Modern Applied Science; Vol. 9, No. 12; 2015
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

The Contribution of Critical Thinking Skills and Metacognitive Awareness on Students' Learning: Teaching Biology at Senior High School

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Received: August 3, 2015 Accepted: October 11, 2015 Online Published: October 31, 2015

doi:10.5539/mas.v9n12p143 URL: http://dx.doi.org/10.5539/mas.v9n12p143

Abstract

This research aimed to examine the contribution of critical thinking skills and metacognitive awareness on biology learning in class XI at a government senior high school in Makassar. The research was a correlational *ex post facto* study, and the population studied consisted of students attending the selected government Senior High Schools in Makassar for the 2013/2014 academic year. Samples were chosen according to random sampling clusters. The Data was analyzed with descriptive and inferential statistics. Research results showed that (1) Both critical thinking skills and metacognitive awareness contributed positively to biology students' learning outcomes in class XI, (2) Critical thinking skills contributed positively to biology students' learning in class XI at senior high school, (3) Metacognitive awareness contributed positively on biology students' learning outcomes.

Keywords: critical thinking, biology, student learning outcomes, metacognitive awareness

1. Introduction

Increasingly rapid developments in science and technology have caused a fast and unlimited flow of information. This has a direct impact on various aspects of life, including education. The education process is charged with preparing and producing quality human resources, who can process information well (Depdiknas 2007). Students are charged with not just memorizing material, but must understand what they have studied. This is often undertaken to form concepts, reasoning, critical thinking and skills to solve problems. A critical thinking habit needs to be instilled in students, so they can observe various issues which will come up in their lives.

Teaching approach contributes to creating the condition of students; so that they have critical thinking skills, or such that they are good at memorizing. The teaching approach used by teachers up until now, fails to give students the opportunity to understand the material learned. The students are only able to memorize, able to answer examination questions well, but not able to apply the material as expected. According to Santrock (2007) only very few schools really teach students to think critically. He believes that many of the students who successfully complete their tasks, do well in their exams and gain good results do not study in depth or think critically. Yet, it is clear that critical thinking influences the student's metacognitive awareness. Metacognitive awareness involves monitoring and reflecting on a person's way of thinking, including how and when to use specific procedures to solve problems (Santrock, 2007).

Metacognitive knowledge can be seen when students are conscious their own cognitive capacity and undertakes monitoring of cognitive possessed in the learning process (Anderson *et al,* 2001). This statement is supported by Winarni (2006) that high academic ability leads to good learning outcomes which appear in the form of mastery of concepts, scientific attitude and also the development high levels of critical thinking.

Based on the results of observation in National Senior High Schools (*SMA Negeri*) in the city of Makassar, these schools tend to train critical thinking skills through discussions or a co-operative study model which directs students to learn in a group or team. Based on this, the authors aimed to establish the contribution of critical thinking skills and metacognitive awareness on biology students' learning for class XI at Government high schools in Indonesia.

2. Literary Review

2.1 Critical Thinking Skills

The ability of humankind to adapt themselves to the environment in order to sustain life is heavily dependent on the ability to think. Purwanto (1998) states that thinking is the main competitive power. Thinking is a process which influences desire for stimulus which involves the processes of sensation, perception and memory (Sobur, 2003). At the point a person faces a problem, first they involve a sensation process, namely capturing writing, pictures, or sound. Subsequently they experience a perception process, namely reading, listening and understanding what is being asked by the problem. Even at this point, actually they are involving the memory process to understand the new terminology in the problem, or undertake recall and recognition if facing the same problem as previously faced (Matlin, 1994).

Thinking skills are needed to be successful in life. Dewey as quoted by (Arends, 2008) states that schools should teach students how to think. Thinking skills can be divided into basic thinking skills and complex thinking skills (Liliasari, 2000). Creative thinking uses basic thought processes to find or develop ideas or original, aesthetic, or constructive results, related to point of view, concept, and underlines intuitive and rational thought aspects in using information and material to bring out or clarify using the original perspective of the thinker. Ennis as quoted by (Winarni, 2006) defines critical thinking as logical thinking focused on decision making about what to believe and do. Ennis (1985) and Marzano *et al* (1988) mention that critical thinking covers the following skills: (1) formulating the problem, (2) providing an argument, (3) proposing a question and providing an answer, (4) determining appropriate and trusted sources of information, observing and reporting, (5) making deductions, (6) making induction, (7) making evaluation, (8) providing definitions, (9) identifiying assumptions, (10) making and implementing decisions, and (11) interacting with others.

In this research, critical thinking is referred to organized processes which involve mental activities, including the ability to formulate a problem, make an argument, make deductions, make induction, evaluate, make and implement decisions. The student's critical thinking skills can be taught at school through the learning process, as suggested by Kronberg and Griffin (2000). They trained students thinking works in studying biology. They established that students enjoyed studying and gained critical thinking skills.

2.2 Metacognitive Awareness

Metacognition has two components, namely: (1) metacognitive knowledge and (2) metacognitive skills. Metacognitive knowledge is related to declarative knowledge, procedural knowledge and conditional knowledge, while metacognitive skills are related to planning skills, predictive abilities and monitoring and evaluation skills (Syaiful, 2011). Weinert and Kluwe (1987) state that metacognition is a second-order cognition, which means thinking about thinking, knowledge about knowledge, or reflection about steps. Woolfolk (1995) explains that there are at least two separate components within metacognition, namely declarative and procedural knowledge about skills, strategy and sources which are required to undertake a task. Flavel as quoted by (Arends, 1997) also defines metacognition as a person's knowledge as it pertains to the cognitive process and product of that person's self, or everything related to this product. Meanwhile, Woolfolk (1993) describes metacognition as "people's awareness of their own cognitive machinery and how the machinery works". In other words, metacognition is knowledge about our own thought processes. Because different people have different knowledge and metacognitive awareness, they also have different levels of learning outcomes. Flavel, *et al* as cited by Slavin (2000) also proposed a similar definition, that the term metacognitive means knowledge of one's own learning, meaning knowledge about how one learns and how one perceives the learning process undertaken. According to Arends (1997) metacognition is defined as thinking about thinking and cognitive process monitoring. In the views of Brown as cited by Weinert and Kluwe (1987) proposes that metacognitive skills or process require a specific mental operation, with which a person can check, plan, regulate, observe, predict and evaluate their own though process.

Suzana (2004) defines learning with a metacognitive approach as learning which plants an awareness of how to plan, monitor and control what they know; what is required to complete the work and how to undertake it. Meanwhile, according to Blakey and Apence (1991) metacognitive strategy is a technique to facilitate metacognition, or "thinking about thinking" and strategy to develop behavior. Metacognitive awareness according to Rivers as noted by Corebima (2006) is divided into two types, namely self-assessment, which is students' skill to see self-cognition, and self-management, which is pupils' skill to manage their own cognitive development. Peters as quoted by Corebima (2006) metacognitive awareness makes it possible for students to develop as independent learners, because they are pushed to self-manage and to evaluate their own thoughts and learning. Flavel, Gardner, and Alexander as written in Slavin (2000), state that development of pupils'

metacognitive awareness to help students monitor their own learning development. While, Livingston (1997) states that the role of metacognitive development is very important in determining learning success. In relation to Livingston, Dunning *et al* (2003) state that metacognitive thinking is important in learning and a determinant factor in academic success.

Metacognitive awareness is a partial mediator of better mastery of academic concepts and is a predictor of Grand Point Average (Coutinho, 2007). Rahman and John (2006)'s research results also show that students' metacognitive awareness has a positive relationship with academic achievement. The metacognitive activity aspects is also further discussed by Flavell as cited by Suzana (2004) who notes that it is about: (1) consciously finding information, (2) monitoring what students know and how to work it out through self-questioning and elucidating in their own words to simulate understanding, (3) regulating, comparing and differentiating possible solutions. For Jacob (2003), he notes that lecturers teach students to plan, monitor and revise their own work. How students master this metacognitive ability may require quite long processes. This implies educators should stare earlier to implement such a model in tehir engagement with students, specifically training students in special skills and strategy (like planning, evaluation, or problem analysis), and with their teaching structure so that students are focussed on how and what they learn (Jacob, 2000).

2.3 Learning Outcomes

In order to determine achievement or not of learning, efforts are made to evaluate learning outcomes. This evaluation aims to show the progress of learners in mastering the material studied (Arikunto, 2006). Bloom as cited by Sudjana (2008) divides learning outcomes into three overall realms, namely: (1) The cognitive realm pertains to intellectual learning outcomes, made up of six aspects: knowledge or memory, understanding, application, analysis, synthesis and evaluation. The first two aspects are low level cognition, while the remaining four are high level cognition. (2) The affective realm pertains to attitudes and comprises five aspects: acceptance, answer or reaction, evaluation, organization and internalization. (3) The psychomotor realm pertains to learning outcomes, skills and ability to act. There are six aspects in the pschomotoric realm: reflex movements, basic movement skills, perceptual ability, harmonization or appropriateness, complex movement skills, and expressive and interpretative motions. These three realms are the object of learning outcome evaluation. Between the three realms, the cognitive realm is the most frequently evaluated by school teachers, because it is related to pupils' ability to master learning material content.

This is in line with Bloom (1976)'s Theory of School Learning, in which Bloom states that there are three main variables in the theory of school learning, namely: individual characteristics, teaching quality and pupil's learning outcomes (Bloom, 1976). Two of the above factors (pupils' ability and teaching quality) have a directly proportional relationship with pupils' learning outcomes, meaning the higher students abilities and learning quality, the better the students' learning outcomes (Sabri, 2010). Learning outcomes expresses learning prestige, while learning prestige is an indicator of the existence and degree of change in the student's behavior (Hamalik, 2003). In other words, evaluation can show the quality evaluated (Sanjaya, 2008). As a result, students need to know the grade system, so that they are motivated to study continuously (Sukardi, 2008).

3. Method

This is a correlational research, which connects two independent variables, namely: critical thinking skill (X_1) and metacognitive awareness (X_2) with a dependent variable: learning outcome (Y). The research design is drawn in the shape of a relationship between research variables.

The population in this research consisted of all students in Class XI in government Senior High Schools (*SMA Negeri*) in Makassar. The sample was chosen through cluster random sampling, involving: (a) making a sampling framework from all the students of *SMA Negeri* comprising 22 schools, where the school (cluster) is a sample unit, (b) randomly choosing 4 (20%) schools from the *SMA Negeri* in Makassar, (c) from each Senior High School one class was randomly chosen from the classes in the chosen schools, (d) all students in the chosen class became research respondents, with a total of 153 people.

Data compilation was conducted using test instruments and questionnaires. The test instrument was in the form of open questions (in essay form) according to the test key learning points. The size of score for each item was determined using evaluation from critical thinking skills development indicators and some questions which measure students' critical thinking skills, while the questionnaire instrument was used to measure students' metacognitive awareness towards learning outcomes.

The data compiled from the research was treated using descriptive statistical analysis and inferential statistics. Descriptive statistics were used to describe respondents' characteristic score for each variable. To achieve this, a

table of frequency distribution, standard deviation, mean (average score), maximum score and minimum score was used. Inferential statistics was used to test the research hypothesis. To achieve this, linear regression analysis and simple and multiple correlations were used.

4. Results of the Research

In this section, the results and discusssion have been handled concurrently. Thus, in accordance with the theories presented and research results obtained, as well as phenomena in the field, the research results and discussion entail the following:

4.1 Critical Thinking Skills

Descriptive statistical analysis results obtained core measurements for critical thinking skills, namely: average score = 72.52, median = 75.00 and modus = 79.17. Quantatively, the critical thinking skills of *SMA Negeri* students in Makassar is high. From the descriptive statistical analysis results obtained measurement distribution, namely: highest score of 87.50 and lowest score of 50.00, with a standard deviation of 8.21 and variance of 67.49. Frequency distribution and percentage of the critical thinking skills variable showed 3 students (1.96%) were in the very high category, 51 students (33.33%) were in the high category, 52 students (33.98%) were in the average category, while 39 students (25.49%) were in the low category and 8 students were in the category of lacking. It can therefore be concluded that the critical thinking skills of senior high school students in Makassar are within the "*qualification categoization of medium to high"*.

4.2 Metacognitive Awareness

Descriptive statistical analysis results obtained core measurements for metacognitive awareness, namely: average score = 73.33, median = 73.55 and modus = 80.29. Quantatively, metacognitive awareness of *SMA Negeri* students in Makassar is in the fair category. Measurement distribution is: highest score of 179.00 and lowest score of 123.00. Standard deviation of 14.18, and variance of 201.12. Frequency distribution and percentage of the metacognitive awareness variable for *SMA Negeri* in Makassar shows 5 students (3.27%) were in the very well developed category, 50 students (32.68%) were in the well-developed category, 53 students (34.64%) were in the starting to develop category, 35 students (22.87%) were in the not particularly developed category, and 10 students (6.54%) are in the high risk category. It can therefore be concluded that the metacognitive awareness of senior high school students in Makassar are within "*qualification category of beginning to develop up to well developed"*.

4.3 Learning Outcomes

Descriptive statistic analysis results obtained core measurements for learning outcomes, namely: average score = 76.59, median = 79.33, and modus = 80.00. Quantatively, learning outcomes of pupils in national senior high schools in Makassar are in the high category. Measurement distribution is: highest score of 88.33 and lowest score of 60.00. standard deviation of 6.57, and variance of 43.23. Biology learning outcomes for *SMA Negeri* in Makassar, show 3 students (1.96%) in the very high category, 114 pupils (74.51%) in the high category, 25 students (16.34%) in the medium category, 11 students (7.19%) in the low category, and no student is in the very low category.

4.3.1 Positive Contribution of Critical Thinking Skills and Metacognitive Awareness on Biology Students' Learning Outcomes

Based on multiple linear regression pair analysis results, data of critical thinking skills and metacognitive awareness with learning outcomes for students of senior high schools in Makassar, it has been found that the regression coeffient value b_1 obtained is 0.511, b_2 obtained is 0.104 and the constant value is 23.762. From these details, the regression equation between the critical thinking skills and metacognitive skills variables on learning outcomes of *SMA Negeri 1* Makassar students is $\hat{Y} = 23.762 + 0.511\ X_1 + 0.104\ X_2$. This regression equation model explains that each change in critical thinking skills and metacognitive awareness is expected to occur in each student's learning outcome from *SMA Negeri* in Makassar of 0.511 and 0.104 at a constant 23.762.

To discover whether the linear regression equation can be used to reach a conclusion or whether the linear regression equation obtained is significant or not, variance analysis (F-test) can be used. The evaluation criteria is $F_{count} > F_{table}$. From the calculation results obtained, the value of F_{count} of 118.351and a value of F_{table} of 0.254. As such, the regression equation model obtained can be considered significant at a significance level of 0.05, so the regression equation $\hat{Y} = 23.762 + 0.511\ X_1 + 0.104\ X_2$ can be used to explain the contribution of students' critical thinking skills and metacognitive awareness on learning outcomes of the students.

The results of variance analysis for multiple regression of the contribution of critical thinking skills and

metacognitive awareness on students' learning outcomes at the government senior high schools in Makassar, can be seen in table 1 below.

Table 1. Variance Analysis Results for critical thinking skills and metacognitive awareness on learning outcomes of biology students at *SMA Negeri 1* in Makassar

Variance Source	Quadrate total	Degrees of freedom	Average quadrate	F_{count}	P
Model	3855.704	2	1927.852	118.351	0.000
Error	2443.394	150	16.289		
Total	6299.098	152			

Application of t-test to investigate the contribution of critical thinking skills and metacognitive awareness variables on learning outcomes for government senior high schools students in Makassar can be seen in table 2 below:

Table 2. t-test results for critical thinking skills and metacognitive awareness variables

Variable	Value R	Value R^2	Value t
Constant			6.234
Critical thinking skills	0.782	0.612	11.459
Metacognitive awareness			4.026

Based on table 2, the contribution of *critical thinking skills and metacognitive awareness variables on learning outcomes* for students of government senior high schools in Makassar, shows that the value of t count which appears in the table related to critical thinking skills and metacognitive awareness above is real or significant at a trusted standard of 0.05 %, because the value of t_{count} 5.692 > value P = 0.000. This shows that predicted regression coefficient parameter β_1 namely $b_1 = 0.511$, is also real and positive, and value t_{count} 11.459 > value P = 0.007, is also real and positive.

Based on table 2 above, it can be further explained that value F_{count} 118.351 > 0.000 is much larger than the standard significance 0.05 used in this research. This means that the regression model chosen is viewed as suitable. Statistical hypothesis $H_o : \beta_1 = \beta_2 = 0$ opposes H_1 : Minimum one $\beta_i \neq 0$ is appcepted. So it can be concluded that for trusted level 61.2 % the critical thinking skills and metacognitive awareness variables have an equally positive contribution on learning outcomes for governement senior high school students. Analysis of the relationship between critical thinking skills and metacognitive awareness variables on learning outcomes of *SMA Negeri* students in Makassar obtained a value R of 0.612, meaning increasingly high critical thinking skills and increasingly high metacognitive awareness, the higher students' learning outcomes. The determining coefficient (R^2) of 0.612 means 63.4 %.

4.3.2 There is a positive contribution of critical thinking skills on biology students' learning outcomes

Based on simple paired linear regression data analysis results of critical thinking skills with learing outcomes from the government senior high school students in Makaaassar, it was discovered that the regression coefficient value b_I obtained is 0.592, and constant value is 33.683. From these details, the regression equation of the critical thinking skills variable on learning outcomes of the government senior high students in Makassar is $\hat{Y} = 33.683 + 0.592\ X_1$. This regression equation model shows that each change in critical thinking skills is expected to cause total learning outcomes of *the government senior high school students (SMA Negeri*) in Makassar of 0.592 for constant 33.683.

To discover whether the linear regression equation model can be used to draw conclusions, or whether the linear regression equation obtained is significant or not can be found out by using variance analysis (F-test). The evaluation criteria is $F_{count} > F_{table}$. From the calculation results, it turns out that F_{count} value is 200.318 and F_{table} value is 0.254. As such, the regression equation model obtained can be said to be significant, at a standard significance of 0.05, so the regression equation $\hat{Y} = 33.683 + 0.592\ X_1$ can be used to explain the contribution of critical thinking skills on learning outcomes of senior high school students in Makassar. More details of the

variance analysis for simple regression of the contribution of critical thinking skills on the learning outcomes of government senior high school students (*SMA Negeri*) in Makassar can be seen in table 3 below:

Table 3. Variance Analysis Results for critical thinking skills on learning outcomes of biology students at government senior high schools in Makassar

Source of Variation	Quadrate total	Degree of freedom	Average quadrate	F_{count}	P
Model	3591.685	1	3591.685	200.318	.000[b]
Error	2707.413	151	17.930		
Total	6299.098	152			

The t-test application to investigate the influence of the critical thinking skills variable on learning outcomes of government senior high students (*SMA Negeri*) in Makassar, can be seen in table 4 below:

Table 4. t-test results for critical thinking skills variable

Variable	Value R	Value R^2	Value t
Critical thinking skills	0.755	0.570	14.153

Based on this table, it is shown that the contribution of the critical thinking skills variable on learning outcomes of senior high school students in Makassar, by refereing to the t count value is real or significant at a trusted standard of 0.05%, because the t count 14.153 > the value of P = 0.000. This shows that the predicted regression coefficient parameter β_1 of $b_1 = 0.592$, is also real and positive.

The relationship of the critical thinking skills variable with learning outcomes of *SMA Negeri* pupils in Makassar, can be discoverd through analysis result R. The analysis results obtained a value of 0.755, meaning that the higher the critical thinking skills, the higher the learning outcomes for students of *SMA Negeri* in Makassar. Coefficient determination (R^2) of 0.570 means 57.0% variation in the score results of student can be explained by critical thinking skills.

4.3.3 There is a positive contribution of metacognitive awareness on the learning outcomes of biology students

Based on the simple pair linear regression data analysis results of metacognitive awareness with learning outcomes of national senior high school students in Makassar, it was found that the regression coefficient value b_I obtained was 0.237 and constant value of 40.670. From these details, it can be explained that the regression equation between the metacognitive awareness variable and learning results of senior highs schools students (*SMA Negeri*) in Makassar is $\hat{Y} = 40.670 + 0.237\ X_1$.

This regression equation model shows that each change in metacognitive awareness is hoped to become total learning outcomes for students in Makassar of 0.237 at constant 40.670. To discover whether the linear regression model can be used to reach a conclusion or whether the linear regression equation obtained is significant can be found out by using variance analysis (F-test). The evaluation criteria is $F_{count} > F_{table}$. From the results calculated, the value of F_{count} obtained is 56.567 and the value of F_{table} is 0.254. As such, the regression equation model obtained can be said to be significant, at significance standard 0.05, so regression equation $\hat{Y} = 40.670 + 0.237\ X_1$ can be used to explain the contribution of metacognitive awareness on learning outcomes of *SMA Negeri* pupils in Makassar. More details of the variance analysis results for simple regression of the contribution of metacognitive awareness on learning outcomes of *SMA Negeri* pupils in Makassar can be seen in table 5 below:

Table 5. Variance Analysis Results for metacognitive awareness on learning outcomes of biology students in national senior high schools in Makassar

Source of Variation	Quadrate Total	Degree of freedom	Auadrate Average	F_{count}	P
Model	1716.665	1	1716.665	56.567	0.000[b]
Error	4582.433	151	30.347		
Total	6299.098	152			

T-test application to investigate the influence of the metacognitive awareness variable on learning outcomes of *SMA Negeri* students in Makassar can be seen in table 6 below:

Table 6. t-test results for metacognitive awareness variable

variable	Value R	Value R^2	Value t
Metacognitive awareness	0.522	0.273	7.521

Based on this table, the contribution of the metacognitive awareness variable on learning outcomes for senior high school (*SMA Negeri*) students in Makassar, the value of t count which appears in the above table related to metacognitive awareness is real or segnificant at a trusted standard of 0.05%, because the value of t count at 7.521 > the value of P = 0.000. This shows that the predicted regression coefficient parameter β_1 namely b_1 = 0.237, is also real and positive.

The relationship of metacognitive awareness variable on learning outcomes of students of senior high school in Makassar can be discovered through the results of analysis R. The analysis results obtained a value of 0.522, meaning that the higher the metacognitive awareness, the higher the learning outcomes for senior high schoo (*SMA Negeri*) students in Makassar. Coefficient determination (R^2) of 0.273 means 27.3% variation in students learning outcome scores is explained by metacognitive awareness.

5. Discussion

5.1 Positive Contribution of Critical Thinking Skills (X1), Metacognitive Awareness (X2) and Learning Outcomes (Y)

Based on data analysis, it was discovered that learning outcomes of biology students at government Senior High Schools (*SMA Negeri*) in Makassar found 3 student (1.96%) in the very high category, 114 students (74.51%) in the high category, 25 students (16.34%) in the medium category, 11 students (7.19%) in the low category, and no student in the very low category. If this is related to critical thinking skills of pupils, the average 72.52 in the medium category is 52 (33.99%), and for students' metacognitive awareness for which the average of 53 stduents (34.64%) is in the starting to develop category, this shows that if critical thinking skills and metacognitive awareness increases, then there is a contribution to increasing biology students' learning outcomes. This is strengthened by Maulana's research (2008), which states that critical thinking skills of mathematics students using a metacognitive approach were better and more significant than those of students who studied conventionally.

Based on biology characteristics and the learning phenomena in school, there are many causes of problems in the process and learning outcomes of students studying biology, which is felt to be less than optimal, including the predicted close relationship with thinking skills. The important critical thinking skill for pupils is metacognitive awareness, because if students are conscious of how to learn, they tend to be more aware of their strengths and weaknesses in the learning process. Conversely, if students are forced to study to pass exams well, this makes them lean towards achieving a studying condition which is not conscious and makes them not activate thinkers during learning (Miranda, 2010).

Based on research results showing a positive corrolation between cognitive learning outcomes, critical thinking skills and metacognitive awareness, where R_{count} value is 0.769 and if consulted with table R (0.254) with a significance of 0.05 shows a value $R_{count} > R_{table}$ of 0.769 if consulted, then the contribution between these three variables has a high interval and it can be said that the contribution between the critical thinking skills variable, metacognitive awarenss and learning outcomes is real. R count value is 0.769 and after consultation with categorization, lies at a high interval. From this testing it can be concluded that there is a positive correlation between cognitive learning outcomes, critical thinking skills and metacognitive awareness, which is real and contributes positively with a standard significance of 0.05 %.

5.2 Positive Contribution of Critical Thinking Skills (X1) and Learning Outcomes (Y)

Based on data analysis obtained, it has been found that the relationship betwwen critical thinking skills and learning outcomes at senior high school is of a highest value, which shows that if students' critical thinking skills increase, then their learning outcomes will also increase, influencing giving tests to increase critical thinking skills. Critical thinking is part of problem solving (Scroufe, 1996). Kurland (2000) believes that critical thinking is a technique to evaluate information and ideas in order to decide what will be accepted and believed.

Munandar (2002) propounds that the basis of critical thinking is stages of Bloom's Taxonomy cognitive behavior, namely knowledge, understanding, implementation, analysis, synthesis and evaluation. Critical thinking is a high level thinking skill, starting from the level of analysis, synthesis and evaluation. In spite of this, other than a tight relationship wth the cognitive domain, critical thinking also has branches with the affective and psychomotoric domain (Jacobsen *et al*, 1989). Secondly, Fisher defines critical thinking is synonomous with understanding "evaluation"; so critical thinking is the highest thought process (Fisher, 1992). If so, then it is clear that a person can be said to have thought critically if thinking at the level of analysis, synthesis and evaluation. If this is related to the revised Bloom's Taxonomy propounded by Anderson *et al* (2001) mention that critical thinking is in every category of knowledge and all three levels of the cognitive process.

The four categories of knowledge are factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge. Each categoryy of knowledge has six cognitive processes, namely remembering, understanding, implementing, analysing, evaluating and creating (Anderson *et al*, 2001). From a number of expert theories above, it can be seen that at its core, critical thinking is a process with rules and characteristics. From the charateristic aspect, critical thinking is basically a questioning activity and foms a cognitive activity from the level of analsys, evaluation and creation. From the rules aspect, critical thinking activities must be preceded by reading critically and based on appropriate evidence.

The relationship between critical thinking skills and learning outcomes is strengthened by Afcariono (2008)'s research mentions that the implementation of problem-based learning in Biology class, increases students critical thinking skills. This can be seen from a change in thinking of the students. Students question and answer skills improved from lower level thinking skills (knowledge, understanding and application) to high level thinking skills (analysis, synthesis, and evaluation). The same thing can be seen from referring to Ennis (1985) aiming to increase learning outcomes of students at senior high school. This is underlined in Corebima (2006)'s theory that one alternative to increase students' critical thinking skills is by using various questions which refer to students' thinking process. Frazee and Rudnitski as cited by Corebima (2006) state that questions are the spark which lights up students' thinking, and one of the most important uses of questions is to accelerate high level thinking skills.

Based on research results, it has been established that there is a relationship between critical thinking skills and learning outcomes, Duron and Wough (2006) concluded that there are 5 steps which should be applied in almost all teaching regulations or training to effectively move learners toward critical thinking. This condition is buit on cognitive development theory and best practices, an effective learning environment, evaluation based on results and provision of a teacher with a useful work framework. This learning framework can be used to move students toward a more active learning environment, and eventually be more fun and effective for both teachers and students.

Based on results of the research, a positive correlation can be seen between cognitive learning outcomes and critical thinking skills, where the value of R_{count} is 0.762 and if consulted to table R (0.254) with a significance of 0.05 showing a value of $R_{count} > R_{table}$, therefore, the contribution between the two variables is at a high interval and it can be said that the contribution between the critical thinking skills variable and learning outcomes is real and has a positive contribution with a trusted standard of 76.2%.

5.3 Positive Contribution of Metacognitive Awareness (X2) and Learning Outcomes (Y)

Based on the data analysis obtained, it has been discovered that the relationship between metacognitive awareness and learning outcomes are mostly in the category of well developed (48 pupils or 84.21%), and there are no students in the not particularly developed or high risk categories. This is linked to students learning outcomes, with 52 pupils (91.22%) in the high category, showing that if pupils' metacognitive awareness increases, learning outcomes also increase. This is strengthened by Corebima (2006), who states that the results of a lesson have a big chance to be meaningful, whether related to cognitive, affective, or psychomotoric aspects. Achieving the aims of a lesson can be seen from student's learning outcomes. However, the learning outcomes highlighted as indicators of achievement of learning aims are those related to the cognitive realm. Cognitive learning outcomes will certainly be more meaningful, if they are not instantly lost from memory. Retension plays an important role.

Achieving these cognitive learning outcomes and retention is closely related to students independence in learning. Students' independence is related to their metacognitive skills. Metacognitive skills can help develop one's thinking skills, which in turn influence their learning outcomes. Livingston (1997) states that metacognition plays a critical (or very important) role in learning success. Metacognition encourages high order thinking, which includes active control of the cognitive process in learning. Activities such as planning how to

achieve a task given, monitor understanding, and evaluate cognitive development form metacognition that occurs every day. Metacognitive skills make it possible for students to plan, follow developments and monitor the learning process (Imel, 2002).

Coutinho (2007), states that there is a positive relationship between learning outcomes and metacognition. Students with good metacognitive awareness will show better learning outcomes than those with low metacognitive skills. As well as low metacognitive skills, students cognitive learning outcomes are also low. Even though pupils' average grade reached KKM, this number is not too significant. Facing this reality, efforts are required to empower students' metacognitive awareness to impact on learning outcomes or students' retention. One way to achieve this is by implementing a learning strategy which pushes pupils to develop their metacognitive awareness. Several learning strategies have been proven to empower students' metacognitive awareness, which subsequently relates to their learning outcomes and retention. Not only this, the relationship between metacognitive skills and retention is claimed by Muhiddin (2012) to show that a learning strategy influences learners metacognitive skills, so an integrated PBL+Jigsaw strategy has greater potential to increase metacognitive skill than a conventional learning strategy. These research results are in line with Kristiani (2009) who notes that academic ability does not influence metacognitive skills.

According to Coutinho (2007) students who have low academic prestige can improve through metacognitive training. Metacognitive awareness (understanding tasks, understanding how to undertake tasks, ability to monitor the implementation of tasks) will increase motivation and confidence to undertake tasks. Metacognitive ability is seen as a form of empowering students' thinking.

Livingston (1997) states that increasing pupils' metacognitive skills depends heavily on their prowess in studying by themselves; the more capable of independent study, the more easily their metacognitive skills develop. Schraw and Sperling Dennison (1994) propound that cognitive knowledge measures awareness of a person's strengths and weaknesses, strategiv knowledge and its use. Cognitive regulation is measureing knowledge of use of planning, monitoring and evaluating. Metacognitive skill is a skill to look back at the thought process in self planing, self monitoring and self reflection in learning activities. Gaining the same treatment in studying makes it possible for them to have the same opportunities to be able to order their own learning process in all research groups.

Based on the results of the research undertaken, it can be seen that there is a positive correlation between cognitive learning outcomes and metacognitive awareness, whwer the value of R_{count} is 0.644 and if consulted with table R (0.254) with a significance of 0.05% it shows that the value of $R_{count} > R_{table}$ and if it is consulted, then the contribution between the two is at a high interval and it can be said that the contribution of the metacognitive awareness variable and learning outcomes is real. The value of R_{count} is 0.644 and after consultation with the categories, is at a high interval. The conclusion of this testing is that there is a positive correlation between cognitive learning outcomes and pupils' metacognitive awareness, which is real and at a significance standard of 0.05%.

6. Conclusion

Critical thinking skills and metacognitive awareness have a positive contribution on biology students' learning outcomes of Government Senior High School (*SMA Negeri*) students in Makassar. In specific, critical thinking skills have a positive contribution on biology students' learning outcomes. While, metacognitive awareness has a positive contribution on biology students' learning outcomes and helps their performance in class activities and learning.

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