Improving Critical Thinking and Emotional Intelligence Capabilities of Secondary School Students Through Realistic Mathematics Education Approach

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Abstract — This study aims at describing the differences in increasing critical thinking ability and emotional intelligence of students based on realistic mathematics an approach with conventional learning. The study was quasi-experimental. The population is secondary school students in Medan. The instrument used in this study consists of tests of critical thinking and mathematical description of the emotional intelligence scale. Data were analyzed by using a qualitative-descriptive technique ANOVA. The findings show that realistic mathematics instruction can enhance critical thinking ability and emotional intelligence of students. Thus, a further suggestion is that (i) Realistic Mathematics Education is used as an alternative method to improve the students' critical thinking ability and emotional intelligence, (ii) the emotional intelligence of students in mathematics is enhanced in order to use realistic mathematics approach through focus group discussions.

Keywords — Emotional, Constructive, Critical, Interactive, Intelligence, Learning, Mathematics, Realistic, Reflective, Thinking.

I. INTRODUCTION

It is fact that the practice of learning process at all levels of education in schools all over this time, is still concentrating on the cognitive capability that tends to memorizing, while the capability on affective domains has not grown and developed seriously and systematically. Pertainring with this, the findings of direct observations which conducted in secondary schools in Medan, indicating that learning process takes place in one way direction and lack of interaction and mental activities. Teachers actively explain materials and provide examples by writing formulas and exercises, while students only listen, write and perform the task initiated by the teachers. This is not surprising when we look the results of interviews show that learning process which has been done was not attracting students' interest, but feeling of fearful, anxiety and worried when learning mathematics at school, and most of them tend to perceive mathematics as difficult subject. Meanwhile, the results of interviews conducted by the teachers, obtained some important information, such as: cognitive abilities of students are generally low, while the affective and psychomotorics domains of students has never been measured.

It is not an exaggeration to say that one factor that lead to lack of students' ability in mathematics is caused by inadequate mechanistic teaching methods which more emphasis on doing repetitive exercise or drill and less involving mental activities. The consequences of these methods often yields poor result of the students that they are less active and low in comprehending the essence of mathematics. The condition causes the graduate is lack self-awareness, critical thinking, less creative, and lack real life application in their society. Relate with this condition, Atwood (1990) mentions that the mechanistic teaching method or conventional teaching with one way direction whereas teachers are more actively explain and give information will not help students to develop their cognitive ability and emotional intelligence as well.

To improve the quality of cognitive and social interactive in this in the 21st century, some experts proposed the reformation in education that teaching method should be done in account of both cognitive and emotional intelligence. Covey (2008) states that the pattern of learning to develop affective and cognitive of the students is in the nuances of social patterns, which is involving the society interactively. Meanwhile, Oleinik T. (2003) states that the learning process which can enhance students’ critical thinking ability and emotional intelligence is student-centered, which takes place in a social context. Furthermore, Treffers, de Moor and Feijis (in Goffree, F., 1995) agrees that there are three key concepts of learning mathematics in developing mathematical thinking and interpersonal intelligences of students: constructive, interactive and reflective.

One of learning approach that refers to these three key concepts is realistic, which in its origin country, Netherlands, called Realistic Mathematics Education (RME) and has been developing since the 1970s. The underlying philosophy of realistic mathematics learning is that mathematics is seen as a human activity (Freudenthal, 1991; Treffers & Goffre, 1985; Gravemeijer, 1994; Moor, E. 1994; de Lange, 1996). The subject should not be given to students in the form of 'ready-made', but students must constructs the content through the completion of the contextual problem-solving in an interactive, either informally or formally, so they can solve the problem themselves or with guided reinvention, to find whether their answers are right or wrong. RME incorporates some views about what is mathematics, how students learn mathematics and how mathematics should be taught. Thus, Freudenthal believes that students should not be viewed as passive recipients of ready-made mathematics (passive receivers of ready-made mathematics). According to Freudenthal, education should lead students to use a variety of situations and opportunities to reinvent mathematics in their own way. Mathematical concepts arise from process of mathematization-starting from accomplishment which related to the context (context-link solution), students gradually developed it as the device and comprehend the mathematics to a more formal level.

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Models that arising from mathematical activity can encourage student interaction in class, leading to the higher level of mathematical thinking and meaningful learning democracy. Realistic mathematics actively involves students both physically and mentally (students centered learning), and is democratic to have a good profile in improving critical thinking ability and emotional intelligence of students (Hasratuddin, 2014). Thus, the formulation of the problem in this study is "how to increase critical thinking ability and emotional intelligence of students through the learning of mathematics by applying realistic mathematics approach".

II. Methodology

Methods and research design this research is a quasi-experimental with pre and post-test control design.

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\begin{align*}
O_1 & \times O_2 \\
O_1 & \div O_2
\end{align*}
\]

In this design, groups of students are taken randomly from some classes, then the chosen groups were treated experimentally with realistic mathematical approach (X), and a control group given the conventional treatment approach, before and after treatment was given pretest and Post-test \((O_{1,2})\). Subjects of the research were secondary schools' students in Medan.

Research instrument using critical thinking ability test in mathematics as much as five about the ideal shape of the description with a score of 20, and the emotional intelligence scale of 50 items with an ideal score of 150. Data analysis was performed using a qualitative descriptive techniques ANOVA test, Post Hoc and Kendall's tau correlation test.

III. Research Findings

A. The Learning Process

Stages are conducted in realistic mathematics learning, beginning with the provision of contextual challenges or problems, giving students the opportunities to comprehend and accomplish individually or in groups, then discuss the findings as a reflection conventionally. Realistic mathematics has a strong paradigm in the learning process that is the principle of reinvention. This suggests that mathematics was not given to students as ready-made, but students must construct or find the concepts, principles or procedures of mathematics through contextual problems solving that realistic for the children. The initial stages of learning process takes place from the real situation, then organize it, compile the problems, identify aspects of the problem mathematically and, through the interaction, students expected to find a mathematical concept itself, which can later be applied in different problems and situations that takes place in a social environment interaction.

Learning process is done by discussion in groups of three to five people. The purpose of this is to enable students to interactively in groups, facilitate researchers / teachers in providing assistance through the form of questions (scaffolding), and foster students' knowledge and emotional intelligence. Starting point of realistic mathematics learning in this study is to provide a contextual issues challenge to students. These problems may include training, establishment or discovery of concepts, procedures or strategies non-routine accomplishment and mathematics rules (Treffers, 1987). If the expected mental action of students does not appear, such as the incapability of students to links the concepts prior to the information contained in the problem, then the teacher shall provide assistance probing indirectly, by providing a scaffolding questions to students, so interaction between students and teachers, fellow students, or with the context of the problem. Activity for the provision of assistance by the teacher through the questions will be used in the learning process until students have the capability to reflect on the mental action that he did and not judge or punish students. The function of teachers in realistic mathematics is as facilitator, mediator and must be understood that the errors made by students is not because of their will, but due to lack of information they have. So, teachers must have a view that to understand means to forgive everything.

Reflection in the learning process will be given a special time on problem solving activities in a group discussion or in the classical style. It is done, because at this stage students will interact actively with other students, teachers, materials and environment, so hopefully will be able to cultivate critical thinking ability and emotional intelligence of students. This activity is carried out for each topic taught in the learning process of this study. So, the students' opportunity to interactive actively is highly required in the undertaken learning process. It is aimed to find a problem solving on their interaction with each other between group members, teachers and learning environment which expected to be able to improve critical thinking ability and emotional intelligence of students. The provision of contextual problems or challenges will determine of the activities to perform problems construction, student interaction and reflection activities in realistic mathematics approach. These characteristics distinguish between realistic and conventional mathematics learning. In conventional learning, routine problem only serves as an application of a theory or formula given. Learning refers to a system of transfer of knowledge, the teacher serves only as a single informant, and students can only develop cognitive domains at the stage of application of the formula given. Learning process such as this do not develop the thinking ability of students and student interpersonal intelligence (Atwood, 1998).

B. Critical Thinking Capabilities

The purpose of this study is to describe an increase in students' critical thinking ability through realistic mathematical learning approach that compared with conventional learning, taking into account the rating of schools and gender. In addition, it also revealed the interaction between learning approaches to the ranks of the schools and gender in improving students' critical thinking ability. In accordance with the purpose of the study, this research will also reveal an increasing in critical thinking ability that are based on school rating factors and gender
through a realistic approach to mathematics learning. Data collected in this study is in the form of score improvement (gain) critical thinking capabilities which gained from the difference between the final score to the initial score in the range of 0-20, and enhancement of emotional intelligence scale scores.

C. **The findings of improvement critical thinking ability**

Calculation summary of increasing students' critical thinking ability is find that total subjects in the experimental class which applying realistic mathematical approaches are 135 people, while the control class with the conventional learning is 130 people. The average gain of students at pretest on realistic learning was 0.88, whereas the conventional learning is 1.02. The average score of the initial acquisition of critical thinking ability with realistic mathematical approach is 11.50, while the conventional learning is 5.96. So that the average improvement obtained by students in learning through realistic mathematical approach is 10.62 and the conventional learning is 4.94.

To examine the differences in learning approaches made statistical hypothesis, Ho: there is a difference in the improvement of students’ critical thinking capability under realistic mathematics approach with normal learning. By using the t-test found that the t-calculated value is 12.037, while the value of the t-table with degrees of freedom, df (n - 2) = (135-2) = 133 and two-way analysis (0.025) is 1.980. Thus, because the testing criteria; - t-table <t-count <t-table, then Ho is rejected. It can be concluded that realistic mathematics significantly affects student improvement on critical thinking ability. Because, the average of students’ improvement on critical thinking ability was increasing by conducting the realistic mathematics, it can be concluded that the learning process with a realistic mathematics approach is better than the conventional, in improving students' critical thinking capability.

The results of the statistical calculation of data increases critical thinking ability of students based on school ratings are that the average increases in critical thinking ability of students at the high school ratings greater than at moderate and low school rating. Likewise, the average of the increasing students' critical thinking ability at moderate level is higher than the average of the increasing of the lower level.

To test differences in improvement of critical thinking ability by rating schools made statistical hypothesis, Ho: No difference increases students' critical thinking capability in realistic mathematics based on the school ratings. By using ANOVA one-way test, obtained that the calculated significance value 0.027, smaller than the 0.05, then Ho is rejected. Thus, it can be concluded that there are differences in the increase of critical thinking abilities of students based on school ratings. Because, the average increase in critical thinking ability of students at the high school ranks higher, it can be concluded that the realistic mathematics learning in high school ratings are better than medium and lower school ratings.

D. **The findings of differences in improvement of critical thinking capability of students based on gender**

To see whether there are differences in the increase of critical thinking ability of students who were given the treatment of learning math with realistic mathematical approach based on gender, the calculation of summary statistics shows that total of male is 58, with an average increase student' critical thinking capabilities of 8.52, and total of female is 77 with an average increase in the capability to think critically 11.87. To examine differences in the capability to think critically by gender made statistical hypothesis, Ho: No difference increases students' critical thinking ability through learning mathematics which is done with realistic mathematical approach to gender.

By using t-test, it was found that the calculated t-value - 3.987, while the value of the t-table with df (2-way; (n-2) = 1.980. From the testing criteria; if - t-table-count ≤ t ≤ t Ho-table then accepted, and if t-count <t-table or t-count > t-table then Ho is rejected. Because t count is bigger than t-table, then Ho is rejected. Thus, it can be concluded that there is the difference in improvement of critical thinking ability of students by gender in realistic mathematics. Since the average improvement critical thinking ability of female students is higher than male students, it can be concluded that in realistic mathematics learning, women are better than male in improving students’ critical thinking capabilities.

E. **The findings of the interaction between learning with a rating of schools to increase students' critical thinking capability**

One of research goals is to reveal differences in students' critical thinking ability improvement through learning math school ratings based on different realistic. From the calculation of statistical significance was found that the interaction between learning approach with a rating of schools on critical thinking ability are 0.173 and greater than 0.05, then Ho is received. Thus, it can be concluded that there is no interaction between learning approaches to schools rating to increase critical thinking ability. More specifically, the interaction is presented in the following figure.

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**Figure 1. Interaction between Learning Approach to Schools Rating in Increase Student Critical Thinking Capability.**
From Figure 1 show that there is no interaction between learning approach with a rating of schools to increase students' critical thinking ability. This means that there is no influence collectively by learning approach with the rating of schools to increase students' critical thinking capabilities.

F. The correlation with the interaction between learning approach of gender towards the improvement of students' critical thinking abilities.

One of research goals is to describe the interaction between learning approach to gender on increasing of students' critical thinking capabilities. From the results of statistical calculations towards the improvement of students' critical thinking ability based on learning approach and gender are average increased in critical thinking capability achieved by male students in learning with realistic mathematical approaches of 8.52 and 11.87 for female students. The average achievement gain critical thinking ability of male students in regular learning and amounted to 4.09 5.60 female students.

To see the interaction between learning approach with a rating of schools to increase the capability to think critically is as follows, made statistical hypothesis, Ho: There is no significant interaction between the different ratings of schools by gender differences in students' critical thinking ability. From the calculation of statistical significance was found that the interaction of learning approaches to rating schools is 0.100, and greater than 0.05, then Ho is received. Thus, it can be concluded that there is no increased interaction between students' critical thinking ability learning approach used by gender. More specifically, the interaction between learning approaches to gender on students' critical thinking ability can be seen as in Figure 2 below.

![Figure 2. Interaction Between Gender in Learning Approach and Improvement of Critical Thinking ability.](image)

From Figure 2 above shows that there is no interaction between gender in improving learning with critical thinking ability. This means there is no influence exerted on the gender differences in learning together to increase students' critical thinking ability. In applying realistic mathematics learning to improve critical thinking capabilities, it was better men and women are not separating. Although, the increase in critical thinking ability of students in learning mathematics learning realistic higher than conventional. And, the increase in female students' critical thinking ability through realistic mathematical approach and conventional are higher than male students. Thus, the findings of interaction of the above description, it was found that the biggest contributing to the improvement of critical thinking ability is a learning approach in comparison with school ratings and gender factors.

G. The findings and analysis of differences in improvement of critical thinking abilities of students based on gender and school ratings.

The analysis of differences in improvement of critical thinking abilities of students based on gender and school ratings that are intended in this study was to reveal differences in students' increased capability to think and gender-based rating of schools. Statistical tests are used to see the difference increased critical thinking ability is by ANOVA two lanes. The research finding that the average increase in students' critical thinking ability of the highest achieved by female students at high schools rating, followed by female students at lower schools rating, then female students at the medium school rating will get treatment by applying the realistic approach. These findings suggest that the increase in critical thinking abilities of female students is higher than male students.

H. Description of Data Analysis and Increased Emotional Intelligence.

The purpose of this study is to reveal an increase in emotional intelligence based on normal learning, school ratings and gender. In addition, also revealed the interaction between learning approaches to schools rating and gender towards emotional intelligence increasing of students. In accordance with the purpose of the study, the data analyzing of this study is the increasing emotional intelligence that includes the initial and final score of 50 items with a score range of 0-150. The results of statistical description and analysis of data about emotional intelligence is presented as follows.

1) The findings of increasing emotional intelligence of students.

The finding research show that increasing the emotional intelligence of students through realistic mathematical approach to learning is higher than conventional. The results of statistical calculations on the data of emotional intelligence of students increased by using t-test at the 0.05 level, it was found that the calculated t-value 9.827, whereas t-table with degrees of freedom, df (n - 2) = (130-2) = 128 and two-sided test (0.025) is 1.980. Thus, based on testing criteria tcount> t-table, then Ho is rejected. Thus, it can be concluded that there are differences based on students' emotional intelligence enhancement learning approach. Because, the average increase in emotional intelligence of students through realistic mathematical approach is higher than the conventional approach, then it can be concluded that learning math with realistic mathematical approach better than the conventional approach in improving the emotional intelligence of students.
2) The findings to increase the emotional intelligence of students based on school ratings.

From the results of statistical calculations to increase the emotional intelligence of students and based on school ratings by ANOVA test found that F-calculated value is 0.347 and 0.708 significance. Meanwhile, from the F table with the 0.05, df1 (total data group - 1) = 3-1 = 2, and df2 (n - 3) = 135-3 = 132, found that the F-table value is equal to 3.072. Because the F-calculated <F-Table and its significance> 0.05, Ho received. Thus, it can be concluded that there is no difference in improvement of emotional intelligence of students based on school rating, high, medium or low levels. It means that realistic mathematical approaches can be used on each school rating: high, medium or low in improving emotional intelligence.

3) The findings to increase the emotional intelligence of students base gender.

From the results of statistical calculations and the t-test obtained by value t count - 0.339 and a significance value of 0.544. From this table, t, for two-sided test with a significance of 0.025, df degrees of freedom (n - 2) = 135-2 = 133, t-table values obtained at - 1.980. From the testing criteria; because - t-table (-1.980) ≤ t-count (-0.339) ≤ t-table (1.980), then Ho is received. Thus, it can be concluded that there is no difference in improvement of emotional intelligence of students based on gender through realistic mathematical approach. It can be said that the realistic approach to mathematics can be used in improving the emotional intelligence of students by not having to separate the female students by male students.

4) The findings of the interaction between learning approach with a rating of schools to increase students’ emotional intelligence.

To determine the interaction between learning approaches to schools rating to increase students’ emotional intelligence, two-way ANOVA is used. From the results obtained by statistical calculations that the significance of interaction with school rating approach is 0.878 and greater than 0.05, then Ho is received. Thus, it can be concluded that there is no interaction between the factors of learning approaches used by school rating factors on students’ emotional intelligence. Interaction between learning approach with the rating of schools to increase students’ emotional intelligence is no interaction between learning approaches to school rating. In other words, it can be concluded that there is no influence with the given approach to learning with a school rating to increase students’ emotional intelligence. This implies that realistic mathematics learning in enhancing students’ emotional intelligence can be done without regard to rank schools. The average increase in emotional intelligence of students through realistic mathematical approach to higher than conventional learning for every school ratings.

5) The findings and analysis of the interaction between learning approach to gender in improving emotional intelligence of students.

From the results of calculations and data analysis statistics of emotional intelligence of students, found that the significance of the interaction between learning approach with a rating of schools is 0.666, and greater than 0.05, then Ho is received. Thus, it can be concluded that there is no interaction between gender-based on learning approach to improve the emotional intelligence of students. This indicates that there is a joint contribution by gender to approach learning with students’ emotional intelligence. Thus, realistic mathematics learning in improving the emotional intelligence can be done without regard to gender groups of male or female. Although, increasing the emotional intelligence of women are better students than male students. However, the increase in students’ emotional intelligence on the realistic approach to mathematics learning is greater than conventional for boys and girls. In addition, it was found that increasing the emotional intelligence of female students is higher than the increase in emotional intelligence of male students learning mathematics through realistic. From the findings of interaction of the above, it can be concluded that the biggest factor contributing to the increase in students’ emotional intelligence is a learning approach when compared with schools rating factors and gender.

6) The findings and analysis of the differences increase emotional intelligence of students based on gender and school ratings.

One objective of this study was to describe the difference increasing emotional intelligence of students based on gender and school ratings. Prior to analysis and increased differences in emotional intelligence test students on school rank and gender, it is necessary first presented a summary of the calculation of descriptive statistics as follows.

Table1. Descriptive Calculation Summary on Improvement of Emotional Intelligence Based on the Rating and Gender.

<table>
<thead>
<tr>
<th>School Rate</th>
<th>Gen</th>
<th>Average of Emotional Intelligence score</th>
<th>Gain</th>
<th>N</th>
<th>Average of Emotional Intelligence score</th>
<th>Gain</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Learning Approach</td>
<td></td>
<td></td>
<td>Realistic Mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>M</td>
<td>88.47</td>
<td>103.68</td>
<td>15.21</td>
<td>19</td>
<td>89.1</td>
<td>96.57</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>88.21</td>
<td>99.17</td>
<td>10.96</td>
<td>29</td>
<td>90.5</td>
<td>104.3</td>
</tr>
<tr>
<td>Med</td>
<td>M</td>
<td>85.37</td>
<td>100.21</td>
<td>14.84</td>
<td>19</td>
<td>84.0</td>
<td>95.80</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>86.91</td>
<td>101.52</td>
<td>14.61</td>
<td>23</td>
<td>86.5</td>
<td>98.65</td>
</tr>
<tr>
<td>Low</td>
<td>M</td>
<td>85.30</td>
<td>94.05</td>
<td>8.75</td>
<td>20</td>
<td>90.6</td>
<td>91.48</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>79.49</td>
<td>96.00</td>
<td>16.51</td>
<td>25</td>
<td>86.2</td>
<td>97.96</td>
</tr>
</tbody>
</table>

From Table 1 above, it can be said that the greatest increase in emotional intelligence of students achieved by female students at low schools rating through realistic mathematical learning, followed by male students at high schools rating through realistic mathematical learning, and male students at medium school rating.

7) The description of the correlation between students’ critical thinking ability with emotional intelligence.

From the research data and calculation results using statistical analysis of test Kendall's tau-b, is obtained that
the coefficient of correlation between the increase in critical thinking ability with an increase in emotional intelligence is equal to 0.105, with a significance value of 0.081 calculated. Since the significance value calculated is greater than 0.025 (two parties), then $H_0$ is received. Thus, it can be concluded that there is no significant relationship between students’ critical thinking abilities of students with emotional intelligence. Thus, one can say that critical thinking ability can be improved without being affected by emotional intelligence, and conversely an increase in emotional intelligence can be improved without being affected by students’ critical thinking ability.

IV. CONCLUSION

Based on the findings of research and statistical analysis it is done, it can be given several conclusions, among others; (1) there is a difference in the improvement of students’ critical thinking capability under realistic mathematics approach with normal learning, (2) there is a difference in the improvement of students’ critical thinking abilities based on school ratings, (3) there is a difference in the improvement of students’ critical thinking abilities based on gender, (4) there is no interaction between learning approach with the school ranking to increase students’ critical thinking capabilities, (5) there is no interaction between learning approaches to gender in the increase of students’ critical thinking capabilities, (6) there is a difference in the improvement of students’ emotional intelligence based on learning approach, (7) there is no difference in the increase of students’ emotional intelligence based on school ratings, (8) there is no difference in the improvement of emotional intelligence of students by gender, (9) there is no interaction between learning approaches of school rating with the increase of students’ emotional intelligence, (10) there is no interaction between learning approaches of gender with the increase of students’ emotional intelligence, (11) there is no correlation between students’ critical thinking ability of students with emotional intelligence, and (12) students have a positive response to the Realistic Mathematics Education. Generally, realistic mathematics instruction can enhance critical thinking ability and emotional intelligence of students.

From the findings of studies that found the learning of mathematics with realistic mathematical approach can be implemented in an effort to improve critical thinking ability and emotional intelligence of students with no need to distinguish between school rating and gender. Therefore it shows research findings that there is no correlation between critical thinking and emotional intelligence capabilities of students, then in an effort to improve students’ critical thinking capability in learning mathematics with realistic mathematical approach does not rely on emotional intelligence, and in improving the emotional intelligence does not depend on the capability to think critically.

Learning mathematics with realistic mathematical approaches can be used as an alternative to improve critical thinking ability and emotional intelligence of students, and can build and improve the education system while building a democratic and character education. To encourage students interaction, in the learning process, starting by giving a contextual problem or a challenge to students as a means of conflict in finding concept, procedure or discontinuous accomplishment strategy and the rules of mathematics. Provide assistance in the form of scaffolding indirectly probing the students to trigger the occurrence of interactions between fellow students, students with teachers, students with the context of the problem, and students with the environment until the student has the capability to reflect on the actions taken. The teachers or educators need to give a chance of negotiating for students to encourage their interaction and initiative of critical thinking and the growth of emotional intelligence. Understand that mistakes made by students not willingly, but because of the limited information they obtained. In learning process, eliminate the culture of patriarchy or more perceptual view of one group or gender to the other. Educators need to pay attention the synchronization of the critical thinking capabilities as the cognitive and emotional intelligence’s development as the affective sphere. Later, the students’ behavior is expected not only uses the ratio, but also involved the affective domain and instincts to be integrated thoroughly. It is not exaggerate to say if the school must requires the teachers that having the knowledge and good emotional intelligence.

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