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# The Effects of Inquiry-based Learning Approach and Emotional Intelligence on Students' Science Achievement Levels

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## ABSTRACT

The aim of this study was to examine the effects of inquiry-based learning approach and emotional intelligence on students' science achievement levels. Within a quasi-experimental research design (pre and post-test), the sample of the research comprised of 56 grade 7 students drawn from two classes at different schools in Binjai, Indonesia. In analyzing data, descriptive and inferential statistics through two-way ANOVA were used. The results of research revealed that the students, who attended inquiry learning approach (experimental group), acquired the highest science achievement. For the students with high emotional intelligence, the students, who were taught with the inquiry-based learning approach, possessed higher science achievement than did the conventional learning approach (control group). For the students with low emotional intelligence, the students, who were exposed to the conventional learning approach, had higher science achievement than did the experimental group. The results showed an interaction between the effects of learning approach and emotional intelligence on science achievement. Teachers need to use inquiry-based learning so that students' science achievements can be improved. In order for effective inquiry-based learning, the emotional intelligence of students needs to be improved.

**Keywords:** conventional learning approach, emotional intelligence, inquiry-based learning approach, science achievement.

## INTRODUCTION

Science includes such four elements as process, product, attitude, and application (Sulistijo, Sukarmin, & Sunarno, 2017; Zubaidah, Fuad, Susriati & Suarsini, 2017). Students should learn science through investigation. Hence, they are able to get learning outcomes in the forms of facts, concepts, principles, theories, and laws (Subali, Humaidi & Aminah, 2018; Zeidan & Jayosi, 2015).

In view of Yarger and Penick (1990), learning science makes students achieve a high quality of life, overcome the existing social problems, develop their interests and talents towards science, and facilitate further science learning. People, who are sufficient knowledge of science, are good at transferring their scientific knowledge to other disciplines (Supriadi, 1994). Therefore, science should be taught earlier to the students in schools.

However, Preliminary studies have shown that learning science in junior high schools (SMP) in Binjai, Indonesia is still very poor level (Dinas Pendidikan Dasar, 2015). The

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survey by Trends in International Mathematics and Science Study (TIMSS) showed that the quality of Indonesian science education fell into the 45th position among 48 countries in Asia, Africa and Australia (TIMSS, 2015). Furthermore, the average test score of science was 60.43 of 100. A low science achievement may result from teacher-centered instruction instead of student-centered one (Fuad, Zubaidah, Mahanal & Suarsini, 2015). This means that science learning should be well-designed / planned to improve students' science achievement.

One of the learning approaches improving students' science achievement is an inquiry-based learning. Yunus, Sanjaya, and Jatmiko (2013) showed that using inquiry-based physics learning improved students' science achievement of auditorics. Sağlam and Şahin (2017) and Abdi (2014) revealed that the inquiry-based learning approach was more effective in improving students' science achievement than conventional approaches. Setiawan et al. (2016) indicated that students, who were exposed to an inquiry-based learning, possessed higher science achievement scores than did those in the traditional instruction. The inquiry-based learning is effective in improving their science achievement levels, enthusiasms towards science practices/activities, and attitudes towards science learning processes (Setiawan, Sunarti & Astriani, 2016).

Such learning factors as interest, motivation, student engagement (Castro & Morales, 2017) and emotional intelligence (Woolfolk, 2004) influences science learning and/or achievement. Emotional intelligence is the ability to deploy emotional information appropriately and efficiently (Woolfolk, 2004). Goleman (1995) suggests that emotional intelligence predicts better academic success than traditional one. Several studies have shown that academic achievement is strongly associated with three dimensions of emotional intelligence, namely intrapersonal, adaptation, and stress management (Radfar, Aghaie, Arani, Nooh & Saburi, 2013; Fallahzadeh, 2011; Parker, Saklofske, Shaugnessy, Huang, Wood & Eastabrook, 2005). That is, there has been a significant relationship between emotional intelligence and academic achievement (Chew, Zain & Hassan, 2013; Noor & Hanafi, 2017).

## Theoretical Background

### a) Science Achievement

In view of Gagne and Briggs (1979), learning achievement is the acquired abilities (i.e., intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes) after a learning process. Meanwhile, Reigeluth (1983) suggests that learning achievement is an observable behavior showing a person's ability. Bloom (1979) divides learning achievement into three domains, namely cognitive, affective, and psychomotor. The cognitive domain is related to learning goals, such as the ability to think, understand, and solve problems. The affective domain concerns on goals related to feelings, emotions, values, and attitudes showing acceptance or rejection of something. The psychomotor domain links to motor skills and manipulation of materials or objects.

Science is a discipline explaining the students' observation processes of nature (Ormrod, 2000). According to Carin and Sund (1989), science, which obtains data through observation and controls experiments via processes, products, and human attitudes, is a knowledge system about the universe.

Science refers to the methods and procedures as processes to acquire knowledge. The procedures are called the scientists' basic skills or abilities (science process skills) and generally consist of the following stages: (1) aware of the problem; (2) construct hypothesis; (3) conduct the experiment; (4) do the observation; (5) construct, collect, and analyze the data; (6) repeat the experiment for data verification; and (7) make a data-based conclusion (Carin & Sund, 1989). In point of Passe's (1999) view, science process skills can be divided

into two categories, namely basic and integrated process skills. The basic process skills include observation, classification, measurement, communication, inference, prediction, and interrelationships while the integrated ones contain formulating a hypothesis, identifying the variable, controlling variable, operationally defining variables, conducting the experiment, interpreting data, and investigation (Akgün, Özden, Çinici, Aslan, and Berber 2014; Yildirim, Çalik, and Özmen, 2016).

Science consists of a cumulative knowledge including facts, concepts, principles, laws, and theories, which are the results of human inventions/attempts to understand and explain nature and various natural phenomena. For elementary level, science materials are separated into three scientific fields: physical science, life science, and earth science. The physical science covers such non-biological phenomena as air, magnetism, electricity, and energy. The life science embraces such all living things as animals and human, plants, and the interaction(s) between plants, animals, and environment. The earth science includes astronomy, meteorology, and geology (Cain & Evans, 1990).

Science also contains a certain system of values and attitudes. In this case, the system of values and attitudes refers to the beliefs, opinions, and values that a scientist needs to seek and develop a new knowledge, such as responsibility, curiosity, discipline, diligence, honesty, and openness to the opinions of others (Carin & Sund, 1989).

### b) Inquiry-Based Learning and Conventional Learning Approach

Inquiry-based learning approach consists of activities focusing on students' knowledge, skills, and attitudes that actively engage students in finding their own answers to a questionable problem (Dostal, 2015; Zubaidah, Fuad, Susriati & Suarsini, 2017). Although this approach has been modified several times since 1910, its elements have almost been the same. For example, a teacher presents any event via puzzles, questions, or problems. Then, students are able to: (1) formulate their own hypothesis to explain the event(s) or solve the problem(s); (2) collect data to test the hypothesis; (3) describe the conclusions; and (4) reflect new problems and think about any problem solving process (Woolfolk, 2004; Lashley, Matczynski & Rowley, 2002).

Accordingly, Burden and Byrd (2010) explained the following steps of inquiry-based learning approach: (a) identifying and formulating problems; (b) formulating hypothesis; (c) collecting data; (d) analyzing and interpreting data to test the hypothesis; and (e) describing the conclusions.

Inquiry-based learning approach is underpinned with a constructivist learning, in which students build an understanding by using their own worldviews or pre-existing knwoledge. That is, since learning is an interaction between new and pre-existing knowledge, they construct their own conceptions through intellectual development activities (Burden & Byrd, 2010; Sağlam & Şahin, 2017).

Inquiry-based learning approach should be well-designed and organized, especially for students, who are not good at mastering science and problem solving. Several studies have shown that inquiry-based learning approach is less effective for lower-ability students (Corno & Snow, 1986; Woolfolk, 2004). The most efficient advantages of inquiry-based learning approach is that the subject and the process of investigation or discovery are taught at the same time (Woolfolk, 2004; Burden & Byrd, 2010).

Teachers act as a single source in the conventional learning approach meaning a teacher-centered instructional procedure (i.e, chalk and talk; a presenter of lesson content). This learning approach tends to outline content and lesson schedules that are delivered at the beginning of the lesson. That is, learning process includes some transparencies, paper sheets

with pictures, charts, and forms. Students listen instructional activities or take notes or fill in the exercise forms, or do tasks assigned by the teachers (Suparman, 1997).
In conventional learning activities, teachers give limited feedbacks to student tasks, use few resources and/or equipments. Namely, teachers are very dominant in using and selecting learning resources (Gerlach & Ely, 1971).

In view of Nasution (2000), conventional learning approach has such characteristics as: (1) lessons are presented to a group or class as a whole without considering individual differences; (2) presentation materials are mostly in the forms of lectures, assignments, written, and other medias; (3) an emphasis on the teaching process centered by the teacher; (4) passive students, who have to listen teacher's lecture; and (5) teacher primarily serves as the primary knowledge disseminator or distributor.

### c) Emotional Intelligence

Emotional intelligence is a part of social intelligence that can motivate oneself, regulate emotions, encourage feelings of understanding, and use emotions effectively for arguing and solving problems, and increasing cognitive activities (Yildizbas, 2017; Mayer, Salovey, Caruso & Sitarenios, 2001).

Emotional intelligence is one's ability to motivate themselves, resist failure, control emotions, delay satisfaction, regulate psychological condition from areas of thinking, empathy, and hope (Goleman, 1995). Emotional intelligence is closely related to work success, quality of life, social experience, communication, learning achievement, cognitive functions, and processes of human (Bagheri, Kosnin & Besharat, 2016). There are five areas of emotional intelligence; (1) recognizing emotions; (2) managing emotions; (3) self-motivating; (4) recognizing the emotions of others; and (5) maintaining relationships with others (Goleman, 1995).

Several researches have shown that emotional intelligence has a significant relationship with academic achievement and performance (Bagheri, Kosnin & Besharat, 2016). People, who have high emotional intelligence, are more fortunate and successful in their personal and professional lives (Yildizbas, 2017) and happy, healthy psychologically, and social networks (Furnham, & Petrides, 2003; Austin, Saklofske & Egan, 2005).

### d) Research Aim

The aim of this research was to examine the effects of inquiry-based learning approach and emotional intelligence on students' science achievement levels.

## METHODS

### a) Model of Research

Within a quasi-experimental research design, the current study sought the effects of the independent variables (inquiry and conventional learning approaches; and emotional intelligence--high and low) on the dependent variable (science learning achievement). A 2 x 2 factorial experimental design is presented in Table 1.

**Table 1**. Factorial Design 2 x 2

| **Emotional Intelegence (I)** | **Learning Approach (S)** | | |
|---|---|---|---|
| | | **Inquiry ($S_1$)** | **Conventional ($S_2$)** |
| | High ($I_1$) | $I_1 S_1$ | $I_1 S_2$ |
| | Low ($I_2$) | $I_2 S_1$ | $I_2 S_2$ |

### b) Research Procedure

Prior to the research, the teachers, who would teach the topic to the experimental group, were trained about inquiry-based learning approach. Researchers also gave the topic, teaching objectives, and instructional media for a eight-week treatment. Meanwhile, teachers, who would instruct the topic to the control group, were only given topic and teaching objectives for an eight-week treatment. Meanwhile, teachers at both groups had similar topic and teaching objectives. For the first week, students in both groups were exposed to an 'emotional intelligence' questionnaire. This questionnaire was used to determine the students' levels of emotional intelligence and to divide them into high and low categories.Then, the experimental group attended to inquiry-based learning approach for the other weeks, whilst the control groups was exposed to conventional learning approach. The researcher also observed all learning processes in the experimental group to make sure the extent to which the teachers followed all prepared instructional stages. The researcher also observed the control group for four times in order to confirm teachers' use of conventional learning approach.

In the experimental group, the teachers introduced the topic and explained objectives to students. Then, they were divided into small groups of 4 or 5. Teachers guided students to identify and formulate related problems and hypotheses. They also facilitated students to design the data collection instruments and guided them to analyze and test their hypotheses. They were then asked to draw their conclusions. Next, they were asked to present their works. The teachers helped them to revise somethings if necessary. Finally, the teachers evaluated their understanding of the topic under investigation throughout their group presentations. At the end of the lesson, they were requested to revise the topics they had learned. These procedures were repeated for 6 weeks (three times a week).

In the control group, the teachers introduced the topic and discussed the topic using textbooks and other teaching props. Next, their understanding levels were evaluated by asking questions. Then, the teachers concluded their classes. Those procedures lasted 6 weeks (three times a week). The topic and duration in both groups were the same.

### c) The Sample of Research

The population of this research was all 7$^{th}$-grade students in the junior high school, Binjai, Indonesia. After the homogeinety test was done, the students drawn from SMP 3 Binjai were assigned as the control group (conventional learning approach). The students selected from SMP 4 Binjai, Indonesia, were devoted to the experimental group (inquiry-based learning approach). The sample of the study consisted of 56 students (28 by 28 for high and low emotional intelligence). Each of the four groups involved in 14 high and 14 low emotional intelligence students (see Table 2).

**Table 2**. The sample of the study in regard to place and type of treatment

| **Places and types treatment** / **Emotional intelligence** | **SMP 4** **Inquiry-based learning** | **SMP 3** **Conventional learning** | **N** |
|---|---|---|---|
| **High** | 14 | 14 | 28 |
| **Low** | 14 | 14 | 28 |
| **Total** | 28 | 28 | 56 |

This research was conducted in period of August – November 2016. The science topics comprised of objects of science and its observations, classification of living things and matter, temperature and heat, and their changes.

### d) Research Instrument

The researcher used a post-test to measure the students' science achievement levels and an 'emotional intelligence' questionnaire. The pre- and post-tests consisted of 50 multiple choice questions. Two experienced science teachers (teaching science more than 9 years) checked and validated the post-test's questions and answers. To avoid any research bias, the teachers were selected from other schools, apart from the sample schools. The reliability co-efficients for the multiple choice questions were found to be 0.81 (KR-21) and 0.84 (KR-20). This means that the questions were reliable.

The 'emotional intelligence' questionnaire consisted of 30 Likert-type items. The researcher adopted 30 items from the questionnaire used by Karmila (2014) and modified them in regard to the objectives of the current research. The questionnaire was ranged from 'absolutely agree' (4 points) to 'absolutely disagree' (1 point). A total score of each student was handled to represent their interests.

Prior to the actual study, a pilot study was conducted with 32 students in a junior high school, in Binjai, Indonesia. The pilot study showed that the instructional materials/docuements and data collection instruments were understandable. Cronbach's Alpha value for the questionnaire was found to be 0.721, which is higher than the acceptable value (0.60) suggested by Sekaran and Bougie (2013). The obtained data were analyzed using two-way ANOVA (analysis of variance).

### e) Data Analysis

Within a 2x2 experimental factorial design, two-way ANOVA (Creswell, 2008) examined the effect(s) of the main and interaction factors by classifying variables into two approaches (inquiry-based and conventional learning). A moderator variable was categorized into low and high emotional intelligence. In data analysis, the requirements for the statistical analysis were tested with the normality (One-Sample Kolmogorov-Smirnov Test) and homogeneity (Levene's Test of Equality of Error Variances) tests.

If the results of the variance analysis show an interaction between independent and dependent variables, the post-hoc variance analysis with Tukey's test or Tukey's Honestly Significant Difference (HSD) appears (Ferguson & Takane, 1989; Kirk, 1982) to test the research hypothesis in depth.

## FINDINGS

The hypothesis of this research were: (1) there was a significant difference between two learning approaches' mean scores of science learning achievement; (2) there was an interaction between the effects of the learning approaches and emotional intelligence on the students' science learning achievement levels; (3) the science learning achievement of the students, who were exposed to the inquiry learning approach and possessed high emotional intelligence, were higher than those taught with the conventional approach; (4) the science learning achievement of the students, who were taught with the inquiry-based learning approach and had low emotional intelligence, were lower than those instructed with the conventional learning approach. The data were analyzed with Statistical Package for the Social Science (SPSS) 22.0™. The statistical test requirements for the analysis of this

research were confirmed with normality (One-Sample Kolmogorov-Smirnov Test) and homogeneity (Levene's Test of Equality of Error Variances) tests (see Table 3).

**Table 3**. The Results of the Normality and Homogeneity Tests

| **Data Groups** | **Normality** | | **Homogeneity** | |
|---|---|---|---|---|
| **Post-test of the science learning achievement** | N | Sig. | Levene's Test Score | Sig. |
| | 56 | 0.719 | 0.892 | 0.451 |

As can be seen from Table 3, the data of the current study were normally distributed and all variances were homogeneous ($p > 0.05$).

The results of two-way ANOVA are presented in Table 4.

**Table 4.** The Results of Two-Way ANOVA

| **Source** | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| **Learning Approach** | 423.500 | 1 | 423.500 | 5.511 | .023 |
| **Emotional Intelligence** | 1.786 | 1 | 1.786 | .023 | .879 |
| **Learning Approach*Emotional Intelligence** | 3301.786 | 1 | 3301.786 | 42.963 | .000 |
| **Within Groups** | 997.05 | 52 | 18.14 | - | - |
| **Total of Reduction** | 1928.82 | 55 | - | - | - |

As seen in Table 4, the first and second hypothesis of the current study were accepted. Regarding the second hypothesis of the current study, Tukey test was performed to test any difference between the mean scores of two paired groups via HSD critical value (honestly significant difference) (see Table 5).

**Table 5.** The Results of Two-Way ANOVA with Post-hoc Tukey Test

| **Paired Groups** | **Mean Difference Value ($q_o$)** | **Degrees of Freedom (df)** | **HSD Critical Value ($q_t$)** | **Description** |
|---|---|---|---|---|
| $I_1S_1$ and $I_1S_2$ | 17.09 | 4;52 | 4.03 | Significant |
| $I_2S_1$ and $I_2S_2$ | 8.08 | 4;52 | 4.03 | Significant |

As seen in Table 5, the results of post-hoc two-way ANOVA with Tukey test accepted the third hypothesis. The results of Tukey test indicated the critical Q value to be 17.09 and the Q table value to be 4.03. Thus, the fact that the critical Q value was higher than the Q table one rejected $H_0$ , and accepted $H_1$. The fourth hypothesis was also accepted. The results of Tukey test calculated the critical Q value to be 8.08 and the Q table value to be 4.03. Thus, the fact that the critical Q value was higher than the Q table one rejected $H_0$ , and accepted $H_1$.

## DISCUSSION, CONCLUSIONS and IMPLICATIONS

A significant difference between different learning approaches' mean scores of science achievement may result from features of the inquiry-based learning approaches. That is, mean scores of the inquiry-based and conventional learning approaches' science achievement levels were found to be 60.86, and 55.36 respectively.

This result is consistent with Setiawan, Sunarti, and Astriani's (2016) statement. That is, the inquiry-based learning approach is more effective in improving students' science achievement than does the conventional learning (Abdi, 2014; Castro & Morales, 2017; Subali, Humaidi & Aminah, 2018). A significant difference between students' science achievement levels may come from the inquiry-based learning approaches.

This result supported Prince and Felder's (2006) view addressing that an inquiry-based learning approach is efficient in improving students' academic understanding and science achievement.

Secondly, an interaction between the effects of learning approach and emotional intelligence on the students' science achievement levels may stem from the inquiry-based learning approach facilitating better science achievement than conventional learning approach. In contrast, the students with low emotional intelligence showed a lower science achievement with inquiry-based learning approach than conventional learning approach. This is in line with Hastuti and Panjaitan's (2014) result implying an interaction between the effects of learning strategies and emotional intelligence on students' learning achievement levels.

An interaction between the effects of the learning model and emotional intelligence on students' learning outcomes is consistent with the result of Amin, Nuriah and Sarkadi (2017). The effectiveness of the learning approach is related with students' characteristics (Burden & Byrd, (2010) herefore, teachers need to understand their students' characteristics to determine the best learning approaches for their students.

Thirdly, the students, who had high emotional intelligence, and attended the inquiry-based learning approach, had higher meanscore of science learning achievement (68.71) than did the conventional learning approach (47.85). This means that active learning approaches (i.e., cooperative and inquiry approaches) engaging students in the learning process are more appropriate for students with high emotional intelligence (Amin, Nuriah & Sarkadi, 2017; Hastuti & Panjaitan, 2014).

Because students with high emotional intelligence have such characteristics as self-motivation, optimistic, independent, high thinking ability, empathy, personal goals, and responsible (Joshi, Srivastava & Raychaudhuri, 2012; Stewart, Chisholm & Allen, 2010; Goleman, 1995), employing learning motivation to success and individual responsibility seems to be essential factors supporting the effectiveness of the inquiry-basedlearning approach in practicum. Both factors would encourage students to help each other during the learning process. Conversely, if two factors are absent, students will not be interested in improving their learning achievement levels (Burden & Byrd, 2010). This is in accordance with Slavin's (1995) two necessary factors to obtain academic achievement: group goals (motivation to success) and individual responsibility. In addition, learning approach engaging students actively in learning process (i.e., inquiry based learning strategies), particularly for science, is more effective than the traditional or conventional learning approach (Bredderrnan, 1983).

Fourthly, the students with low emotional intelligence, who were taught by the inquiry-based learning approach, had a lower mean score of science learning achievement (53.00) than did the conventional learning approach (62.85). This means that using a conventional learning approach is more effective for the students with low emotional intelligence because

this approach does not require teamwork, giving learning responsibility to students and challenging to science learning (Amin, Nuriah & Sarkadi, 2017; Hastuti & Panjaitan, 2014). Students with low emotional intelligence will easily follow learning process facilitated by the teacherby. In other words, it can be deduced that the inquiry learning approach is not effective for the low-ability students and low-emotional intelligence (Woolfolk, 2004).

Students with low emotional intelligence take less learning responsibility through active learning processes and show less self-confidence in completing learning tasks. These characteristics need to be guided by teachers during learning process. According to Burden and Byrd (2010), students learn basic skills quickly throughout teachers' directions and explanations in the conventional learning approach. This is in a harmony with Suprihatiningrum's (2016) statement depicting that the conventional learning approach is useful for students with low self-confident and skills in doing their tasks.

In light of the results, it can be concluded that the inquiry-based learning and conventional learning approaches significantly impact the students' science learning achievements. In fact, the inquiry-based learning approachs seems to have highly influenced students' science learning outcomes.

An interaction between the effects of learning approach and emotional intelligence onthe students' science learning achievement levels revealed that the inquiry-based learning approach is more effective for the students with high emotional intelligence. On the contrary, it can be concluded that the conventional learning approach is more efficient for the students with low emotional intelligence.

Based on the findings of this study, the researcher recommends the implementation of inquiry-based learning, especially in science subjects, to improve students' science achievement. Students ' science achievement need to be improved so that students have a high quality of life, can solve social problems, can develop their interests and talents, and can adapt to the development of science and technology needed in the 21st century. In addition, students' emotional intelligence needs to be improved so that inquiry-based learning can be implemented effectively.

Because this study is only limited to science subjects in junior high schools, further researches should be undertaken on different subjects in primary and/or senior high schools. Furthermore, future researches should focus on the learning outcomes of other subjects, such as mathematics, geography, and history.

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