Mathematical disposition of strategic thinking ability in working on HOTS questions

E Firmansyah¹, M P Mubarika², L Saniah³
¹,²Magister Pendidikan Matematika, Universitas Pasundan
³Universitas Putra Indonesia

E-mail: eka_firmansyah@unpas.ac.id

Abstract. This article contains the results of a study of the mathematical disposition of strategic thinking skills in working on HOTS (High Order Thinking Skills) questions. HOTS's problem in learning mathematics has recently become a trend. Therefore, many educators have begun to learn about the characteristics of HOTS questions, and some of them consider HOTS problems to be closely related to problems with a high degree of difficulty. This study was made with the aim of looking at the relationship between mathematical dispositions and the ability to think strategically in working on HOTS questions. In learning mathematics, it is suspected that the mathematical disposition has an important role in solving HOTS problems with the assumption that if a student has a good mathematical disposition then he can do HOTS problems easily. Working on HOTS questions is also closely related to the ability to think strategically because the characteristics of HOTS questions require students to think strategically in solving existing problems. The ability to think strategically, basically run by personal characteristics, one of which is mathematical disposition. Therefore, mathematical disposition has an important role in the ability to think strategically in working on HOTS problems.

1. Introduction
The development of the school mathematics curriculum is very interesting to talk about, especially regarding the implementation and aspects of learning theory that underlie it. This is the impact of curriculum changes that over time continue to be done, in order to improve the quality of learning for the achievement of educational goals. The national curriculum, or better known as the 2013 curriculum, requires mathematics teachers to have a broader view of mathematics learning, including mastering mathematical material in accordance with the demands of the times. Teacher and student perceptions are crucial to understanding classroom processes, and teacher efficacy interacts with class difficulty to predict teachers' perceptions is an important thing in the demands of learning at this time. In fact, there are other factors that influence learning in the present, namely: teacher self-reported efficacy is related to student perceptions of teacher traits, and higher efficacy teachers rate remedial students as increasing in effort [15].

The mission of the 2013 curriculum is to build student competencies ranging from elementary school to high school to have: (1) abilities that can be used in solving problems related to mathematics,
other subjects, and problems related to real life; (2) the ability to use mathematics as a communication tool; (3) the ability to use mathematics as a way of reasoning that can be transferred in every circumstance. These abilities are very useful in following higher education, and can become a provision in social life, including in the world of work. In addition, with the abilities possessed by these students, it is expected that students’ mathematical thinking abilities will increase and arouse curiosity and enjoy learning mathematics [1]. Real-life connections provide a deeper understanding to the purpose of math concepts and skills [16]. this will happen if students understand the problem and are diligent in solving it [17].

Mathematical thinking ability that is widely known that is about the ability to think critically and think creatively. To carry out the mission of the 2013 curriculum, scientists developed questions by emphasizing the HOTS (High Order Thinking Skills) approach. HOTS or higher order thinking ability is an ability to think that not only requires the ability to remember, but requires other higher abilities. The ability to think critically and think creatively includes the ability to think at a higher level. However, in this study we will focus more on mathematical strategic thinking abilities. This is done with the allegation that to work on HOTS questions students are not only required to be able to think critically and creatively, but must be able to think strategically so that students can understand, solve problems, and get solutions well. Instructional design developed generally include three main components: (1) involve students in the activities non-routine problem solving; (2) facilitating students to develop the ability to analyze and evaluate (critical thinking) and the ability to create (creative thinking); and (3) encourage students to construct their own knowledge (strategic thinking) [18].

Thinking is one of the main components in learning mathematics. Therefore, mathematics is one of the tools to develop human thought patterns. School mathematics is one of the instruments to train students' mindset through its procedures with the aim that these students can easily provide solutions to the real problems they face. Therefore, students' mathematical thinking habits need to be done through mathematics learning which substantially challenges students to think at a higher level by developing strategic thinking skills to make it easier to carry out existing procedures in solving problems [2].

Learning mathematics is not only to develop cognitive aspects, but also affective aspects such as mathematical disposition. Mathematical disposition is related to students’ tendencies to reflect on their own perspective. Mathematical disposition is one of the factors supporting the success of students' mathematics learning. Mathematical disposition is also one of the factors that influence student behavior in dealing with problems / problems. There was a positive relationship between mathematical disposition and student mathematics achievement [3][12].

The above statement, we can conclude that in mathematics learning by giving HOTS questions in addition to developing mathematical thinking skills also must develop mathematical dispositions. This is allegedly because not all students are able to utilize all the material from mathematics learning, but it is certain that students need a positive mathematical disposition to deal with problematic situations in real life.

2. Method
Therefore, this study is made as a theoretical description of the relationship between disposition and strategic thinking skills in working on HOTS questions. From this study it is also expected that every teacher does not rule out affective competence in students, apart from the demands of the curriculum, student affective competence is one of the most important factors in learning.

3. Result and Discussion
3.1 Mathematical Disposition
Mathematical disposition has a long-term effect in terms of students convincing toward mathematics [13]. This relates to how students reflect on their own perspective that allows students to have a
positive mathematical disposition or vice versa. Negative mathematical disposition, not because students do not have the ability in mathematics only they have a negative perception of mathematics. Teachers are challenged to transform their negative mathematical disposition into positive (productive) mathematical disposition, so that they trust in mathematical power and function to solve problems and for their future career progress [4].

Mathematical disposition is defined as one's belief or behavior about mathematics supporting a tendency to observe mathematics as something logical, useful and valuable [5-6]. The mathematical disposition of students develops when they learn other aspects of competence. For example, when students build strategic competence in solving non-routine problems, their attitudes and beliefs as a learner become more positive. The more concepts a student understands, the more confident the student is that mathematics can be mastered. Conversely, if students are rarely given a challenge in the form of mathematical problems to solve, they tend to memorize rather than follow the proper ways of learning mathematics, and they begin to lose confidence as learners. The more assignments given to students, it can be seen that commitment and challenges in learning will also be less good. How not, boredom in dealing with learning tasks makes student commitment weakens. The number of assignments that students often work on will increasingly reduce the challenges in themselves, as if students are responding to these assignments as usual. When students feel themselves capable of learning mathematics and using it in problem solving, they can develop skills using procedures and adaptive reasoning [14]. The mathematical disposition of students is a major factor in determining the success of their education [7].

3.2 Strategic Thinking Ability

In the previous discussion it was explained that in working on non-routine questions needed a strategic ability that is nothing but the ability to think strategically. The non-routine question in question is a matter of the HOTS approach. The ability to think strategically is the ability to take decisions in undergoing procedures by placing focus and use of time in the process.

The ability to think strategically is needed by students in analyzing problems / problems. Correspondingly, in a changing environment, strategic thinking abilities are needed in one's competence about the more general analytical abilities that have been taught in schools. There are two indicators of strategic thinking ability, including: (1) recognizing dependency, interrelation and patterns; and (2) make consequential decisions using analytical skills and intuition. The two indicators can be divided into three indicators, where the second indicator can be separated between those who use analytical skills and intuition abilities in making consequent decisions [8].

Strategic thinking is creative, critical, and analytical, although using all types of thinking together is difficult. From this statement, we can understand that someone who thinks effectively will show complex mental skills compared to someone who does not think effectively. Mental or cognitive skills enable the acquisition of knowledge by manipulating ideas and processing new information and beliefs in our minds so that it is easier to find solutions to problems [8].

3.3 HOTS Questions in Mathematics Learning

HOTS (High Order Thinking Skills) is known as high-level thinking skills. In its implementation HOTS is a development of Bloom's taxonomy theory. HOTS is the ability to apply knowledge or methods to solve problems creatively, innovatively and consequently able to create new dimensions based on knowledge that has been learned. The implementation of HOTS also refers to curriculum changes and also assessment [10].

HOTS is implemented in an assessment framework so students can assess their ability to solve non-routine questions. The implementation of HOTS in learning mathematics is very important to change the community's stigma of difficulties in learning mathematics. HOTS can also attract students to foster their mathematical disposition in mathematics.

One of HOTS's problems refers to the theory of constructivism. Therefore, students are given the opportunity to build their understanding, attitudes, and creativity. It is expected that students can think
if mathematics is an easy and fun subject. HOTS is consistent with this idea because one of the indicators highlighted in HOTS is creating sustainable learning and instilling creativity among individuals. This is in accordance with the understanding of HOTS which states that HOTS is able to create a new dimension based on knowledge that has been learned so as to create sustainable learning and instill creativity among individuals [11].

3.4 Illustration Example HOTS Problem

To give an idea of the ability to think strategically in working on HOTS problems, an example of a problem that can be adjusted to the indicators of strategic thinking ability can be illustrated as follows:

Examples of questions used to measure ability to recognize dependencies, interrelationships and patterns:

In a class there are 22 students. The teacher holds a Math test. The results of student tests were obtained an average of 5 and a range of 4. If a student's lowest grade and the highest student's grade were not included, the average grade changed to 4.9. The lowest and highest values in a row are ...

Examples of questions used to measure the ability to make consequential decisions using analytical skills:

![Figure 1. Rectangle](image)

It is known that the ABCD rectangle is 12 cm long and 8 cm wide. On each side, a point x cm is determined from each vertex, so that a rectangular PQRS is formed as shown in the figure. The smallest possible area of the PQRS square is ... cm²

(a) 40
(b) 46
(c) 64
(d) 72
(e) 85

Examples of questions used to measure the ability to make consequential decisions using intuitive ability:

In a soccer competition participated by 38 teams, the determination of the winning team was based on the most points gained, with the following points being set: (1) The winning team gets 3 points; (2) If a match is a draw, each team gets 1 point; (3) The losing team gets 0 points. The following table contains the temporary positions of the top 6 teams from a total of 38 teams with 5 matches remaining.
Table 1. Ranking of Match Teams

| Ranking | Team | Points |
|---------|------|--------|
| 1       | K    | 74     |
| 2       | L    | 72     |
| 3       | M    | 70     |
| 4       | N    | 64     |
| 5       | O    | 63     |
| 6       | P    | 60     |

Each team will meet each other in the remaining 5 matches. The exact statement based on that data is ...

(a) Team K will win only 3 times in the remaining matches and one of them wins against Team L
(b) Team L will win only 4 times in the remaining matches and one of them wins over Team K
(c) If Team M wins all remaining matches, then Team L’s position may still be above Team M
(d) If Team L always draws in all remaining matches, then Team O may not be above Team M
(e) Team P will win if it wins all the remaining matches and Team K always loses all remaining matches

Based on the results obtained through such thought processes, it has become a necessity to provide non-routine questions to students so that they are accustomed to new problems that may correspond to what is happening in their lives. In this case, the process of learning mathematics that can lead to situations that can encourage students to think strategically, of course, by giving non-routine questions that are nothing but HOTS problems. To improve their strategic thinking abilities, students are expected to have a good mathematical disposition so that they can reflect on their perspective through these strategic thinking abilities.

4. Conclusions

Mathematical disposition is related to students' tendencies to reflect on their own perspective. The mathematical disposition of students develops when they learn other aspects of competence. For example, when students build strategic competence in solving non-routine problems, their attitudes and beliefs as a learner become more positive. The more concepts a student understands, the more confident the student is that mathematics can be mastered. Conversely, if students are rarely given a challenge in the form of mathematical problems to solve, they tend to memorize rather than follow the proper ways of learning mathematics, and they begin to lose confidence as learners. The ability to think strategically includes three indicators, including: (1) recognizing dependencies, interrelationships and patterns; (2) make consequential decisions using analytical skills; and (3) make consequential decisions using intuitive abilities. HOTS is the ability to apply knowledge or methods to solve problems creatively, innovatively and consequently able to create new dimensions based on knowledge that has been learned so as to create continuous learning and instill creativity among individuals. HOTS is implemented in an assessment framework so students can assess their ability to solve non-routine questions

Acknowledgments

We would like to express our gratitude to our institutions, namely the Postgraduate of Pasundan University and Universitas Putra Indonesia who have given us a lot of support in publishing this article.
References
[1] Badan Standar Nasional Pendidikan 2013 Kurikulum 2013 standar kompetensi inti mata pelajaran matematika Jakarta BNSP
[2] Sutawidjaja 2013 Proses berpikir matematis dan pembelajaran matematika Kongres Nasional Pendidikan Matematika ke V FPMIPA UM Malang
[3] Setiawati 2014 Mengembangkan kemampuan berpikir logis, kreatif, dan habits of mind (HOM) matematis melalui pembelajaran berbasis masalah Disertasi PPs UPI Pelajaran Matematika Jakarta BNSP
[4] Cai J, Robison V, Moyer J, and Wang N 2012 Mathematical dispositions and student learning A Metaphorical Analysis AERA Online Paper Repository p 1-9
[5] Feldhaus C A 2014 How pre service elementary school teachers’ mathematical dispositions are influenced by school mathematics American International Journal of Contemporary Research 4 p 91–97.
[6] Rahayu R, and Kartono 2014 The effect of mathematical disposition toward problem solving ability based on iDEAL problem solver International Journal of Science and Research (IJSR) 3 p 2012–2015
[7] Kilpatrick J, Swafford J, and Findell B 2001 Adding it up: helping children learn mathematics Washington DC: National academy Press.
[8] Pisapia J, 2009 A comparison of the use of strategic thinking skills of aspiring school leaders in Hong Kong, Malaysia, Shanghai, and the United States: an exploratory study International Education Studies 2
[10] Ministry of Education Malaysia 2013 Inisiatif kemahiran berfikir aras tinggi di sekolah.
[11] Abdullah A H, et al. 2017 Mathematics teachers’ level of knowledge and practice on the implementation of higher-order thinking skills (HOTS) EURASIA Journal of Mathematics Science and Technology Education ISSN 1305-8223 (online) 1305-8215 (print) 13 p 3-17
[12] NCTM 2003 Standards for secondary mathematics teacher. United States of America: The National Council of Teachers of Mathematics, Inc.
[13] NCTM 2014 Principles to actions: ensuring mathematical success for all Reston VA Author.
[14] Firmanyah E, and Mubarka M P 2019 Ketangguhan belajar matematika siswa madrasah aiyah JNPM (Jurnal Nasional Pendidikan Matematika) 3
[15] Miller A E, Ramirez E M, and Murdock T B 2017 The influence of teachers’ self-efficacy on perceptions: perceived teacher competence and respect and student effort and achievement Teaching and Teacher Education 64 p 1-304
[16] O’connor C D B, McDaniel C, and Carr J 2019 Bringing math to life: provide students opportunities to connect their lives to math Networks: An Online Journal for Teacher Research 21 p 2
[17] Common Core State Standards Initiative 2018 Standards for mathematical practices.retrieved from http://www.corestandards.org/Math/Practice/Foley
[18] E Apino, H Retnawati 2017 Developing Instructional Design to Improve Mathematical Higher Order Thinking Skills of Students J. Phys. Conf. Ser. 812 012100