11 802 and had contribution value of 32.5%. On the other hand, related to TEQ learning, reference [11] reported the regression equation of the correlation between the two variables as Y = 0.857X + 17 904 having contribution value of 52.9%.

Some of these research investigated whether or not there was a correlation between one variable and another variable. There were only a few researches investigating the comparisons between the regression equations. In this research, the analysis of variance related to regression equation will be used to reveal the parallelism of the regression lines are formed from the correlation between metacognitive skills and concept gaining expressed in different conditions, due to the use of different learnings and different levels of academic ability. If there are certain patterns found after the analysis of variance related to those regression equations, the information can be very useful for the future researchers.

II. METHOD

This is a correlational research investigating the correlation of metacognitive skills as the predictor and concept understanding as the criterion. The research was conducted within one semester in 2013/2014 academic year. The population of this research was the eleventh grade students of senior high schools in Malang, Indonesia. Fourteen classes were taken as the samples of this research divided into two types of academic ability, seven classes as the high academic ability and the other seven classes as the low academic ability. The classes consisted of 350 students. In each class, only one learning model was implemented. The learning models implemented were Jigsaw, Think Pair Share (TPS), Cooperative Script (CS), Reciprocal Teaching (RT), Problem Based Learning (PBL), Thinking Empowerment by Questioning (TEQ), and TEQ Integrated with TPS (TEQ + TPS).

Data collection instrument used was in the form of essay test. The essay test was used to measure students' metacognitive skills and concept gaining [13]. The hypothesis testing used was simple linear regression test. The simple linear regression test would eventually be useful for uncovering the regression equation of the correlation between students' metacognitive skills and their concept gaining in each learning model. Normality test and homogeneity test was performed before the hypothesis testing was conducted. After the regression equation of the correlation between students' metacognitive skills and concept gaining was found, the analysis of variance related to correlation regression equations was performed to determine the paralellism and coincidence of the regression lines formed.

III. RESULT

A. The Correlation Between Students' Metacognitive Skills and Their Concept Gaining In Each Learning Model

The results of data analysis related to the correlation between students' metacognitive skills and their concept gaining in each learning strategy is presented in Table 1. The results of the data analysis in the Table 1 indicated that the correlations between metacognitive skills and concept gaining in all learning models except PBL related to low academic students, are really all very significant.

Table 1. Summary of the ANOVA test related to the correlation between students' metacognitive skills and concept gaining of the students

Model / Academic Ability	Significance value						
	Jigsaw	TPS	CS	RT	PBL	TEQ	TEQ + TPS
High	0.000	0.002	0.000	0.000	0.049	0.000	0.000
Low	0.000	0.000	0.000	0.000	0.499	0.000	0.004

B. Anova Test of The Regression Equations of The Correlation between Metacognitive Skills and Concept Gaining of The Students having High Academic Ability in The Seven Different Learnings

Test results of the analysis of variance related to correlation regression equations between metacognitive skills and concept gaining of the students having high academic ability in the Seven Different Learning are illustrated in Table 2.

Table 2. Summary of the ANOVA test result of the seven regression equations of the correlation between metacognitive skills and concept gaining of the students high academic ability on the implementation of seven leaning models

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	12607.837	13	969.834	26.515	0.000
b1, b2, b3, b4, b5	179.719	5	35.944	0.983	***0.427***
b1, b2, b3, b4, b5, b6, b7	796.434	1	796.434	21.774	0.000
Residual	6071.783	166	36.577		
Total	18679.620	179			

ANOVA test result indicates that the significance value of b1, b2, b3, b4, b5 is 0.427 (>0.05) and that of b1, b2, b3, b4, b5, b6, b7 is 0.000 (<0.01). The values prove that the regression lines related to the correlation between metacognitive skills and biological concept gaining on seven learnings are parallel to each other as well as are not coincide. To find out more details about the parallelism of the regression lines related to the correlation between metacognitive skills and concept gaining of the students having high academic ability, the analysis of variance of the regression equation is also conducted on every two learnings (Anova test on two regression equations). The analysis of variance results related to regression equation of every two learnings on the students having high academic ability are illustrated in Table 3.

Table 3. Summary of the ANOVA test result of the regression equation of every two learnings on the students having high academic ability

	Jigsaw	TPS	CS	RT	PBL	TEQ	TEQ + TPS
Jigsaw		Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
		Coincide	Coincide	Coincide	Coincide	Coincide	Coincide
TPS			Parallel	Parallel	Parallel	Parallel	Parallel
			Coincide	Coincide	Coincide	Coincide	Coincide
CS				Parallel	Parallel	Parallel	Parallel
				Coincide	Coincide	Coincide	Coincide
RT					Parallel	Parallel	Parallel
					Not coincide	Coincide	Coincide
PBL						Parallel	Parallel
						Not coincide	Not coincide
TEQ							Parallel
							Coincide
TEQ + TPS							

The results of the data analysis in Table 3 show that the regression lines between students' metacognitive skills and their biology concept gaining in the majority of the learnings being compared among the students having high academic ability are parallel and coincide with the percentage of 85.72%. There are regression lines among several learnings being compared parallel but not coincide with the percentage of 14.28%. Those regression lines are between RT and PBL, PBL and TEQ, as well as between PBL and TEQ + TPS.

C. Anova Test of The Regression Equations of the Correlation between Metacognitive Skills and Concept gaining of the Students having Low Academic Ability in the Seven Different Learnings

The results of the analysis of variance related to correlation regression equation between metacognitive skills and concept gaining of the students having low academic ability in the seven different learnings are illustrated in table 4.

Table 4. Summary of the ANOVA test result of the regression equations of the correlation between metacognitive skills and concept gaining of the students having low academic ability in the seven learning models

Model	Sum of Squares	Df	mean Square	F	Sig.
Regression	11454.148	13	881.088	23.642	0.000
b1, b2, b3, b4, b5	832.594	5	166.519	4.468	0.001
b1, b2, b3, b4, b5, b6, b7	1993.607	1	1993.607	53.495	0.000
residual	5813.683	156	37.267		
Total	17267.832	169			

ANOVA test result indicates that the significance value of b1, b2, b3, b4, b5 is 0.001 (<0.01) and that of b1, b2, b3, b4, b5, b6, b7 is 0.000 (<0.01). Those values prove that the regression lines related to the correlation between metacognitive skills and biology concept gaining in the seven learnings are not parallel. To find out more details about the parallelism of the regression lines of the correlation between metacognitive skills and concept gaining of the students having low academic ability, the analysis of variance of the regression equation was also conducted on every two learnings (ANOVA test of two regression equations). The results of the ANOVA test of the regression equation on every two learnings of the students having low academic ability are illustraed in Table 5.

Table 5. Summary of the ANOVA test result of the regression equations on every two learnings on the students with low academic ability

	Jigsaw	TPS	CS	RT	PBL	TEQ	TEQ + TPS
Jigsaw		Parallel	Parallel	Parallel	Not parallel	Parallel	Parallel
		Not coincide	Coincide	Coincide	Not coincide	Coincide	Coincide
TPS			Parallel	Not parallel	Not parallel	Parallel	Parallel
			Not coincide	Not coincide	Not coincide	Not coincide	Not coincide
CS				Not parallel	Not parallel	Parallel	Parallel
				Not coincide	Not coincide	Coincide	Coincide
RT					Parallel	Parallel	Parallel
					Not coincide	Coincide	Coincide
PBL						Not parallel	Parallel
						Not coincide	Not coincide
TEQ							Parallel
							Coincide
TEQ + TPS							

The results of the data analysis in Table 5 show that the regression of correlation between students' metacognitive skills and their biology concept gaining in the majority of the learnings being compared on the students having low academic ability is parallel and coincides with the percentage of 42.86%. There are regression lines among several learnings being compared parallel but not coincide with the percentage of 28.57%. Those regression lines are between Jigsaw and TPS, TPS and CS, TPS and TEQ, TPS and TEQ + TPS, RT and PBL, as well as between PBL and TEQ + TPS. On the other hand, there are the regression lines among the learnings being compared which intersect with the percentage of 28.57%, Those regression lines are between Jigsaw and PBL, TPS and RT, TPS and PBL, CS and RT, CS and PBL, as well as between PBL and TEQ learnings.

D. Anova Test of 14 Regression Equations of The Correlation between Metacognitive Skills and Concept Gaining of The Students having different Academic Ability (high and low)

Anova test results related to correlation regression equations between metacognitive skills and concept gaining of the students having different academic ability in the fourteen classes learnings are illustrated in Table 6.

Table 6. Summary of the ANOVA test of fourteen regression equations of the correlation between metacognitive skills and concept gaining of the students

Model	Sum of Squares	df	mean Square	F	Sig.
Regression	27396.161	27	1014.673	27.489	0,000
b1, b2, b3, b4, b5	1083.087	13	83.314	2.257	0,017
b1, b2, b3, b4, b5, b6, b7	3403.610	1	3403.610	92.210	0,000
residual	11885.466	322	36.911		
Total	39281.627	349			

ANOVA test result indicates that the significance value of b1, b2 b3, b4, b5 is 0.017 (<0.05) and that of b1, b2, b3 b4, b5, b6, b7 is 0.000 (<0.01). The values prove that the regression lines related to the correlation between metacognitive skills and biology concept gaining in the fourteen learnings are not parallel. To find out more details about the parallelism of the regression line of the correlation between metacognitive skills and concept understanding of the students having different academic ability, the analysis of variance of the regression equation was also conducted on every two models of the learnings (Anova test of two regression equations). The results of the ANOVA test of the regression equation on every two learnings of the students having different academic ability are illustrated in Table 7.

Table 7. Summary of the ANOVA test result of the regression equation on every two learnings of the students having different academic ability

Academic Ability & Model		High						
		Jigsaw	TPS	CS	RT	PBL	TEQ	TEQ + TPS
Low	Jigsaw	Parallel Not coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide	Parallel Coincide
	TPS	Not parallel Not coincide	Parallel Coincide	Parallel Coincide	Parallel Coincide	Parallel Coincide	Parallel Coincide	Parallel Coincide
	CS	Parallel Not coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide
	RT	Not parallel Not coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide	Parallel Coincide	Not parallel Not coincide	Not parallel Not coincide
	PBL	Not parallel Not coincide	Not parallel Not coincide	Not parallel Not coincide	Not parallel Not coincide	Parallel Coincide	Not parallel Not coincide	Not parallel Not coincide
	TEQ	Parallel Not coincide	Parallel Coincide	Parallel Coincide	Parallel Coincide	Parallel Not coincide	Parallel Coincide	Parallel Coincide
	TEQ + TPS	Parallel Not coincide	Parallel Coincide	Parallel Not coincide	Parallel Not coincide	Parallel Not coincide	Parallel Coincide	Parallel Coincide

The results of the data analysis in Table 7 show that the regression equation of students' metacognitive skills and their biology concept gaining in the majority of the learnings being compared of the students having high academic ability and low academic ability are parallel and coincide with the percentage of 53.07%. There are regression lines among several learnings being compared parallel but not coincide with the percentage of 26.53%. Those were between Jigsaw (low) and Jigsaw (high), Jigsaw (l) and CS (h), Jigsaw (l) and PBL (h), CS (l) and Jigsaw (h), CS (l) and CS (h), CS (l) and TEQ (h), RT (l) and CS (h), TEQ (l) and Jigsaw (h), TEQ (l) and PBL (h), TEQ + TPS (l) and Jigsaw (h), TEQ + TPS (l) and CS (h), TEQ + TPS (l) and RT (h), as well as TEQ + TPS (l) and PBL (h). There are regression lines among several learnings being compared which intersect with the percentage of 20.40%. Those were between RT (l) and Jigsaw (h), RT (l) and TEQ (h), RT (l) and TEQ + TPS (h), PBL (l) and Jigsaw (h), PBL (l) and TPS (h), PBL (l) and CS (h), PBL (l) and RT (h), PBL (l) and TEQ (h), as well as PBL (l) and TEQ + TPS (h).

IV. Discussion

The results of data analysis reveal that there is a correlation between students' metacognitive skills and their concept gaining. The correlation between students' metacognitive skills and their concept gaining has previously been studied [14] revealing that there was a positive correlation between metacognitive skills and academic achievements. The results of this research are consistent with Coutinho's report. Reference [15] explained that metacognition was "cognition about cognition" or "knowledge about knowing and learning". From these explanations, it can be interpreted that metacognition plays a role in a person's cognition. Reference [16] explained that when students became more aware of their thinking process when learning, they would

be more able to control any things such as goals, motivation and attention. Thus, students having good metacognition skills will be able to easily control their cognition.

The results of the analysis of variance related to correlation regression equation showed that the regression lines being compared are mostly parallel. The parallelism of regression lines means that the slope coefficient value of each regression line does not differ from one another.

The results of the analysis of variance related to correlation regression equation of the seven learnings on the students having high academic ability show that the percentage of regression lines which is parallel and coincide is 85.72%, and parallel but not coincide is 14:28%. The results of the analysis of variance related to correlation regrresion equation of seven learnings on the students having low academic ability show that the percentage of the regression lines which is parallel and coincide is 42.86%, and parallel but not coincide is 28.57%. Similarly, the percentage of the regression lines of fourteen learnings on the students having different academic ability which is parallel and coincide is 53.07%, and parallel but not coincide is 26.53%.

Based on the results of the data analysis leading to the parallelism of the regression lines, it is seen that maybe there is a particular factor affecting the the slope coefficient values, so the slope coefficient values being compared do not differ from one another. Reference [9] explained that it was very important to remember that each of the regression coefficient was influenced by other variables in the regression model. It means that the value of a (the slope coefficient) and b (intercept coefficient) of a regression equation $y = ax + b$ can be affected by other variables. These variables is referred to as factors in this research.

The factors that may influence the slope coefficient are learning models, academic ability, grade level, motivation to learn, and learning styles. Reference [17] stated that the factors presumed to influence the slope coefficients and intercept coefficients, included the learning model implemented, the way teachers teach, students' learning styles, and perhaps the other factors (gender, school level, and ethnicity). Reference [10] explained that the slope coefficient in a regression equation, as well as the determination coefficient and correlation coefficient can be influenced by four factors, namely the errors of measurement, the effects of the common variables on the X and Y, forced variation in X or Y, or both, and continuous data correlation. However, in this research, the factor considered to be the most possible one to influence the slope coeficients and intercept coeficients is the academic ability, so the factors mentioned above [10] and [17] have no effect on the values of the slope coefficients and intercept coefficients.

The research result shows that generally the regression equations related to the correlation between metacognitive skills and concept gaining do not have significant different slopes. Even if there are some slopes which are different significantly among each other, causing their regression lines intersected, it is usually occuredunder extreme circumstances affecting the slopes.

Related to the academic ability as the most possible factor influencing the slope coeficient and intercept coeficient, it meant that there is a certain condition of the academic ability causing the regression lines intersected. The intersecting lines in this research are only found on the regression lines being compared among the students of low academic ability, and those among the students of low academic ability and those of high academic ability. It means that there are certain conditions that make the lines intersect. The examples of such conditions are a small number of samples, students' low academic ability which causes the ability to understand materials differs, or the other conditions that can not be found among students of high academic ability. Based on the results of this research, it can be concluded that the regression lines of the correlation between metacognitive skills and concept gaining will always be parallel as long as there is not any extreme condition causing the regression lines intersect to each other.

V. Conclusion and Recommendation

Based on the results of this research, four conclusions will be described further.

1. There is a correlation between metacognitive skills and biology concept gaining of the students of high academic ability as well as those of low academic ability on the seven learnings implemented.
2. The regression equations of the seven learnings implemented among the students of high academic ability are parallel and coincide as much as 85.72%, are parallel but not coincide as much as 14.28%.
3. The regression equations of seven learnings implemented among the students of low academic ability are parallel and coincide as much as 42.86%, parallel but not coincide as much as 28.57%, and intersecting as much as 28.57%.
4. The regression equations of 14 learnings implemented among the students of different academic ability (low and high academic ability) are parallel and coincide as much as 53.07%, parallel but not coincide as much as 26.53%, and intersecting as much as 20.40%.

The recommendation that can be proposed based on the results of this research is that the tendency of regression line parallelism related to the correlation between metacognitive skills and concept gaining needs to be explored further in the next researches. Future researches can focus on the conditions, other than academic ability and learning models, such as similar or different level of education, similar or different grade level, as well as similar or different gender of the students. By those furthe researches, the factors affecting the slope coefficient and the intercept coefficient of the regression equation of the correlation between students' metacognitive skills and concept understanding, causing the regression lines intersecting to each other, can be detected precisely.

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