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# THE CORRELATION BETWEEN ATTITUDE TOWARD SCIENCE AND COGNITIVE LEARNING RESULT OF STUDENTS IN DIFFERENT BIOLOGY LEARNINGS

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**Abstract.** *This research was conducted during one year in three different classes that were taught biology by using three different learnings, Inquiry-based learning, Thinking Empowerment by Questioning integrated with Inquiry learning (TEQI), and Scientific learning. This study investigated the correlation between attitude toward science and cognitive learning results in the three different learnings, and compared the three regression lines whether or not they are parallel. The results of this study show that the correlations between attitude toward science and cognitive learning results in the three biology learnings are significant, with the value of contribution as much as 0.634, 0.448, and 0.708 respectively. The results of the analysis of variance related to the regression equation in the three different learnings are parallel and do not coincide; the regression line of TEQI strategy is at the highest position. It indicated that TEQI strategy has the advantage of training attitude toward science and simultaneously increases students' cognitive learning results.*

**Key words:** *cognitive learning result, inquiry based learning, regression line, attitude toward science.*

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## Introduction

Attitude is defined as a psychological tendency expressed by a particular entity, supportive or not supportive (Eagly & Chaiken, 1998). Attitude has three main components, namely the cognitive component, affective component, and behavior component (Triandis, 1971). The cognitive component refers to the idea generally containing several categories used by humans in their thinking process; those categories are derived from the consistency of response toward different stimuli. Affective component refers to the emotional component that generates ideas, while behavior component is associated with the tendency to act.

The involvement of cognitive component in someone's attitude will give him or her the power to be able to think systematically as a scientist does. Such attitude reflects the mind-set which is in accordance with the science principle or science ethics. Science ethics represents the reflection of scientific ethics. If a reaction of a certain attitude is in line with science ethics, this attitude can be considered as attitude toward science. Attitude toward science reflects the attributes of a person who does not only conduct himself or herself physically towards all the scientific works, but he or she also knows what may be done as a scientist (Rao, 1996).

The indication that an attitude toward science cannot be separated from the other components can be seen from the involvement of cognitive and non-cognitive components in the attitude toward science. According to Adeyemo (2012), Chen and Howard (2010), George (2000), and Papanastasiou (2000), attitude toward science has three fundamental components: belief, feeling, and action. Belief or trust is the cognitive basis of attitude toward science, providing the learners with scientific information, scientific

phenomena, scientific findings, and so forth. The main component of attitude toward science is the feeling toward the belief. The effective teaching and learning, teacher's personalities, learning environment and some others play important role in which the students' belief or trust is converted into actions or feelings towards that direction. This idea supports the previous ideas that there are three main components of attitude, which are cognitive, affective, and behavioral components (Triandis, 1971).

Theoretically, attitude toward science is believed to have a correlation with cognitive learning results. This statement is supported by the previous idea that cognitive component is a part of attitude toward science (Triandis, 1971; Adeyemo, 2012; Chen & Howard, 2010; George, 2000; and Papanastasiou, 2000). An important aspect of attitude toward science is its hierarchical characteristics and having framework of an organized and integrated mental condition. According to Krathwohl (1965) the tendency to react to an object positively or negatively will affect the cognitive structure in achieving something; it is also pointed out that both the positive and the negative effects refer to the object and the power of the effect which are interrelated with the cognitive structure. This means that attitude toward science has a correlation with the cognitive aspect.

The use of an appropriate biology learning strategy can train the students' attitude toward science very well. The researches of the correlation between attitude toward science and academic achievement have been frequently reported especially related to the implementation of certain learning strategy (Altun & Cakan, 2006; Kusutanto et al., 2012; Li & Armstrong, 2009; and Mubeen et al., 2013). This report is supported by Shrigley (1990) stating that attitude has a correlation with cognitive ability related to the implementation of certain learning strategy. Furthermore, George (2003) said that the key factors in natural science learning were students' attitude toward science and the development of positive attitude toward knowledge. Therefore, natural science learning can train students' attitude toward science by the implementation of learning strategy. Usak et al. (2009) also reported that statistically there was a correlation between students' attitudes toward biology and their biology learning achievement, although the correlation was weak. It is also reported that the correlation was not affected by gender but by the students' interest toward the biology program.

The use of different biology learning strategies may display different correlation between students' attitude toward science and students' cognitive learning result. Natural Science learning can be carried out by various learning strategies, such as inquiry based learning, Thinking Empowerment by Questioning integrated with Inquiry Learning (TEQI) learning, and scientific learning. There have been many reports of the correlation between one variable and the other variables in different conditions and different fields of knowledge (Skaalvik & Skaalvik, 2010; Nancy & Miller, 1994; and Baran & Maskan, 2011). Thus, it is possible too that there are different correlations between attitude toward science and cognitive learning result in various biology learning strategies. Therefore, it is necessary to reveal the correlation between the attitude toward science and cognitive learning result of the students which possibly shows different correlations. Based on the results of the previous researches, it is necessary to conduct a research to investigate the correlation between students' attitude toward science and their cognitive learning result using three different biology learnings. Those learnings are inquiry based learning strategy, TEQI strategy, and scientific learning. The significances of this research are that the results can be valuable information for the teachers to choose the appropriate biology learning strategies which do not only improve students' cognitive learning result, but also train students' attitude toward science.

### *Purpose of Research*

This research was carried out to investigate the correlation between attitude toward science and cognitive learning results in three different learning strategies and to compare the three regression lines of the learning strategies whether or not they are parallel. The research questions are formulated as the following:

1. How is the correlation between attitude toward science of students and their cognitive learning results in three different biology learnings?
2. Are the three regression equations of the three biology learnings similar or different?

There have been several studies on attitude toward science, but attitude toward science of students such as honesty, discipline, responsibility, care for the environment, and cooperation during the study of biology is not yet revealed. Therefore, this research is important to be carried to provide more relevant information about attitude toward science in biology learning. This study is expected to provide the biology teachers, curriculum developers and policy makers with more insights relating to attitude toward science of students.



## Method of Research

### *General Characteristics of Research*

This research is a correlation research to investigate the correlation between students' attitude toward science as the predictor and students' cognitive learning result as the criterion. This research was conducted for a year. The population of this research was all of the tenth grade students of senior high school in Malang, Indonesia**.** Three different classes were taken as the subjects of the research, and each class was taught using different learnings: inquiry based learning, TEQI, and scientific learning.

The instruments used in this research were a questionnaire used to measure the students' scientific attitude, and an essay test used to measure the students' cognitive learning result. The indicators of the attitude toward science in this research involved (1) honesty, (2) discipline, (3) responsibility, (4) environment awareness, (5) cooperation. Both instruments were validated before used.

The hypothesis testing began with the prerequisite testing to know if the data distribution was normal. Simple linier regression was used to analyze the correlation between students' attitude toward science and their cognitive learning result in each learning. Analysis of variance related to regression equation was used to uncover the parallelism and the coincidence among the regression lines, as well as to see which learning strategy has the highest correlation between attitude toward science and cognitive learning result.

### *Samples*

Sampling process began with the analysis on student's biology achievement of the state senior high schools in Malang, Indonesia. The analysis results showed that students of three different schools had equal biology scores. Totally all the three schools had nine classes. Each class had 30 students (270 students). Three intact classes (90 students) were randomly taken from each school. The students' ages were between 14 to 15 years old. In this connection, the mean of students' age was 14.82 years old and the SE related was 0.044. During this study, several students did not completely participate in the learning activities due to various reasons. As a result, the number of students in each class sample was not always complete as many as 30 people. Therefore, the data were only collected from 78 students (40 women and 38 men), instead of the total of 90 students. The inquiry learning strategy was implemented in the first class, the TEQI learning strategy was implemented in the second class, and the scientific learning was implemented in the third class. The learning process in this study was conducted during one academic year.

### *Instrument*

The observation sheet of attitude toward science used for the data collection in this study was developed by the researcher, referring to the National Curriculum of Indonesia, with the choice of yes or no toward statements relating to the attitude toward science. Table 1 illustrates the indicators and the criteria of the attitude toward science.

**Table 1. Indicator and criteria of the instrument of attitude toward science.**

| Indicator | Criteria |
|---|---|
| 1. Honest | 1. Reporting the data in accordance with the reality or fact/ similar to the results of the observation.<br>2. Stating opinion or arguments based on the concrete data/ the observed data. |
| 3. Discipline | 1. Attending the experiment or the discussion both inside and outside the classrooms in accordance with the predetermined procedures.<br>2. Submitting the report of the experiments or the results of the discussions both inside and outside the classrooms on time. |
| 3. Responsible | 1. Accepting the consequences or the risks of the actions he or she does during the experiments or discussion both inside and outside the classrooms.<br>2. Collecting evidences before accepting any statements. |
| 4. Environmental care | 1. Maintaining the cleanliness especially in the site where he or she conducts experiments or discussion both inside and outside the classrooms.<br>2. Taking a good care of all the equipment/ materials/books/and the other learning resources. |
| 5. Cooperation | 1. Flexible and open to scientific ideas.<br>2. Involved in the learning activities, from observing, questioning, collecting data, analysing data, and communicating the results of the experiment/activity. |

*Note: It was developed referring to the National Curriculum of Indonesia*

### *Data Collection*

This study used an observation sheet to assess students' attitude toward science in order to collect the data. The observation sheet was filled out by the teacher using observation techniques during the biology learning activities in the classroom. The assessment of the students' attitude toward science was carried out for one year, which was in the 2014-2015 academic year. In that year, the students studied six biological materials. The assessment of students' attitude toward science was carried out two to four times in each biological material. Thus, in one year, the students' attitude toward science were assessed for 12 to 24 times. The attitude score was not kept as a secret because the indicators and the criteria have been informed to the students before the classroom activities began. Before the data were collected, the students were told about the objectives of this study/research, and they were asked to give contribution in the research especially related to their performance of attitude toward science.

### *Data Analysis*

The hypothesis testing began with the prerequisite testing to know if the data distribution was normal. Simple linier regression was used to analyze the correlation between students' attitude toward science and cognitive learning result in each learning. Analysis of variance related to regression equation was used to uncover the parallelism and the coincidence among the regression lines, as well as to see which learning has the highest correlation between attitude toward science and cognitive learning result.



**Results of Research**

*The Correlation between Attitude toward Science and Cognitive Learning Results of Students in Different Learnings*

The results of the data analysis related to the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of inquiry-based learning are illustrated in Table 2.

**Table 2. The regression correlation coefficient of attitude toward science and students' cognitive learning result in inquiry based learning.**

| Model | | Unstandardized coefficients | | Standardized coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 32.105 | 2.030 | | 15.815 | 0.0001 |
| | CoglearningRInquiry | 1.119 | 0.167 | .796 | 6.712 | 0.0001 |

The results of the data analysis in Table 2 show that the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of inquiry learning is Y = 1.119X + 32.105. The contribution value related is 0.634, meaning that the contribution of students' attitude toward science on their cognitive learning results is 63.4% and the contribution of the factors other than students' attitude toward science is 36.6%.

The results of the data analysis related to the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of TEQI learning are illustrated in Table 3.

**Table 3. The regression correlation coefficient of attitude toward science and the cognitive learning result of the students in TEQI learning.**

| Model | | Unstandardized coefficients | | Standardized coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 44.604 | 2.697 | | 16.538 | 0.0001 |
| | CogLearningRTEQI | 0.747 | 0.181 | .669 | 4.128 | 0.0001 |

The results of the data analysis in Table 3 show that the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of TEQI learning strategy is Y = 0.747X + 44.604. The contribution value related is 0.448, meaning that the contribution of students' attitude toward science on their cognitive learning results is 44.8%, and the contribution of the factors other than students' attitude toward science is 55.2%.

The results of the data analysis related to the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of scientific learning are illustrated in Table 4.



**Table 4. The regression correlation coefficient of attitude toward science and cognitive learning result of the students in scientific learning.**

| Model | | Unstandardized coefficients | | Standardized coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 26.032 | 1.236 | | 21.066 | .0001 |
| | CogLearingRStandart | 0.888 | 0.114 | .842 | 7.797 | .0001 |

The results of the data analysis in Table 4 show that the correlation regression equation between students' attitude toward science and their cognitive learning results in the implementation of scientific learning is Y = 0.888X + 26 032. The contribution value related is 0.708, meaning that the contribution of students' attitude toward science on their cognitive learning results is 70.8%, and the contribution of the factors other than students' attitude toward science is 29.2%.

*Anova Test of the Regression Equation of the Correlation between Attitude toward Science and Cognitive Learning Result of the Students in the Three Different Learnings*

The results of the analysis of variance related to correlation regression equation between students' attitude toward science and their cognitive learning results in the three different learnings are illustrated in Table 5.

**Table 5. Summary of the ANOVA test result of the regression equation of the correlation between attitude toward science and cognitive learning results of the students in the three different learnings.**

| Model | Sum of Squares | df | Mean Squares | F | Sig. |
|---|---|---|---|---|---|
| Regression | 9153.682 | 5 | 1830.736 | 56.125 | 0.0001 |
| b3,b5 | 88.756 | 2 | 44.378 | 1.361 | 0.351 |
| b2,b3,b4,b5 | 3329.034 | 4 | 832.258 | 25.515 | 0.001 |
| Residual | 2348.558 | 72 | 32.619 | | |

Result: parallel & not coincide

ANOVA test result indicates that the value of b3, b5 is 0.351 (>0.05), but the value of b2, b3, b4, b5 is 0.001 (<0.05). Those values prove that the regression lines related to the correlation between the students' attitude toward science and their cognitive learning results are parallel to each other, as well as do not coincide.

## Discussion

The first interest of this research is to investigate the correlation between students' attitude toward science and their cognitive learning result in the three different learning, the inquiry based learning strategy, TEQI strategy, and the scientific learning. The result of the data analysis shows that there is a significant correlation between attitude toward science and the cognitive learning result in each kind of learning. It indicates that there is a correlation between attitude toward science and the cognitive learning result in the three kinds of learning. The result of the data analysis also shows that there is a positive value of the correlation coefficient in the three different learnings used. It means that the higher attitude toward science the students have, the higher cognitive learning result they will achieve and vice versa. The finding of this study is still in line with the report of Usak et al. (2009). However, unlike his findings which reported a weak correlation between attitude toward science and

cognitive learning results, the results of this study reveal a strong correlation between attitude toward science and cognitive learning results in the three learning strategies implemented.

This finding implies that it is important to pay attention on students' attitude toward science in the teaching-learning processes since students' attitude toward science has a positive significant correlation with their cognitive learning results. This phenomenon is supported by Carin (1997), stating that similar to cognitive aspect, the development of attitude toward science is also one of the essential aspects in science education.

In line with the phenomenon, Mukhopadhyay (2014) proposed that students' attitude toward science should become a main concern of science teachers. Furthermore, Abell & Lederman (2007) said that attitude was one of the main factors determining students' achievement in science, which has become the main quality parameter of a student who lives in a scientific society these days. Hence, attitude toward science is a fundamental factor in achieving cognitive learning result. Supporting the idea, Lee & Burkam (1996), Simpson & Oliver (1990), and Shauhnessy & Haladyna (1985) stated too that there was a strong correlation between attitude and achievement. Moreover, Osborne (2003), Simpson & Oliver (1990), and Zhyang & Cambell (2010) also stated that attitude was one of the main concerns in science education because it had a significant correlation with academic achievement.

The achievement of cognitive learning result is more likely due to attitude toward science. This idea is supported by the findings of this research that through the implementation of Inquiry Based Learning Strategy, TEQI Strategy, and Scientific Learning, the determinant coefficients of attitude toward science are 0.634, 0.448, and 0.708 respectively. It means that the contribution of students' attitude toward science on their cognitive learning result in the implementation of Inquiry Based Learning Strategy, TEQI Strategy, and Scientific Learning is 63.4%, 44.8%, and 70.8% respectively. Similar to this finding, Clark & Grandy (1984) stated that cognitive learning result, as the final component of learning, was influenced by students' external and internal conditions. In this case, students' attitude toward science is regarded as one of the internal factors.

Both the attitude toward science and the other factors in the teaching and learning of Biology should be taken into account. Curry's taxonomy (1990) explained that motivation and learning styles are correlated with learning achievement. Likewise, Dwyer & Moore (2001) stated that cognitive styles had correlation with learning achievement; moreover, according to Cooper & Mclntyre (1996), Haladyna et al. (1982), Myers & Fouts (1992), and Talton & Simpson (1987), teacher was also the factor which determined the success of students' learning. Therefore, it is important to pay attention on not only the attitude toward science but also the other determining factors in teaching and learning of Biology.

The second interest of this research is to investigate regression equation difference of correlation between attitude toward science and cognitive learning result in different Biology learning strategies. The result of the ANOVA test shows that the regression equations between students' attitude toward science and their cognitive learning result in the three different learning strategies are parallel and not coincide. It means that the improvement rate of students' cognitive learning result in the three different learning strategies is equal. However, the amount of improvement of students' cognitive learning result among the learning strategies differs. In this case, there has been an improvement of students' cognitive learning result caused by attitude toward science in the three different learning strategies, though the amount of cognitive learning result improvement is different. A similar research finding has been reported by Siswati (2014) who said that the improvement rate of students' cognitive learning result with different academic abilities in several learning strategies was the same, yet the amount of students' cognitive learning result improvement in those learning strategies was not similar.

The different amount of cognitive learning result improvement is caused by the different learning strategies used. This finding is in line with the idea of correlation among variables in different conditions (Skaalvik & Skaalvik, 2010; Nancy & Miller, 1994; and Baran & Maskan, 2011). Nancy & Miller (1994) said too that expressing feelings in different situation or condition, for instance feeling of love, might have different results. Baran & Maskan (2011) reported that the significant correlation and difference was found in self academic concept of students related to gender difference, parents' education, family financial condition, and the availability of computers at home. These two findings inform that different situations can yield different results. Thus, the different amount of cognitive learning result improvement in this research is caused by the different learning strategies used.

The graph of the ANOVA test related to regression equation of correlation between attitude toward science and cognitive learning results in the three different learning used shows that the integration of TEQ and Inquiry based learning strategy, known as TEQI, has the highest regression line position than those of the other two learning. This can be interpreted that TEQI strategy is better than the other two learning strategies for training attitude toward science of the students, which also improves their cognitive learning results. This finding may be



caused by the fact that there is TEQ learning in the TEQI learning strategy, which the other learning strategies do not have. In TEQ learning strategy, students are given a worksheet containing several questions. The questions are presented hierarchically and logically so that it can guide the students' mental condition well. This is relevant with the previous statement that an important aspect of attitude toward science is its hierarchical state, and the guarantee of the organized mental working state (Triandis, 1971); besides, Corebima (2010) stated that the questions hierarchically presented in TEQ learning strategy gave the opportunity to the students to think and master the concepts.

In TEQI learning strategy, beside TEQ learning strategy there is also inquiry based learning strategy. Both learning strategies almost have similar characteristics. Inquiry based learning strategy trains students' thinking ability through the process of investigation, while TEQ learning strategy trains students' thinking ability through systematically and logically selected questions. Thus, both learning strategies put emphasis on training students' thinking ability. According to Beyer (1997), Dantonio & Beisenherz (2001), and Wilen (1992), questioning technique has become one of the most common learning techniques used to train students' thinking ability and to encourage students' curiosity as well as to stimulate students' mental activity through inquiry processes. Moreover, Cuevas et al. (2005) stated that questioning technique could be used for helping to conclude learning material. These ideas imply that there is a correlation between questioning and concept comprehension. Concept comprehension gained with investigation process guided by logical and systematic questions will have better effect on students' learning result.

The second highest regression line position of the correlation between students' attitude toward science and their cognitive learning result is related to the inquiry based learning strategy. The inquiry based learning strategy occurs when learners comprehend new information and relate it with their prior knowledge in an organized and systematic manner. Kristiani (2005) stated that inquiry based learning strategy was implemented systematically in a logical order through investigation process. This systematic investigation process is relevant with the cognitive component of attitude toward science. Adeyemo (2012), Chen & Howard (2010), George (2000), and Papanastasiou (2000) previously mentioned that one component of attitude toward science was belief. It is the cognitive basis of attitude toward science facilitating learners with scientific information, scientific phenomena, scientific findings, and so forth. Hence, inquiry based learning strategy can train students' attitude toward science which eventually contributes to their cognitive learning result.

The third regression line position of the correlation between students' attitude toward science and their cognitive learning result is related to the scientific learning. The procedure of this learning is very simple, compared to that of either the inquiry based learning or TEQI learning strategies. The scientific learning procedure covers observing, questioning, collecting data, analysing data, and communicating it. This learning reminds us of the scientific method. The use of scientific method still becomes the icon which actively shapes the teachers and learners to think of scientific practice (Bencze & Bowen, 2001; Palmquist & Finley, 1997; and Simmons et al., 1999). Consequently, the scientific learning can also train students' attitude toward science and improve their cognitive learning result.

**Conclusions**

The results show that the correlation between students' attitude toward science and their cognitive learning results in the three biology learning implemented (Inquiry, TEQI and Scientific Learning) is significant, having the relatively high contribution value (63.4%, 44.8% and 70.8%). The results of further analysis of variance on the three regression equations prove that the three regression lines are parallel. Moreover, the regression line of TEQI learning strategy is proved being at the highest position. It is apparent that the TEQI learning has the greatest potential in empowering students' attitude toward science and simultaneously produces higher cognitive learning results compared to the other two learnings.

Based on the conclusion of the study presented above, it is suggested that teachers use TEQI learning strategy in the classroom activities more frequently. Moreover, due to this study limitation relating to the small number of student participants, it is suggested that further researches use a bigger number of student participants, and are conducted at schools with different background and environments including considering the gender of participants.



**References**

Abell, S. K., & Lederman, N. G. (2007). *Handbook of research on science education*. Lawrence Erlbaum Asssociates: N. Jercy.

Adeyemo, S. A. (2010). Background and classroom correlates of students' achievement in Physics. *International Journal of Educational Research and Technology*, *1* (1), 25-34. Retrieved from http://www.journals.elsevier.com/international.journal.of.educational.research/.

Adeyemo, S. A. (2012). The relationship between effective classroom management and students' academic achievement. *Journal of Educational Studies*, *4* (3), 58-61.

Altun, A., & Cakan, M. (2006). Undergraduate students' academic achievement, field dependent/independent cognitive styles and attitude toward computers. *Journal Educational Technology & Society*, *9* (1), 289-297.

Baran, M., & Maskan, A. K. (2011). A study of relationships between academic self concepts, some selected variables and physics course achievement. *International Journal of Education, 3* (1), 1-12.

Bencze, J. L., & Bowen, G. M. (2001). *Learner-controlled projects in science teacher education: Planting seeds for revolutionary change*. Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Beyer, B. K. (1997). *Improving student thinking: A comprehensive approach*. Boston: Allyn and Bacon.

Carin, M. (1997). Teaching modern science. Upper Saddle River, NJ: Merrill/ Prentice Hall. In S.Yasar, & S. S. Anagun. (Eds), Scale for measuring Scientific Attitude, Turkish *Journal of Science Education*, *6* (2), 169-178.

Chen, C. H., & Howard, B. (2010). Effect of live simulation on middle school students' attitudes and learning toward science. *Journal Educational Technology & Society*, *13* (1), 133–139.

Clark, M. J., & Grandy, J. (1984). Sex differences in the academic performance of Scholastic Aptitude Test takers. *Journal Educational Testing Science Research*, *84* (43), 165-172.

Collins, N. L., & Miller, C. (1994). Self-Disclosure and liking: A meta-analytic review. *Psychological Bulletin*, *116* (3), 457-475.

Cooper, P., & Mcintyre, D. 1996. Effective teaching and learning: teachers' and students' perspectives. Buckingham: Open University Press.

Corebima, A. D. (2010). *Berdayakan Keterampilan Berpikir Selama Pembelajaran Sains Demi Masa Depan Kita* [*Empowering the thinking skills in the science learning for our future*]. Papers Presented at the National Seminar on Science in Surabaya, Indonesia.

Cuevas, P., Lee, O., Hart, J., & Deaktor, R. (2005). Improving science inquiry with elementary students of diverse backgrounds. *Journal of Research in Science Teaching*, *42* (3), 337-357.

Curry, L. (1990). *Learning styles in secondary schools: A review of instruments and implications for their use*. ERIC Document Reproduction Service No. D 317 283.

Dantonio, M., & Beisenherz, P. C. (2001). *Learning to question, questioning to learn: Developing effective teacher questioning practices*. Boston: Allyn and Bacon.

Eagly, Alice H., & Shelly Chaiken (1998). Attitude structure and function. In D.T. Gilbert, Susan T. Fiske, G. Lindzey (Eds.), *Handbook of Social Psychology*. New York: McGraw-Hill, 269–322.

George, R. (2000). Measuring change in students' attitudes towards science over time: An application of latent variable growth modeling. *Journal of Science Education and Technology*, *9* (3), 217-225.

George, R. (2003). Growth in students' attitudes about the utility of science over the middle and high school years: Evidence from the longitudinal study of American youth. *Journal of Science Education and Technology*, *12* (4), 439-448.

Haladyna, T., Olsen, R., & Shaughnessy, J. (1982). Relation of student, teacher, and learning environment variables to attitudes toward science. *Journal Science Education*, *66* (5), 671-687.

Krathwohl, David E., & others. (1965). *Taxonomy of educational objectives*: *Handbook II*, Affective Domain, p. 55.

Kristiani, N. (2005). *Penerapan Pembelajaran Inkuiri untuk Meningkatkan Kerja Ilmiah dan Motivasi Belajar Siswa Kelas II SMA Negeri 5 Malang Pada Pokok Bahasan Alat Indera [The implementation of inquiry learning to enhance students'scientific work and learning motivation in the second grade of state senior high school 5 Malang on the topic tools of senses*]. Paper presented at CAR Training, Biology MGMPs Malang, Indonesia.

Kususanto, P., Fui, C. S., & Lan, L. H. (2012). Teachers' expectancy and students' attitude towards science. *Journal of Education and Learning*, *6* (2), 87-98.

Lee, V. E., & Burkam, D. T. (1996). Gender differences in middle grade science achievement: Subject domain, ability Level, and course emphasis. *Journal Science Education, 80* (6), 613-650.

Li, H., & Armstrong, D. (2009). Is there a correlation between academic achievement and behavior in mainland Chinese students? *Journal Asian Social Science*, *5* (4), 3-9.

Moore, D. M., & Dwyer, F. M. (2001). The relationship of field dependence and color-coding to female students' achievement. *Journal Perceptual and Motor Skills*, *93*, 81-85.

Mubeen, S., Saeed S., & Arif, M. H. (2013). Attitiude towards mathematics and achademic achievement in mathematics among secondary level boys and girls. *Journal of Humanities And Social Science (JHSS)*, *6* (4), 38-41.

Mukhopadhyay, R. (2014). Scientific attitude – some psychometric considerations. *Journal of Humanities and Social Science* (IOSR-JHSS), *19* (1), 98-100.

Myers, R. E., & Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude toward science. *Journal of Research in Science Teaching*, *29* (9), 929-937.

Palmquist, B. C., & Finley, F. N. (1997). Pre-service teachers' views of the nature of science during a postbaccalaureate science-teaching program. *Journal of Research in Science Teaching*, *34* (6), 595 – 615.



Papanastasiou, C. (2000). Effects of attitudes and beliefs on mathematics achievement. *Journal Studies in Educational Evaluation*, *26*, 27-42.

Rao, D. B. (1996). *Scientific attitude vis-à-vis scientific aptitude*. Discovery Publishing House: N.Delhi.

Shauhnessy, J. M., & Haladyna, T. (1985). Research on student attitude toward social study. *Journal Social Education*, *49*, 692–695.

Shrigley, R. L. (1990). Attitude and behaviour are correlates. *Journal of Research in Science Teaching*, *27*, 97-113.

Simmons, P. E., Emory, A., Carter, T., Coker, T., Finnegan, B., & Crockett, D. (1999). Beginning teachers: Beliefs and classroom actions. *Journal of Research in Science Teaching*, *36* (8), 930 – 954.

Simpson, R., & Oliver, J. (1990). A summary of major influences on attitude towards science and achievement in science among adolescent students. *Journal Science Education*, *74*, 1-18.

Siswati, B. H. (2014). *Hubungan Antara Keterampilan Metakognitif dengan Hasil Belajar Siswa Berkemampuan Akademik Berbeda Pada Pembelajaran Biologi yang Menerapkan Beberapa Model Pembelajaran [The Correlation Between Metacognitive Skills and the learning results of the students having different academic achievement in the Biology learning implementing various learning models]*. Unpublished magister's thesis.The State University of Malang, Indonesia.

Skaalvik, E. M., & Skaalvik, S. (2010). Teacher self-efficacy and teacher burnout: A study of relations. *Journal of Teaching and Teacher Education*, *26*, 1059-1069.

Talton, E. L., & Simpson, R. D. (1987). Relationships of attitude toward classroom environment with attitude toward and achievement in science among tenth grade biology students. *Journal of Research in Science Teaching*, *24*, 507–525.

Triandis, C. H. (1971). *Attitude and attitude change*. New York: John Wiley & Sons Inc.

Usak, M., Prokop, P., Özden, M., Özel, M., Bilen, K., Erdoğan, M. (2009). Turkish university students' attitudes toward biology: The effects of gender and enrolment in biology classes. *Journal of Baltic Science Education*, *8* (2), 88–96.

Wilen, W. W. (1992). *Questions, questioning techniques and effective teaching* (3rd Ed.). Washington, D.C: NEA Professional Library, National Education Association.

Zhyang, D., & Campbell, T. (2010). The psychometric evaluation of a three-dimension elementary science attitude survey. *Journal of Science Teacher Education*. Advance online publication.

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