

## TEACHING HIGHER-ORDER THINKING SKILLS IN MATHEMATICS CLASSROOMS: GENDER DIFFERENCES

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### Abstract

This case study aims to explore how male and female Indonesian mathematics teachers enact decision-making processes in teaching High-Order Thinking Skills (HOTS). Non-random purposive sampling technique was used to select the participants. The participants involved in this study were two Indonesian mathematics teachers who teach HOTS in their classrooms. The participants were chosen from 87 Indonesian mathematics teachers in 23 secondary schools in East Java, Indonesia, who were invited to our survey and confirmed that they taught HOTS and underwent classroom observation. Data were collected from classroom teaching and interview sessions. The data of classroom teaching consisted of a video-audio recording of two meetings and field notes of observation. In the interview session, we recorded the teachers' responses during semi-structured interviews. We coded and explained our interpretation for each code. We also conducted investigator triangulation by comparing coding and interpretation made by two researchers and discussing them to find the best representation of the meaning of the data. Our findings indicate that both male and female teachers performed four steps of decision making, consisting of giving problems, asking students to solve, checking, and obtaining new ideas. The difference of male and female teachers' decision-making process is observed in the process of giving problem (non-contextual vs contextual), how they ask students to solve and check the solution (individual vs group), and the criteria of the new idea of problem-solving (correct vs the best solution). The study findings can be a catalyst for enacting decision-making steps in teaching HOTS. Also, these can be a reflective practice for mathematics teachers to improve their teaching quality.

**Keywords:** Teaching HOTS, Decision-making, Gender

### Abstrak

Studi kasus ini bertujuan untuk mengeksplorasi bagaimana pengambilan keputusan guru matematika Indonesia dalam membelajarkan keterampilan berpikir tingkat tinggi (HOTS) ditinjau dari gender. Teknik *nonrandom purposive sampling* digunakan untuk memilih partisipan. Partisipan penelitian ini adalah dua orang guru matematika Indonesia yang mengajar HOTS di kelasnya. Kedua partisipan dipilih dari tujuh guru yang diamati pembelajarannya. Ketujuh guru tersebut berasal dari 87 guru matematika Indonesia pada 23 sekolah menengah di Jawa Timur, Indonesia, yang dilibatkan dalam survei dan mengkonfirmasi bahwa mereka mengajar HOTS di kelasnya. Data penelitian ini dikumpulkan dari sesi pembelajaran di kelas dan wawancara. Data pembelajaran di kelas meliputi rekaman video-audio masing-masing dua kali pertemuan dan catatan observasi lapangan. Dalam sesi wawancara, peneliti merekam respon guru terhadap wawancara semi terstruktur. Peneliti membuat kode dan menjelaskan interpretasi untuk setiap kode. Peneliti melakukan triangulasi dengan cara membandingkan pengkodean dan interpretasi yang dibuat oleh dua peneliti dan mendiskusikannya untuk menemukan representasi terbaik dari makna data. Kesimpulan penelitian ini menunjukkan bahwa baik guru laki-laki maupun perempuan melakukan empat langkah dalam pengambilan keputusan membelajarkan HOTS: memberi masalah, meminta untuk menyelesaikan, meminta untuk memeriksa dan meminta untuk mendapatkan ide baru. Perbedaan keputusan guru laki-laki dan perempuan berkaitan dengan penyediaan masalah (non kontekstual vs kontekstual), bagaimana guru meminta siswa untuk memecahkan masalah dan mengevaluasi solusi (individu vs kelompok) dan kriteria ide baru dari pemecahan masalah (solusi benar vs solusi terbaik). Temuan penelitian ini dapat digunakan sebagai bahan pertimbangan tentang pengambilan keputusan dalam membelajarkan HOTS di kelas matematika. Hal ini dapat digunakan sebagai bahan refleksi guru matematika untuk meningkatkan kualitas pembelajarannya.

**Kata kunci:** Pembelajaran HOTS, Pengambilan Keputusan, Gender

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Higher-Order Thinking Skills (HOTS) are highly demanded in the 21<sup>st</sup> century. The development of HOTS is expected to support the mastery of four keys of 21<sup>st</sup>-century competencies, namely critical thinking, creativity, communication, and collaboration (Scott, 2015). One of the current education reformations in Indonesia is to increase the application of HOTS-oriented assignments in classroom learning, including mathematics learning (Kemdikbud, 2016). The development of students' HOTS is essential in classroom mathematics learning. HOTS development is one of the inherent responsibilities in mathematics learning.

HOTS constitutes an important aspect of education. If a teacher deliberately and continuously practices high-level thinking strategies such as encouraging students to deal with a real-world problem, class discussions, and inquiry-based experiments, there is a good opportunity that the students will consequently develop the critical thinking skills as a part of high-level thinking (Miri, David, & Uri, 2007). Teaching HOTS is not only effective in improving students' academic performance but also in eliminating their weaknesses (Heong et al., 2019). In addition, Pogrow (2005) encouraged the teaching of HOTS as an effort to prepare learners for difficult academic challenges, work, and responsibilities in their future. Therefore, HOTS can be used to predict the success of a student. Students who have good HOTS levels are expected to succeed in their future education.

Many teachers have weak conceptions of high-level thinking (Harpster, 1999; Thompson, 2008; Goethals, 2013). Teaching higher-order thinking possesses high challenges as it requires teacher's creativity (Henningsen & Stein, 1997; Thompson, 2008; Alhassora, Abu, & Abdullah, 2017). Research related to HOTS has been carried out to determine students' thinking processes in solving mathematical problems involving HOTS (Bakry & Bakar, 2015). Several learning models to improve higher-order thinking skills have also been developed and proven to work effectively (Samo, Darhim, & Kartasasmita, 2017; Hendriana, Prahmana, & Hidayat, 2019; Saragih, Napitupulu, & Fauzi, 2017; Apino & Retnawati, 2017; Rubin & Rajakaruna, 2015).

Studies on HOTS and the development of several learning models designed to teach HOTS have been conducted. Kurtulus and Ada (2017) revealed that only about two-thirds of prospective teachers are in the high-level cognitive learning domain category (such as analyzing, evaluating, or creating). Alhassora et al. (2017) contended that three main factors are contributing to the challenges faced by mathematics teachers in guiding students to develop high-level thinking skills, namely the condition of teachers, students, and others (time constraints, student diversity, and lack of resources). Apino and Retnawati (2017) asserted that instructional design developed by teachers to teach HOTS generally includes three main components of (1) encouraging learners to be involved in non-routine problem-solving activities; (2) facilitating the development of analysis, evaluation, and creative abilities; and (3) encouraging learners to acquire their knowledge. However, studies on teachers' decision-making process in teaching HOTS remain sparse.

In determining mathematics learning and assessment, the teacher certainly engages in the thinking process. One of the aspects that can influence HOTS learning and assessment is teacher

decision-making. Based on our preliminary observations in some East Java, Indonesia secondary schools, two teachers, one male, and one female, were found to teach HOTS consistently. They teach mathematics in secondary schools in East Java, Indonesia. Gender is one of the aspects that affect and provide differences in the quality of teachers in learning mathematics (Beswick, 2005; Maulana, Helms-Lorenz, & van de Grift, 2015; Abdullah et al., 2017). Thus, this study explores how male and female Indonesian mathematics teachers enact decision-making processes in teaching HOTS.

### ***Higher-Order Thinking Skills (HOTS)***

There is a difference between low-level and high-level thinking skills (Lewis & Smith, 1993). The term “high-level thinking skills” represents a set of lower-order skills that take precedence. Wheary and Ennis (1995) pointed to the need to improve students’ higher-order thinking skills emerges because developing these skills improves the diagnosis of students’ higher thinking levels. It provides feedback about students’ levels of thinking and encourages them to think effectively. Thus, the teachers can obtain information on how far they have achieved the goals of education by conducting studies the ways to teach higher-order thinking skills.

The approach to high-level thinking is divided into learning to remember and learning to transfer (Anderson & Krathwohl, 2001). This approach has adopted the construction of the cognitive dimensions of Bloom's revised taxonomy. Most teachers who work according to country standards and the national curriculum, construe high-level thinking as the items constituting the "top end" of Bloom's taxonomy (analysis, evaluation, and creation, or, in previous terms, analysis, synthesis, and evaluation). The purpose of teaching at the end of one cognitive taxonomy is to equip students to make transfers. Students’ ability to think represents their competence to transfer the knowledge and skills they develop during their learning to a new context. High-level thinking is the students’ ability to associate their learning results to the elements that they were not taught earlier.

Other researchers have given various definitions of HOTS (see, for instance, King et al., 1998; NCTM, 2000; Anderson & Krathwohl, 2001; Lopez & Whittington, 2001; Weiss, 2003; Miri et al., 2007; Thompson, 2008; Kruger, 2013). King et al. (1998) state that HOTS includes critical, logical, reflective, metacognitive, and creative thinking that is activated when individuals face unknown problems, uncertainties, questions, or dilemmas. HOTS entails solving non-routine problems (NCTM, 2000) and constitutes the process of analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). Moreover, HOTS occurs when someone picks up new information and relates to, rearranges, and expands their stored information to achieve a goal or find possible answers in a confusing situation (Lopez & Whittington, 2001).

HOTS includes collaborative, authentic, unstructured, and challenging problems (Weiss, 2003), also strategies, and meta-goal arrangements. Meanwhile, critical, systemic, and creative thinking in HOTS is tactics/activities needed to achieve the stated goals (Miri et al., 2007). HOTS represents the use of an expanded mind to confronting new challenges, and non-algorithmic thinking (Thompson,

2008). It requires people to do something with the facts. People must understand, connect, categorize, manipulate, integrate, and apply them when they seek new solutions to problems. Kruger (2013) states that HOTS involves concept formation, critical thinking, creativity or brainstorming, problem-solving, mental representation, the use of rules, reasoning, and logical thinking.

As discussed earlier in this study, HOTS refers to the highest cognitive domain of the revised Bloom Taxonomy (see Table 1), which includes analyzing, evaluating, and creating. The teacher is encouraged to choose a strategy or method that engaged students to analyze, evaluate, and create.

**Table 1.** Indicator of HOTS Activity (Anderson & Krathwohl, 2001)

<b>HOT Cognitive Domain</b>	<b>Description</b>
Analyzing	Breaking information into parts to explore understandings and relationships, comparing, organizing, deconstructing, interrogating, and finding.
Evaluating	Justifying a decision or course of action, checking, hypothesizing, critiquing, experimenting, and judging.
Creating	Generating new ideas, products, or ways of viewing things, designing, constructing, planning, producing, and inventing.

### ***Decision-Making***

Decision-making is a process that selects the preferred option or series of actions among a set of alternatives based on the provided criteria or strategies (Wang, Wang, Patel, & Patel, 2006; Wang & Ruhe, 2007). Decisions can be considered to be the outcome or output of mental or cognitive processes that lead to the selection of action among several available alternatives (Facione & Facione, 2008). Previous studies on decision-making issues have been exclusively carried out (see Cokely & Kelley, 2009; Ketterlin-Geller & Yovanoff, 2009; Wang & Ruhe, 2007). Decision-making involves one's cognitive processes (Wang & Ruhe, 2007). Decision-making processes include generating ideas, clarifying ideas, and assessing the fairness of ideas (Swartz, Fischer, & Parks, 1998).

Research on decision-making in mathematics learning has also been conducted on teachers and prospective teachers (see Arzarello, Ascari, Thomas, & Yoon, 2011; Kosko, 2016; Dede, 2013). Kosko (2016) studied how elementary prospective teachers decide the teaching-learning processes. Decision-making has also been investigated by comparing the decision-making of two teachers in mathematics learning based on resources, orientations, and goals (Arzarello et al., 2011). Other research has explored the values that underlie the decision-making process of Turkish and German teachers in group learning (Dede, 2013). Further research is needed to find out the teacher's decision-making as an individual actor in teaching (Lande & Mesa, 2016).

Decision-making enacted by the teacher is important and should be studied intensively. Consequently, the present study looks at the teacher's decision-making process in the teaching of HOTS

in the Indonesian secondary schooling contexts. This includes decisions which the teacher makes as well as decision-making processes which include generating, clarifying, and assessing the fairness of ideas (Swartz et al., 1998), as presented in Table 2. It describes that decision-makers can choose following the existing conditions and their objectives. Thus, their choices carry positive effects. In this study, the male and female teachers' decisions and decision-making processes in teaching HOTS are explained in the following sections.

**Table 2.** Decision-Making Process Enacted by Mathematics Teachers in Designing Learning

Decision-Making Steps	Description
Generating Ideas	Registering/classifying possible choices of ideas. Decision-makers are expected to be able to collect various kinds of ideas.
Clarifying Ideas	Analyzing existing ideas, referring to the stage of building ideas. Decision-makers must be able to compare or contrast existing ideas. Furthermore, they must be able to classify and define the ideas then give reasons and describe assumptions based on the ideas.
Assessing the Fairness of Ideas	Assessing all existing logical ideas. Assessment can be done by determining accurate observations, determining reliable secondary sources, or based on existing facts or logical and correct principles.

### **Gender**

Gender issues in mathematics education have been studied for more than three decades in many countries (Haroun, Abdelfattah, & AlSalouli, 2016). Gender is one of the aspects that affect and provide differences in teachers' quality in learning mathematics (Maulana, Helms-Lorenz, & van de Grift, 2015; Abdullah et al., 2017). Haroun et al. (2016) examined teachers' gender differences in teaching knowledge in Saudi Arabia, which concluded that female teachers obtained significantly better content knowledge scores than male teachers. Chudgar & Sankar (2008) found that male and female teachers were different in managing classrooms. They identified female teachers were better in terms of language or communication in the teaching-learning process. However, Smail (2017) found that males and females teachers taught mathematics differently even though they have the same opinion about how to teach mathematics.

Other studies also found a significant effect of gender in terms of learning. Female teachers spent more time closing lessons than male teachers (Maulana, Opdenakker, Stroet, & Bosker, 2012). It was also found that certification status and teacher gender differences cause differences and teaching quality changes (Maulana et al., 2015). Research on mathematics teachers in Malaysia shows that male teachers

are more dominant and have higher average scores in most categories of dependent variables (mathematics teachers' knowledge and practice in HOTS application) than female teachers (Abdullah et al., 2017).

According to Smail (2017), this difference can be driven by the fact that mathematics is often considered a male field, so it should be investigated more closely in future research (Smail, 2017). This is also in line with the idea of Yazici and Ertekin (2010), contending that an in-depth investigation of the reasons for gender differences faced in mathematics belief variables and mathematics teaching anxiety in future qualitative research plays an essential role in the training of future educators. Thus, this study aims to explore male and female mathematics teachers' decision-making processes in teaching HOTS in an Indonesia schooling context.

## **METHOD**

### ***Research Design***

The current study aimed to explore male and female teachers' decision-making processes in teaching HOTS. Therefore, we employed a qualitative case study, which provides the overarching research design to address the research questions and presents a detailed analysis of a single document or a special event (Miles, Huberman, & Saldana, 2014).

### ***Participants***

The case study participants were two Indonesian mathematics teachers, consisting of one male and one female mathematics teacher. The male and female participants were referred to by pseudonyms, Budi and Wati, respectively. We used non-random purposive sampling technique to select the participants. First of all, we invited eighty-seven Indonesian mathematics teachers from 23 secondary schools located in East Java, Indonesia to join our survey aimed to identify the teachers who teach HOTS in their school. Then, we observed the classroom activities of seven mathematics teachers who confirmed that they teach HOTS in our survey. We selected two participants from the seven teachers that we observed based on some criteria. The criteria of selecting the participants were (1) they represented two different genders (male and female), (2) they implemented the best method in teaching HOTS, such as analyzing, evaluating, and creating, (3) they were expert teachers indicated by their year of teaching experience (20 years) (i.e., the winner of local Mathematics Teacher Olympiads), and (4) they were willing to participate in this study.

### ***Data Collection***

Data in this study were obtained through classroom observation of participants' teaching and semi-structured interviews. The data from classroom observation consisted of a video-audio recording of two classroom meetings, as shown in Table 3, and observation/field notes during the teaching. The

observation focused on the teachers' procedures in teaching HOTS.

**Table 3.** Teaching Schedules for Mathematics Learning

Teacher	Meeting	Topics	Indicators
Budi	First meeting	Equations of Absolute Value	Students can solve the problem related to Equations of Absolute Value
	Second meeting	Inequalities of Absolute Value	Students can solve the problem related to Inequalities of Absolute Value
Wati	First meeting	Function	Students can solve the daily life problem using the concept of Function
	Second meeting	Solid	Students can solve the daily life problem by using the concept of Volume in Geometry

Note: each meeting was conducted in 2 x 45 minutes

In the interview session, we recorded participants' responses to our list of interview questions using the video-audio recorder, as shown in [Table 4](#). The interview focused on teachers' decision-making process to choose strategies and how the teachers taught the aspects of HOTS to students, consisting of analyzing, evaluating, and creating, using problems in mathematics learning. The list of questions used in the interview was adapted from a study carried out by Swartz et al. (1998). The data from the interview session were used to enrich and triangulate the data obtained during the classroom teaching. All these data were used to interpret and explain the evidence regarding the participants' decision-making in teaching HOTS.

**Table 4.** Questions from the semi-structured interview protocol

Decision Making Stages	Questions
Generating ideas	a. What kind of math problems-related ideas that you use to teach HOTS? b. What new ideas on math problems you use to teach HOTS? c. ...
Clarifying Ideas	a. What is the reason for choosing a mathematical problem to teach HOTS? b. ...
Assessing the fairness of ideas	a. What is the cause of choosing math problems to teach HOTS? b. What is the effect of choosing math problems to teach HOTS? c. ...

**Data Analysis**

In the current study, there were two main phases of data analysis namely coding and interpreting phases. In the coding phase, first of all, the video-audio recording of classroom teaching and interview session of both participants were transcribed. Then, line-by-line of the transcripts were read. Based on the data, the dialogues were coded based on some themes (i.e., bottom-up coding) (Saldaña, 2013). We also conducted reflection about coding choices and emergent patterns gained from analysis.

In the interpretation phase, we developed an explanation of teachers' decision-making process within each code/category. To do so, the data (e.g., transcripts and codes) were interpreted by two different researchers, then, we compared their interpretation. If the interpretations differed, then they discussed finding the most suitable interpretation representing the meaning of data. We also determined an explanation of teachers' decision-making process to be viable through considering alternative explanations and searching for potential counter-example from the data. All interpretation of the data was not based on the researchers' preferences and viewpoints but be grounded from the data.

**RESULTS AND DISCUSSION**

We found four main categories/themes during the coding process, namely (1) giving a problem, (2) asking students to solve the problem, (3) asking the students to check the solution, and (4) asking students to obtain new ideas. The following subsection discusses each of these main findings in detail.

**Decision-Making Process regarding Problems Given**

In teaching high-order thinking, Budi and Wati were accustomed to giving problems to their students so that they could conduct analyses. The structured problems used by Budi and Wati are shown in [Table 5](#).

**Table 5.** Problems of Budi and Wati

First meeting	Second meeting
<b>Giving Problems by Budi</b>	
Determine the absolute value of the following statement: For $a, b, c$ is the element of $\mathbb{R}$ Applies $a b + c  =  ab + ac $ Explain!	Determine the absolute value of the following statement: $ 5x - 2 ^2 - 5 5x - 2  + 6 \leq 0$ , for $x$ is an element of $\mathbb{R}$ Explain!
<b>Giving Problems by Wati</b>	
There are two taxi companies in a city namely Taxi A and Taxi B. They offer fares as seen below:	A tube with a diameter of 24 cm and a height of 50 cm is filled with water up to $\frac{3}{5}$ of its height. Three 6 cm iron balls are inserted into



First meeting				Second meeting
Distance ( <i>km</i> )	Initial	2	4	the tube. The heigh of water in the tube currently is ... ( $\pi = 3.14$ )
Fares ( <i>Rp</i> )	(0)			
Taxi A	13.000	15.000	17.000	
Taxi B	6.000	10.000	14.000	

Taxi passengers can choose cheaper taxi fares.

Amir wants to go to the Cinema which is 9 *km* from his house. To get a cheaper cost, which taxi should Amir used?

Table 6 shows the decision-making process of the participants based on the interviews transcript. Budi and Wati enact different decision-making processes in giving problems to their students. Budi generates the idea about problems by modifying a simple form of absolute value equation and inequality. Meanwhile, Wati generates the idea about problems by modifying a problem from her previous problem by adding question(s) or changing the context in problems. In clarifying ideas, Budi chooses problems so that the students could investigate the truth value of absolute value equation and inequality. He selects the problem because it is an analysis-type problem. Simultaneously, Wati adopts the contextual mathematics problem in daily life. The problem is solved using several strategies to facilitate her students to do thinking skills. Budi assesses the reasonableness of the idea of the problem because the verification question is an analytical problem included in HOTS. If students resolve the problem, they practice thinking at a high level, in the analysis level. Wati assesses the fairness of the problem idea. Thus, she selects the problem because by solving the problem, students analyze and attempt to use some strategies to get the solution.

**Table 6.** Decision-making process of the participants

Budi	Wati
Generating Ideas	
In the first meeting, Budi generated the idea about the problem by modifying it from the simple form of the absolute value equation. He said, “in the first time, I give simple problem like that, $ a + b  =  b + a $ is the correct statement; $ a + b  =  b - a $ is a false statement; $ a.b  =  b.a $ is the correct statement. The $a, b, c$ is a real number of the three statements, and then I modify the equation to be $a / b + c =  ab + ac $ , $a, b, c$	In the first meeting, Wati chose a non-routine contextual mathematics problem. She said, “I make a problem by modifying my previous problem. I change the context in the problem from the clothing production company to the taxi company. I modify the problem by adding a question, I ask students to choose cheaper production costs.” In the second meeting, Wati also selected a non-routine contextual

<b>Budi</b>	<b>Wati</b>
<p><math>\in \mathbb{R}</math> and ask students to clarify the solution.” In the second meeting, he said, “in the first time I give a problem of <math>x^2 - 5x + 6 = 0</math>, for <math>x</math> is an element of <math>\mathbb{R}</math> and then I modify that problem to be <math> x ^2 - 5 x  + 6 = 0</math>. Then I change it into <math>x</math> to <math>5x - 2</math> and also change equal sign into inequality sign. So that the problem becomes <math> 5x - 2 ^2 - 5 5x - 2  + 6 \leq 0</math>, for <math>x</math> is an element of <math>\mathbb{R}</math>. Then I ask students to clarify the solution.”</p>	<p>mathematics problem. She said, “I modify the existing problem, namely the level of water in the tube which was <math>3/5</math> of the height of the tube. I modify the problem by adding a question, I ask students to determine the level changing of water if 3 balls entered in the tube.”</p>
<b>Clarifying Ideas</b>	
<p>In the first meeting, Budi clarified the problem idea. He said, “I choose the problem of a matter of proof and not a procedural problem, compared to the previous problem.” Also in the second meeting, he clarified the reason for his choice as follows, “I choose a problem that is not a procedural problem, I ask my students to clarify the solution.”</p>	<p>In the first meeting, Wati clarified the problem idea. She said, “I give a contextual mathematics problem to my students and I ask them to solve the problem by using several strategies.” In the second meeting, she also said like the first meeting, “I give non-routine mathematics problem in daily life.”</p>
<b>Assessing the Fairness of Ideas</b>	
<p>In the first meeting, Budi assessed the fairness problem idea. He said, “I choose that problem because the students need thinking skills to solve the problems. In solving the problem, the students need to analyze why he/she solve the problem like that.” In the second meeting, Budi said: “I choose that problem because the students need to analyze the problem using his/her sentences, before solving the problem.”</p>	<p>In the first meeting, Wati assessed the fairness problem idea. She said, “I choose the problem because by solving the problem, students must analyze and try to use some strategies to get the solution(s)”. Meanwhile, in the second meeting, Wati assessed the fairness problem idea. She said, “I choose a daily life mathematics problem to encourage my students to learn how to analyze and think many strategies to solve the problem. Finally, they get the solution(s).”</p>

Budi and Wati enact different types of decision-making processes about problem provision. This difference is in line with Smail (2017) which states that there are differences between males and females teachers in teaching mathematics. The decision of Wati about contextual problems is in line with Freudenthal (1973) and Widjaja (2013), who argued that mathematics is very close and cannot be

separated from the context of human life. Budi and Wati were experienced teachers, based on their 20 years of teaching experiences. It is believed that the mathematics problems given should be compatible with the students' level of cognitive development. Teachers' schemes for designing and implementing learning are influenced by their beliefs and experiences (Borko et al., 2008; Belo, Driel, Veen, & Verloop, 2014; Muhtarom, Juniati, & Siswono, 2019). Teachers often used experiences, such as the abilities possessed by students for several years, to decide which assistance or what instructions can be given to identify students' needs in solving HOTS problems (Sa'dijah, Sa'diyah, Sisworo, & Anwar, 2020). Teachers are encouraged to have a high awareness of students' mathematical dispositions when solving math problems (Sa'diyah, Sa'dijah, Sisworo, & Handayani, 2019). Even though Budi and Wati are both experienced mathematics teachers, they have different views in deciding the mathematics problems for their students. Wati prefers contextual mathematics problem(s), which is in line with Chudgar and Sankar (2008) that female teachers have more language and good communication in teaching mathematics.

### ***Decision-Making Process in Asking Students to Solve Problems***

Table 7 presents an interview excerpt from the teachers' decision-making process. Budi generates the idea of asking students to solve the problems. He uses several alternatives to ask students to work on problems, such as individually, in pairs, or in groups. In generating the idea, Wati employs several methods of directing students to analyze problems individually, in pairs, or groups. Budi clarifies his idea of asking students to solve the problems. If students are asked to do a task individually, they think independently about the problem or analyze the problem to prove the truth value. However, if students are asked to work in a pair or a group, some students are depending on others. Meanwhile, Wati clarifies her idea, by asking each student to understand the problem of a cylinder individually. After which, students discuss the possible solution strategies in groups. In assessing the fairness idea, Budi asks students to work individually because he believes that his students can solve this problem. Besides, he also argues that it is an appropriate activity to develop students' higher-order thinking skills optimally. In assessing the fairness idea, Wati asks students to work in groups because she believes that the students can solve this problem by discussing it with each other.

**Table 7.** Decision-making process in asking students to solve problems

<b>Budi</b>	<b>Wati</b>
<b>Generating Ideas</b>	
In the first meeting, Budi generated the idea by asking students to solve the problems. Budi said, "I ask my students to do mathematics problem(s) individually, in pairs, or groups." In the second	In the first meeting, Wati generated the idea by asking students to solve the problems. Wati said, "I ask my students to analyze the problem(s) individually, in pairs, or in groups." In the second

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meeting, Budi also said, “I ask students to work on the problem(s) individually, in pairs, or groups.”

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meeting, Wati also states, “There are several ways to ask students to analyze the problem(s) individually, in pairs, or groups.”

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#### **Clarifying Ideas**

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In the first meeting, Budi clarified his idea, he said, “If the students do the problem individually, they can solve the problem independently. If the students do the problem in pairs or groups, some students depend on the others.” He also clarified his idea in the second meeting, “If I ask students to think the problem individually, the students think independently. But if students work the problem in pairs or groups, some students depend on the others.”

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In the first meeting, Wati clarified her idea, “I ask students to analyze the problem in groups. I ask students to understand the problem about 2 taxi companies, after that they discuss the solution strategies.” In the second meeting, she also clarified, “Firstly, I ask my student to do it individually to understand the problem about a tube. After that, I ask my students to discuss the possible solution strategies in groups.”

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#### **Assessing the Fairness of Ideas**

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In the first meeting, Budi assessed the fairness idea, “I ask my students to work individually because I believe that he/she can solve the problem by his/her self. It is important to develop their thinking skill optimally”. He also asked the students to work individually in the second meeting. He said, “Doing the task individually is appropriate in this activity. I develop a new mathematics problem from some simple problems. By the way, I expect my students can get the solution and think optimally.”

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In the first meeting, Wati assessed the fairness idea, “I ask my students to work and discuss the problem in groups. That way they can share their ideas.” She also asked her students to work in a group in the second meeting. She said, “Because the problem is a non-routine problem, I think it is appropriate for my students to discuss the problem and share their ideas.”

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The ways Budi and Wati ask students to solve the problems are different. This is in line with Maulana et al. (2015) that gender differences also provide differences in how to teach mathematics. This difference can also be seen in how Budi and Wati manage their classroom as stated by Chudgar & Sankar (2008). However, the ways used by Budi and Wati are in line with Apino and Retnawati's (2017) study who revealed that the model for teaching HOTS facilitates students' independent thinking and encourages them to build their knowledge. Students can also use various representations, which is in line with Sirajuddin, Sa'dijah, Parta, and Sukoriyanto's (2020) investigation that problems need to be given to training students in developing representations in solving problems. This finding highlights that students can analyze the ways to solve the problem (Murtafiah, Sa'dijah, Chandra, & Susiswo,

2020).

**Decision-Making Process in Asking Students to Check the Solution**

Table 8 presents interview excerpts to reveal the decision-making process in asking students to check problem solutions. In generating ideas, Budi has several choices, namely, asking the students to check their solution or asking them to check their solution and also their friends' solution. Out of several variations of these ideas, he chooses to ask the students to check their answers and also their friends' answers. Similarly, Wati also has several strategies to ask students to check the problem solution, namely individually, in pairs, or in groups. She asks the students to evaluate the group's solution by comparing their results with other groups. Budi clarified the chosen idea by considering two choices. If the students are only asked to evaluate their solution, then their skills in evaluating are less optimally. In contrast, if the students are asked to evaluate their solution and their friends' solution, their thinking skills in the evaluation will be better. Meanwhile, Wati, in clarifying her idea, asks the students to check the answer of the groups' solution by comparing their results with other groups, so the students evaluate their solution. In assessing the fairness of his idea, Budi asks students to check their solutions. Consequently, students can develop their higher-order thinking skills (evaluate level). Similarly, in assessing the fairness of her idea, Wati asks students to check the answers of groups solution because she teaches students to evaluate as a part of higher-order thinking skills.

**Table 8.** Decision-making in asking students to check the solution

Budi	Wati
<b>Generating Ideas</b>	
In the first meeting, Budi generated his idea of asking students to check the solution. He said, "I ask students to check their solution individually and in pairs." In the second meeting, he said, "I ask students to check their solution individually and with their friends."	In the first meeting, Wati stated, "There are several strategies to ask students to check the solution, it can be individually, in pairs or groups. I ask the students to evaluate the group's solution by comparing the result with other groups." In the second meeting, she stated, "I guide students to check the solution individually, in pairs or groups. I ask my students to evaluate the group solution by comparing the result with other groups."
<b>Clarifying Ideas</b>	
In the first meeting, Budi clarified his idea, "I ask students to evaluate their solution and ask their friends to check it." In the second meeting, he	In the first meeting, Wati clarified her idea, "I asked the students to check the groups' solution by comparing the solution with other groups, so

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said, "Students can evaluate their answers and their friends' answers."

the students evaluate their solution." In the second meeting, she stated, "I guide students to check their solution by comparing the solution with other groups."

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#### **Assessing the Fairness of Ideas**

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In the first meeting, Budi assessed the fairness of his idea, "I ask students to check the solution because that way can develop higher-order thinking skill (evaluate level)." In the second meeting, he said, "It is an appropriate activity because students do an evaluation which is one of the higher-order thinking skills aspects."

In the first meeting, Wati assessed the fairness of her idea, "I ask students to check the solution of group solution because I teach students to evaluate as a part of higher-order thinking skills." In the second meeting, she said, "I guide students to check their solutions by comparing the result with other groups because that way students do an evaluation, as one of the higher-order thinking skills elements."

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Budi and Wati ask students to check their solutions. They have different ways with the same purposes, asking students to check their solution, their friends' and other groups' solution. It is in line with Anderson and Krathwohl's (2001) observation that checking hypotheses (students' check of both their answers and their friends' answers) is an evaluation activity. Besides, the evaluation activities accorded with Wilson's (2016) statement, that evaluating is justifying a decision or course of action, checking, hypothesizing, critiquing, experimenting, and judging. The students evaluate the analysis results because of the differences in the results. This difference is supported by several previous researchers that gender differences provide differences in teaching mathematics (Chudgar & Sankar, 2008; Haroun et al., 2016; Smail, 2017).

#### ***Decision-Making Process in Directing Students to Find the Right Solution***

Budi and Wati experience a decision-making process in directing students to find the right solution. Table 9 presents Budi and Wati interview excerpts to reveal the decision-making process in directing students to find the solution.

When generating ideas of directing students to find the right solution, Budi has two choices, not giving the students additional questions or giving them some additional questions. Out of several variations of these ideas, he chooses to give some additional questions to the students. Meanwhile, Wati generated her idea in directing students to find problem solutions. The strategy found by the students is new as they have never worked on the problem. Budi clarified the chosen idea by considering two choices, that if he gives additional questions, the students will develop their thinking skills so that they develop new ideas to find solutions in the appropriate activity. If the students get no additional questions, they will take a long time to find new ideas for solving the problems.

**Table 9.** Decision-making process in directing students to find the right solution

<b>Budi</b>	<b>Wati</b>
<b>Generating Ideas</b>	
In the first meeting, Budi generated his idea about how students get the problem solved correctly. He said, "I have several choices, namely, not giving the students additional questions or giving them some additional questions." In the second meeting, he said a similar thing, "I have 2 ways in directing students to find the right solution by giving additional questions or not."	In the first meeting, Wati generated her idea in directing students to find problem solutions. She said, "The strategy found by the students is a new strategy as they have never worked on the problem." In the second meeting, she said, "Students can use several strategies according to their previous knowledge."
<b>Clarifying Ideas</b>	
In the first meeting, Budi clarified the chosen idea, "If I give additional questions, the students will develop their thinking skills so that they can develop new ideas for finding solutions in the appropriate activity. If the students did not get additional questions, they will take a long time to find new ideas for solving problems." In the second meeting, he said, "I give an additional question for students to develop their higher order thinking skill, to find a new strategy in solving the problem."	In the first meeting, Wati clarified her idea of directing students to find problem solutions. Wati said, "Students can use several solution strategies, for example by using the concept of functions, line equations graph or arithmetic series." In the second meeting, she said, "Students can solve the problem by reducing the volume of the tube with the volume of the 3 balls or adding the volume of the tube with the volume of the 3 balls."
<b>Assessing the Fairness of Ideas</b>	
In the first meeting, Budi assessed the fairness of an idea. He said, "I believe that giving the students additional questions can direct them to find new ideas for solving the problems given." In the second meeting, he also mentioned, "I give scaffolding like an additional question to direct students find the new strategy in problem-solving."	In the first meeting, Wati assessed the fairness of an idea. She said, "I believe that the student can find a new strategy because the problem can be solved by using a new strategy that uses previous mathematics topics. In the second meeting, she said, "I give a contextual mathematics problem that can be solved by using students' previous knowledge, so they can find new ideas to solve the problems."

Wati clarified her idea in directing students to find problem solutions. Students can use several solution strategies for example by using the concept of functions, line equations graph, or arithmetic

series which are mathematics topics that they have learned. In assessing the fairness of an idea, Budi was confident that his giving the students additional questions can direct them to find new ideas for solving the problems given. On the other hand, Wati assessed the fairness of an idea, by believing that the student can find a new strategy because she gives students a problem that can be solved by using a new strategy that uses previous mathematics topics.

Budi and Wati have differences in directing students to find the right solution. This difference is in line with the results of previous research that the gender difference gives a difference to the way they teach mathematics, including in teaching HOTS (Maulana et al., 2015; Haroun et al., 2016; Smail, 2017; Abdullah et al., 2017). However, the differences between the Budi and Wati methods in the mathematics learning process are based on the same goal of teaching HOTS to students. This is in line with Smail (2017) that although they have the same opinion about teaching mathematics, they have different ways of mathematics learning practice.

Budi and Wati can teach HOTS to students. Students can practice higher-order thinking skills, including reflective thinking which is a very active and rigorous activity concerning student knowledge (Kholid, Sa'dijah, Hidayanto, & Permadi, 2020). The students can use additional questions from the teacher to overcome their misunderstandings and build their understanding (Schoenfeld, 2011; Handayani, Sa'dijah, Sisworo, Sa'diyah, & Anwar, 2020). Thus, it enables them to generate new ideas in solving problems, creating and generating new ideas, products, or ways of viewing things (Anderson & Krathwohl, 2001). The students can find the right solutions to the problem. They can generate new ideas and are also encouraged to produce verbal explanations using language that is accorded with mathematical concepts.

The problem that the teachers gave is a form of mathematics task-oriented HOTS since the teacher encouraged the students to engage in higher-order thinking activities. The two teachers ask the students to solve the problem by analyzing it, evaluating it, then creating ideas. In presenting the problem, the teachers give several questions to facilitate the students' thinking. The teachers' assignment pattern is proven to develop HOTS among the students. The most dominant planning involved in teaching is designing assignments and applying them to learning (Borko et al., 2008; Murtafiah, Sa'dijah, Candra, Susiswo, & As'ari, 2018). Assignments in problem form which are given to students in the classroom create the potential for student learning (Stein & Kaufman, 2010; Sa'dijah et al., 2019). Besides, teachers with a high level of mathematical knowledge will produce students with higher academic achievements if they do something different in their classes (Hill, Schilling, & Ball, 2004).

## **CONCLUSION**

There are four main components of teachers' decisions in teaching HOTS. They are giving the problem, asking for solving the problem, asking for checking the solution and asking for obtaining the new idea. According to gender differences, the male teacher prefers to give non-contextual mathematics problems, while the female teacher adopts contextual mathematics problems. The male teacher chooses



to ask students to work individually, but the female teacher asks the students to work in a group to solve and check the solution. For obtaining the new idea, the male teacher recommends correct problem solving as criteria. In contrast, the female teacher uses the best quality of problem-solving as consideration for the students. These results can be used as a consideration or caution for educators or pre-service teachers about the effect of gender on their decision-making for supporting students learn in HOTS. Future research is encouraged to investigate how this different decision-making of male and female teachers affects their students' HOTS performance, particularly in terms of gender differences.

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