Mathematics teachers’ perception of learning models associated with high school students’ critical thinking skills

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Abstract. Critical thinking skills must be included in the classroom learning process since it is an important aspect of 21st century learning. This study was intended to investigate high school Mathematics teachers’ perception of the learning models associated with students’ critical thinking skills. This study was conducted through a survey and the respondents were 44 Mathematics teachers from various high schools in several cities in Indonesia. Random sampling technique was employed to decide the subjects of the study. The research instrument used was a questionnaire and it was distributed by using Google Form. The data were then analyzed quantitatively and qualitatively. The results revealed that high school Mathematics teachers recognized various innovative learning models. Moreover, the teachers had a positive perception of critical thinking implementation in learning. They took the learning model which was appropriate to develop high school students’ critical thinking in learning Mathematics. Most teachers chose and applied problem-based learning models to improve high school students’ critical thinking skills.

1. Introduction
Indonesia is one of the countries which currently develop all sectors to keep abreast of 21st century era. Education is one of the sectors that needs to be improved. Thus, the government made an innovation in learning which was actually a plan to realize a betterment in learning process. Teachers, who always do some innovations in approaches, strategies, models, media and learning resources, make students not easily get bored in learning [1], especially in learning Mathematics. Moreover, the 21st century learning skills consists of critical thinking, creativity, collaboration, and communication [2].

Critical thinking is an essential ability for students which has to be one of the main learning activities in every subject [3]. This is because critical thinking helps students draw conclusion correctly and make decision wisely [4] and it is considered as an important aspect of 21st century learning [5]. Therefore, students are expected to have critical thinking skills in various areas [6]. The attempts to develop critical thinking skills in Mathematics have taken a major part of Mathematics education curriculum all over the world [7,8,9]. Bloom stated that critical thinking is a set of skills such as knowing, understanding, applying, analyzing, synthesizing, and evaluating which are carried out to encounter certain conditions [10].

The current teaching and learning processes mostly occurred in schools were lecturing, which was based on memorizing facts that made students think less critically [11,12]. Thus, disregarding the importance of thinking skills in teaching and learning affects students’ ability to think [13,14]. Even though there are many innovative learning models that can be applied to improve students’ critical
thinking skills, there are a lot of studies in developing critical thinking skills through classroom learning such as inquiry learning [15], problem-based learning [16], project-based learning [17], and discovery learning [1].

In addition, it is important to know the perception of high school Mathematics teachers towards the application of critical thinking at high school level in Indonesia. Studies conducted previously focused on the development of students’ critical thinking skills in Mathematics learning [18] and concentrated on elementary school teachers’ perceptions of learning models associated with creative thinking skills and engineering skills [19]. However, there were limited studies on perception and teachers’ attitudes regarding critical thinking in explicit learning. Investigating teachers’ perception of learning models that foster students’ critical thinking is important to understand how teachers carry out the lesson in the classroom [20]. Therefore, the aim of this study was to investigate high school Mathematics teachers’ perception of learning models that support students’ critical thinking.

2. Methods
This study utilized a survey method with a questionnaire as the research instrument. The questionnaire consisted of two parts. The first part was about the respondents’ profile with nine questions and the second part consisted of fifteen questions about the teachers’ knowledge on learning models. The questions were in the form of multiple choices and open-ended questions. The open-ended questions aimed to delve Mathematics teachers’ perception of learning models that support students' critical thinking. There were 44 high school Mathematics teachers teaching at various levels participated in this study. The respondents were selected using random sampling technique to fill the questionnaire. The questionnaire was distributed to the teachers with various educational background from 37 schools in diverse cities in Indonesia. The data from questionnaire was collected through Google Form and then analyzed quantitatively and qualitatively. The quantitative data were about teacher’s identity and their knowledge about learning models. On the other hand, the qualitative data were presented by using the results of teachers’ perception of students' critical thinking. In addition, Mathematics teachers’ perception of learning models supporting students' critical thinking in high schools was also presented. The data on the respondents are presented in Table 1 and the question items in the questionnaire can be seen in Table 2.

| Table 1. Respondents’ Data |
|-----------------------------|
| **Respondents** | **Percentage (%)** |
| Gender | | |
| Male | 25 |
| Female | 75 |
| Education | | |
| Bachelor degree | 72.7 |
| Master degree | 25 |
| Teacher professional Education program | 2.3 |
| Education Level | | |
| Junior High School/ Islamic Junior High School | 34.1 |
| Senior High School/ Islamic Senior High School | 50 |
| Vocational High School | 15.9 |
| Teaching Experience | | |
| < 1 Year | 2.3 |
| 1 – 5 Year | 45.5 |
| 6 – 10 Year | 22.7 |
| > 10 Year | 29.5 |
| Type of School | | |
| Public School | 54.5 |
| Private School | 45.5 |
Table 2. Question Items in the Questionnaire

| No | Items                                                                 |
|----|----------------------------------------------------------------------|
| 1. | What are the learning models that you are familiar with? Choose the models below (You can choose more than one model) |
|    | ▪ Inquiry                                                          |
|    | ▪ Discovery Learning                                               |
|    | ▪ Cooperative Learning                                             |
|    | ▪ Contextual Learning                                              |
|    | ▪ Learning Cycle                                                   |
|    | ▪ Problem Based Learning                                           |
|    | ▪ Project Based Learning                                           |
|    | ▪ STEM                                                             |
|    | ▪ Open-Ended Learning                                              |
|    | ▪ RME                                                              |
|    | ▪ Others                                                           |
| 2. | Please mention one of the learning models steps that you know.     |
| 3. | Is it important to teach critical thinking skills to high school students? |
|    |   ▪ Yes                                                             |
|    |   ▪ No                                                              |
|    | Please provide the reason!                                         |
| 4. | In your opinion, what is critical thinking skills?                 |
| 5. | In your opinion, which learning models appropriate and you have been implemented to develop high school students critical thinking in learning Mathematics? |
|    | ▪ Inquiry                                                          |
|    | ▪ Discovery Learning                                               |
|    | ▪ Cooperative Learning                                             |
|    | ▪ Contextual Learning                                              |
|    | ▪ Learning Cycle                                                   |
|    | ▪ Problem Based Learning                                           |
|    | ▪ Project Based Learning                                           |
|    | ▪ STEM                                                             |
|    | ▪ Open-Ended Learning                                              |
|    | ▪ RME                                                             |
|    | ▪ Others                                                           |
| 6. | Why do you think those learning models are appropriate to develop students’ critical thinking skills? |
| 7. | What are the results of implementing the learning models (you have been implemented) to the students’ critical thinking skills? |

3. Result and Discussion
The importance of acknowledging various innovative learning models for teachers is that they can choose appropriate learning models to match the skills and the subjects being taught [20]. Figure 1 describes high school Mathematics teachers’ knowledge on innovative learning models. The data were collected from the teachers’ answers on the learning models they were familiar with. The learning models that the teachers know can be seen in figure 1.

Figure 1. Percentage of Learning Models Known by Teachers
In Figure 1 the respondents could recognize all the models mentioned in the questionnaire. Moreover, some of them mentioned several learning models other than those presented in the questionnaire, namely the SSCS model, Reciprocal Teaching and Conventional Learning. Most of the respondents knew problem-based learning, discovery learning and cooperative learning. The teachers’ knowledge of learning models varies according to their educational background and teaching places. However, they knew about innovative learning models. Teachers who had taken professional teacher education and who have completed master's degrees had better knowledge on learning models. Teachers who teach in public and private schools had likely similar understanding on learning models. Furthermore, another factor influencing teachers’ knowledge is teaching experience [20,21]. The teachers’ knowledge could influence the effectiveness and the quality of learning in the classroom [22]. Some learning models that had been implemented to teach Mathematics in high schools as an attempt to improve critical thinking skills were problem-based learning [16] and RME [23]. Several studies conducted previously had focused on improving students' critical thinking skills and how students think critically, and elementary school teachers' perceptions of learning models associated with creative thinking skills and engineering skills. It is also important to know the teachers’ perception of critical thinking skills and its importance in Mathematics learning. Before teachers considered the importance of critical thinking, they must have known the meaning of critical thinking. Teachers' perception of the importance of critical thinking skills were acquired from their answers in the questionnaire. All the teachers perceived that critical thinking skills were important to be taught in high school level, especially in Mathematics. Based on this response, conclusions can be drawn. The result of teachers’ perceptions of critical thinking and the importance of critical thinking skills analysis is presented in Table 3.

### Table 3. Teachers’ Perception of Critical Thinking Skills

| Education Level                      | Teachers’ Perception of Critical Thinking Skills                                                                 |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Junior High School/ Islamic Junior High School | X Critical thinking is a systematic process that allows students to formulate and evaluate their own beliefs.                                                                                   |
|                                       | Y Learning Mathematics requires a problem-solving process so critical thinking is needed.                                                                                  |
| Senior High School/ Islamic Senior High School | X Inquisitiveness on the presented problem so that it can trigger students to ask questions on how, what, and why.                                                                                   |
|                                       | Y One of the goals of Mathematics learning is to develop critical thinking skills. Students are expected not only to receive information but also to be more critical in perceiving why and where the information was obtained with scientific reasoning |
| Vocational High School               | X The ability to analyse, observe and evaluate information to be used as the basis in making decision.                                                              |
|                                       | Y By using critical thinking, students will understand a problem in detail. Therefore, they are expected to solve the problem precisely.                                                                |

*Critical thinking according the teacher: X, *The reason behind the importance of critical thinking according to the teachers: Y

Based on the data in Table 3, teachers have the perception that critical thinking skills can be taught to students at high school level. Teachers who teach at junior high school or Islamic junior high school observed that critical thinking skills were essential to be developed since Mathematics learning required a problem-solving process to help students think in higher level. Nevertheless, teachers teaching in senior high school or Islamic senior high school conceived that critical thinking was important to be developed to make students not only gain information but also be more critical to examine the sources of information obtained by providing it with scientific reason. Furthermore, the teachers who teach at vocational high school believed that critical thinking was critical to be improved as students with critical thinking skills will understand a problem in detail. Therefore, they were expected to solve problems correctly. Besides delving teachers’ perceptions of critical thinking, the questionnaire demanded teachers
to choose one of the innovative models which was appropriate to develop students’ critical thinking skills and they were required to give the reason and the result obtained from the implementation of the learning model they chose. Referring to the questionnaire, the teacher preferred to apply discovery learning, cooperative learning, contextual learning, problem-based learning, project-based learning, open-ended learning, and RME. The reasons and the results after implementing the selected learning model were concluded based on similar learning model. Some teachers’ perceptions of the reasons and the results after implementing certain learning models are briefly explained in Table 4.

Table 4. Learning Model Selection to Develop Critical Thinking Skills

| Selected Model & Percentage (%) | Description of Learning Model Selection to Develop Critical Thinking Skills |
|---------------------------------|-----------------------------------------------------------------------------|
| Discovery Learning (18.2)       | Reason Based on the procedure, students were asked to find their own concepts and answers to problems given with the teacher's guidance. |
|                                 | Result Students had broader insights in analysing and solving problems       |
| Cooperative Learning (6.8)      | Reason In cooperative learning process, there was a step that requires students to develop their critical thinking skills. It was when they were asked to present information in written and spoken form, and solve Mathematical problems by discussing |
|                                 | Result Students became more critical to respond the problem given and they were able to work together and develop their ability to evaluate an opinion or ideas |
| Contextual Learning (4.5)       | Reason Contextual learning could correlate learning material with students’ real-world contexts so that they were able to make connections between the knowledge they acquired with the application in daily life |
|                                 | Result Students could connect the materials obtained with their application in daily life. Therefore, students would be curious which could trigger their critical thinking. |
| Problem Based Learning (45.5)   | Reason The learning model demanded children to develop their mind in drawing conclusions through discovery and problems |
|                                 | Result Students could solve mathematical problems with their own method and the method provided by the teacher |
| Project Based Learning (9.1)    | Reason Students directly involved in the problem-solving process so that they were able to develop their critical thinking skill |
|                                 | Result Students were able to express their opinions and tried to be the best in the process, and it stimulated students’ curiosity |
| Open-ended Learning (45)        | Reason Teacher gave problems to students in which solutions or answers were not limited to only single answer or solution |
|                                 | Result Students actively participated during the lesson and they often expressed their ideas. |
| RME (11.4)                      | Reason Realistic Mathematics Education (RME) focused on students’ real-life concept. |
|                                 | Result Students did not directly receive the materials being taught. They argued on the benefits and the purpose of the knowledge they obtained in their life. |

Based on the data in Table 4, the teacher had selected learning models which can support students’ critical thinking skills based on their assumptions. This indicated teachers’ readiness to develop critical thinking skills in learning Mathematics for high school students. Most teachers selected and
implemented problem-based learning models to develop students’ critical thinking skills. They argued that the learning models required students to expand their mind in drawing conclusions through discovery process and problems. Furthermore, the results obtained after applying the models indicated that students could solve mathematical problems with their own way aside from using the method provided by the teacher.

4. Conclusion
In conclusion, it is important to know about teachers’ perception and knowledge of learning models which support students’ critical thinking. Teachers’ perception of the learning models could predict the possible teaching practices conducted by teachers in the classroom. Based on the analysis of 44 high school teachers, the teachers’ various perceptions and knowledge were influenced by their educational background and experience in teaching. In addition, the teacher had positive perception of critical thinking. According to them, these skills can be developed during the learning so that high school students could obtain critical thinking, high logical reasoning, and other skills essential to face the 21st century. According to the teachers, students’ critical thinking skills could be implemented with various learning models such as discovery learning, cooperative learning, contextual learning, problem-based learning, project-based learning, open-ended learning, and RME. This study was expected to give contribution to high school teachers’ perception of learning models that support the development of critical thinking skills in high school level. The data in this study are expected to be used as the learning foundation at high school level in Indonesia in the future.

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**Acknowledgments**
The author would like to acknowledge the participants, LPDP and also the Postgraduate School of Universitas Pendidikan Indonesia for supporting this research.