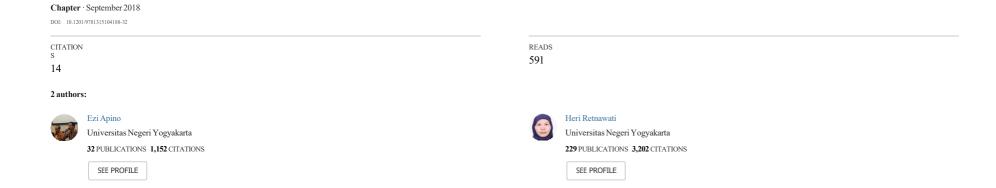
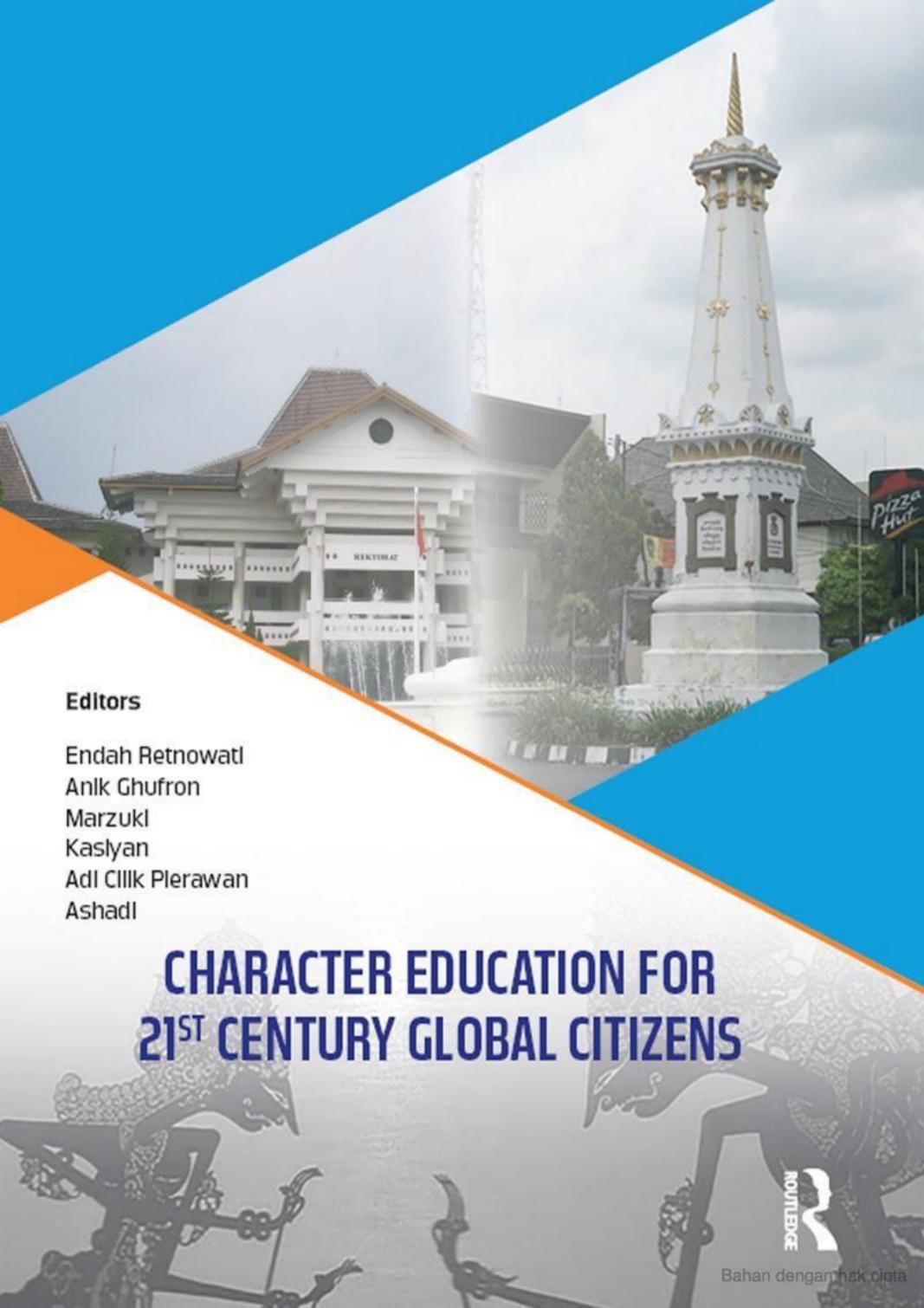
### Creative problem solving for improving students' Higher Order Thinking Skills (HOTS) and characters





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### Preface

The 2nd International Conference on Teacher Education and Professional Development was held in Yogyakarta (Indonesia) on 21–22 October 2017. The conference is an annual event, conducted by Universitas Negeri Yogyakarta's Institute of Educational Development and Quality Assurance. Similar to the previous conference, this conference received enthusiastic response from scholars and practitioners particulcarly interested in character education. Participants from Australia, Japan, Malaysia, the Netherlands, and many cities in Indonesia attended this year's conference.

Exploring the theme "Character Education for 21st Century Global Citizens", the committee has invited Prof. dr. Ali Ghufron Mukti, M.Sc., Ph.D. (General Director of Higher Education and Human Resources from the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia) as a keynote speaker. Moreover, the committee has also invited Prof. Azyumardi Azra, Ph.D., Prof. Dr. Wiel Veugelers, Asst. Prof. Dr. Betania Kartika Muflih, Emeritus Prof. Dr. Terry Lovat, Prof. Dr. Kerry John Kennedy and Prof. Suyanto, Ph.D as invited speakers. Participants presented their papers, which are categorized under subthemes: 1) Values for 21st century global citizens, 2) Preparing teachers for integrative values education, 3) Teacher professional development for enhanced character education, 4) Curriculum/syllabus/lesson plan/learning materials development for integrated values education, 5) Developing learning activities/tasks/strategies for character education, 6) Assessing student's character development (values acquisition assessment), 7) Creating/managing conducive school culture to character education, and 8) Parents and public involvement in character education.

There were approximately 232 submissions from various countries to the conference. The committee selected 127 papers to be presented in this year's conference. The scientific committee has reviewed 117 papers that are qualified for publication. After a careful consideration, there are 83 papers (covering sub-themes 1 to 7) included in the proceeding of the conference that is published by CRC Press/Balkema and submitted for indexation to Thomson Reuters/Scopus.

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## Creative problem solving for improving students' Higher Order Thinking Skills (HOTS) and characters

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ABSTRACT: In order to achieve success, an individual should have good thinking skills and character. Both matters can be achieved through a well-qualified educational system. In the mathematics' learning process, a Creative Problem Solving (CPS) model might be selected as one of the tools for improving students' thinking skills and character. Therefore, this study aimed at describing students' Higher Order Thinking Skills (HOTS) and character improvement in the mathematics' learning process through a CPS model. This study itself was a design research. The subjects in this study were tenth grade students of the Natural Science Program from an Islamic senior high school (namely Madrasah Aliyah Negeri/MAN 3) in Yogyakarta, Indonesia. The data were gathered through test and observation, while the data analysis was conducted in a descriptive manner both quantitatively and qualitatively. The results of this study showed that: (1) the students' HOTS score improved after the CPS model had been implemented in the mathematics' learning process; (2) the students' character score improved after the CPS model had been implemented in the mathematics' learning process; and (3) the characteristics that might be trained through the implementation of the CPS model in the mathematics' learning process included hard work, curiosity, responsibility, teamwork, tolerance, care and self-confidence.

#### 1 INTRODUCTION

The rapid advancement of knowledge and technology demands each individual to improve his or her self-competencies as their equipment to deal with more complex global competition. The results of various studies show that in order to achieve success within global competition, an individual should have strong thinking skills and character. Specifically, there are four skills that should be possessed as the equipment to deal with twenty-first century competition and these skills are also known as twenty-first century skills. The four skills include communication, collaboration, critical thinking and creativity (Partnership for 21st Century Skills, 2002). The four skills might be integrated and trained through an educational process that starts from elementary until higher education level.

Indonesian education started implementing a curriculum that leads to the development of these skills, namely Curriculum 2013. Referring to the content standards (Regulation of the minister of education and culture number 20 on 2016) (RoI, 2016), Curriculum 2013 sets higher priority on the development of character aspects (social and spiritual attitudes), Higher Order Thinking Skills (HOTS) and various skills both abstract and concrete. In Curriculum 2013, character development aspects might be regarded as the means for developing communication and collaboration skills, while a learning process that leads to the development of HOTS might be turned to as the means for training critical and creative thinking skills. Therefore, the content standards of the governing curriculum in Indonesia is currently relevant to the four skills contained in the twenty-first century skills.

One of the aspects that has become the focus in the current Indonesian educational process is the development of HOTS. HOTS are skills that involve critical thinking and creative thinking skills (Conklin, 2012; King et al., 2010; Krulik & Rudnick, 1999; Presseisen, 1988;

Yen & Halili, 2015), problem solving skills (Brookhart, 2010; Presseisen, 1988; Yen & Halili, 2015), logical and reflective thinking skills (King et al., 2010), metacognitive thinking skills (King et al., 2010; Yen & Halili, 2015) and decision-making skills (Presseisen, 1988; Yen & Halili, 2015). If these skills are associated with the revised Bloom taxonomy (Anderson & Krathwohl, 2001), then HOTS will involve cognitive process namely analyze, evaluate and create (Liu, 2010). In addition, the Indonesian educational process not only focuses on developing thinking skills solely but also on shaping character values that are integrated into the learning process. Therefore, developing various thinking skills and characters at the same time might be regarded as the main objective of the current Indonesian educational process.

The aspects that will be achieved in the educational process are still contradictory to the facts in the today's field. The results of several studies reported that students' HOTS in Indonesia still currently fall into the low category (Nurina & Retnawati, 2015; Riadi & Retnawati, 2014; Susanti et al., 2014). In addition, the indication that students' HOTS in Indonesia is still low might also be found in Indonesian achievement in various international studies such as PISA (Program for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study). The latest release of both international studies puts Indonesia in the lower rank (Mullis et al., 2012; Mullis et al., 2016; OECD, 2014, 2016). Other indications might be seen from the difficulties of students in working on the equivalent problems of PISA which began to be accommodated in the Mathematics National Examination in 2014 (Retnawati et al., 2017).

In terms of character, there are still various problems related to students' moral degradation such as student brawls, adolescent misbehavior and negative phenomena among students such as cheating during exams, not doing homework and being less confident in learning mathematics (Musfiqi & Jailani, 2014). These matters should be handled seriously and solutions to these matters determined; one of which might be improving learning quality within classrooms. In addition, the obstacles faced in the implementation of Curriculum 2013, such as the learning process using a scientific approach that has not been maximized, as well as difficulties in the implementation of the assessment, especially for attitude assessment (Retnawati, 2015a; Retnawati et al., 2016), impacts the implementation of character education which has not been maximized.

One of the efforts that could be conducted in order to improve learning quality is implementing a learning process that might facilitate students in developing their HOTS and also shaping their character. A learning process that might manifest this effort is one that involves problem solving activities (Apino & Retnawati, 2016, 2017; Jailani & Retnawati, 2016; Musfiqi & Jailani, 2014; Saido et al., 2015; Susanto & Retnawati, 2016; Haryanto, 2015) and cooperative learning (Matchett, 2009; Zakaria et al., 2010). One learning model that involves problem solving activities and might be used to improve students' HOTS is Creative Problem Solving (CPS) (Apino & Retnawati, 2016, 2017; Bohan & Bohan, 1993). CPS is a learning model that encourages students to solve problems through good and systematic thinking skills, and includes creative and critical thinking skills (Isaksen et al., 2011; Treffinger, 1995; Tseng et al., Operationally, Osborn and Parnes (Giangreco et al., 1994) explained that CPS might be implemented through the following stages: (1) objective-finding, namely proposing problems and determining learning topics; (2) fact-finding, namely analyzing important information that has been relevant to the problems; (3) problem-finding, namely identifying the key questions of the problems; (4) idea-finding, namely searching as many ideas as possible that might be used to solve the problems; (5) solution-finding, namely implementing each idea that has been found in order to solve the problems; and (6) acceptance-finding, namely selecting the best solution in order to solve the problems based on certain criteria. By paying attention to these stages, CPS implementation in mathematics learning might also be used as a tool for training characteristics such as hard work, curiosity, responsibility, care, teamwork, tolerance and self-confidence. Some reasons why implementation of a CPS model in learning might improve students' character are: (1) CPS encourages and strengthens many academic and attitude skills (Giangreco et al., 1994); (2) the learning process conducted in groups (Bohan & Bohan, 1993; Giangreco et al., 1994) trains students' collaborative skills useful for improving cooperation, tolerance, care and responsibility.

Implementation of a CPS model is not only able to improve students' HOTS but also to shape students' positive characters. In order to shape students' characters, several actions that might be taken include role modeling (Lumpkin, 2008; Thornberg & Oğuz, 2013; Zuchdi et al., 2011; Partawibawa et al, 2014); consistent habituation (Choudhury, 2016; Zuchdi et al. 2011); intervention and strengthening (Zuchdi et al., 2011). These four actions might certainly be facilitated through the implementation of CPS in mathematics learning with a hope that students' HOTS and characters will improve. Therefore, this study aimed at describing students' HOTS and character improvement in mathematics learning through the use of a CPS model.

#### 2 METHOD

The study was a design research. The stages in the study were adapted from the Plomp model (Plomp, 2013) which consisted of: (1) needs analysis; (2) intervention development in the form of learning design for improving students' HOTS and characters; and (3) evaluation. The subjects in the study were tenth grade students from the Natural Science Program in MAN 3 Yogyakarta, the Province of Yogyakarta Special Region, Indonesia. The data were gathered through test and observation. A test was administered in order to gather data regarding students' HOTS before and after the CPS model was implemented in mathematics learning. Then, observation was conducted in order to gather data regarding students' characters before and after the CPS model was implemented in mathematics learning. The HOTS' data were analyzed in a descriptive, quantitative manner by comparing the pretest and the post-test scores. On the other hand, the character data were analyzed in a descriptive, qualitative manner by identifying and describing the characters that appeared before and after the CPS model was implemented in mathematics learning.

#### 3 RESULTS AND DISCUSSION

### 3.1 Needs analysis

Needs analysis was conducted by interview with mathematics teachers and observation of the learning process in classrooms. Interviews were conducted with three mathematics teachers from MAN 3 Yogyakarta. From the results of the interviews, the researchers found that: (1) teachers still had difficulties in implementing learning processes that trained HOTS within mathematics learning; (2) there were limited examples of HOTS development oriented learning sets such as lesson plans and student worksheets; (3) teachers still had difficulties in creating HOTS test items; (4) in group activities, there were still some students who had not been able to cooperate with one another as group members; (5) the students had a lack of responsibility in completing the assignments that had been provided; and (6) the students had not been confident when they were asked to do a presentation in front of the class. In order to support these findings, the researchers observed the mathematics learning process directly in the classroom. From this observation, the researchers might conclude that information that had been attained in the interview was in accordance with the condition that had occurred within the classroom, in which the learning process had not been oriented to the development of students' HOTS and still lacked character values that should be trained during the learning process. The reason was that the teachers still implemented a conventional learning model in which the teacher's role was very dominant during the learning process.

#### 3.2 Learning design for improving students' HOTS and characters

The information attained from the needs analysis was followed up by creating a learning design in order to train HOTS and characters. Based on the theoretical review, a CPS learning model was selected in order to train HOTS and characters during the mathematical learning process. The learning process was formulated into a lesson plan that contained the CPS model syntax and that had been equipped with student worksheets. The characteristics of the lesson plan designed were: (1) the learning objectives led to the development of critical

thinking and creative thinking skills; (2) the design contained stimulus-providing activities from the teachers by asking "why" and "how" questions; (3) the design contained activities that led to the discovery of multiple answers and or multiple ways to solve given problems as a response to the given stimulus; (4) the design maximized the active role in students' interaction; and (5) the design facilitated group activities. The design of the student worksheet implemented had the following characteristics: (1) the content of the student worksheet had an association between materials and concepts; (2) the student worksheet contained reflection activities; (3) the student worksheet contained discovery and investigative activities that had been adjusted to the characteristics of the learning materials; (4) the student worksheet applied creative problems that demanded multiple answers or solutions; and (5) the problems implemented were associated with the actual context and had ill-structure (unstructured).

#### 3.3 Evaluation

After the learning design and the learning support kits had been designed, the researchers gathered the data through the CPS model implemented into the mathematical learning process in the tenth grade of MAN 3 Yogyakarta. Before the learning process took place, the students were provided with a pretest in order to measure their initial ability in completing HOTS test items. The CPS model was implemented in six meetings and the materials applied were trigonometric comparison in right triangle. During the learning process, the researchers also observed the character values that appeared. Eventually, the students were provided with a post-test in order to measure their HOTS after the CPS model had been implemented in the mathematics' learning process. The evaluation in this study targeted viewing the impacts of the CPS model implementation in the improvement of students' HOTS and character.

#### 3.3.1 HOTS data

The following are the data from the students' pretest and post-test in completing the HOTS test items.

From the data in Table 1, the researcher attained information that there was an improvement in students' HOTS scores after the CPS learning model was implemented in the mathematical learning process. The mean score of students' HOTS improved by approximately 45.69% after the implementation. The percentage of settlement also experienced a drastic increase from 0.00% to 74.07%. These findings show that CPS implementation in the mathematics' learning process might improve students' HOTS. This achievement is in accordance with the opinion proposed by Apino and Retnawati (2017), Bohan and Bohan (1993) and Susanto and Retnawati (2016) that learning by means of a CPS model might be performed in order to improve students' HOTS. In addition, the use of creative problems through student worksheets caused the students to be more challenged in solving these problems. Loewen (1995) proposed that the use of creative problems might increase students' awareness that not all problems had one appropriate solution. This is a matter that might trigger and train students' creativity in mathematics learning and this creativity is part of HOTS development.

Another factor that caused the improvement of students' HOTS was the meaningful learning activities where the students were actively engaged in a discussion process in order to construct their knowledge and use multiple relevant sources for gathering the desired insight. This is in accordance with the opinion of Bohan and Bohan (1993) that the learning process by

Table 1. Data analysis results of students' HOTS.

Description	Pretest	Post-test
Highest score	56.52	93.33
Lowest score	17.39	46.47
Mean score	31.72	77.41
Number of settled students	0.00	20.00
Number of unsettled students	27.00	7.00
Percentage of settlement (%)	0.00%	74.07%

means of a CPS model might present meaningful learning activities for students. Furthermore, students might be enthusiastic because they are challenged by the problems provided. This matter is certainly able to improve students' motivation to learn. These findings are in accordance with the opinion of Loewen (1995), which stated that the presentation of challenging creative problems in a CPS model might improve students' interest and motivation to learn. Thereby, there will be an improvement in students' interest and motivation to learn and this improvement becomes one of the decisive factors within the improvement of students' HOTS.

#### 3.3.2 Character data

Data regarding the development of students' characters were gathered through observation. Observation was conducted before and during the CPS model implementation in the mathematics' learning process. Results of the observation are presented in Table 2 and Table 3.

From Table 2 it is apparent that the implementation of a CPS model in a mathematical learning process impacts students' attitudes and behaviors during the learning process. These results provide evidence that learning intervention by means of CPS model implementation might train students' character values. Based on the observation that was conducted during the learning process, the character values that might be trained through the implementation of a CPS model are presented in Table 3.

Based on the qualitative data in Table 2 and Table 3, the researchers concluded that the implementation of a CPS model in the mathematics' learning process might train and improve students' characters altogether in the same time. The character values that might be trained and be improved namely curiosity, hard work, teamwork, care, responsibility, tolerance and self-confidence. The implementation of a CPS model in the mathematical learning process is one of the interventions that teachers might perform in order to train and to improve students' characters. These results are certainly in accordance to the opinion of Zuchdi et al. (2011) which stated that one of the ways to improve character is by providing intervention. Furthermore, the CPS model is one of the variations in problem-based learning models and the results of previous studies (Arofah, 2015; Jailani & Retnawati, 2016; Musfiqi & Jailani, 2014; Wardani, 2014) showed that problem-based learning models might improve students' character. The collaborative aspects in the implementation of the CPS model also played an important role in improving the students' characters (Bohan & Bohan, 1993; Giangreco et al., 1994). The most prominent characteristic that might be trained through the implementation

Table 2. Description on the observation results before and during CPS model implementation.

Before CPS model implementation	During CPS model implementation  Students have been able to perform task division within the group discussion under the teacher's direction.			
Students have not been able to perform task division within the group discussion.				
Students select group members based on gender and familiarity.	Students belong to heterogeneous groups according to the group division that the teacher has determined.			
Students with high academic performance tend to work alone, while students with low academic performance tend to wait and be passive.	There is an interaction among students with high, moderate and low academic performance.			
Students have not been confident in performing their presentation; they will perform their presentation after the teacher appoints them.	The representatives of each group become confident in performing their presentation.			
Students have not been encouraged to share their opinions when the teacher asks them to respond their peers' presentation.	There are several students who respond to the results of the presentation by the speaking groups.			
Only few students were encouraged to raise questions to the teacher if they have not understood some parts in the learning materials.	Some students are encouraged to raise questions, both to the teacher and to their peers, if they have not understood some parts in the learning materials.			

Table 3. Character values that might be trained through the implementation of a CPS model.

CPS syntax	Learning activities	Character values tha might be trained Curiosity	
Objective-finding	Proposing problems (by teachers) and determining learning topics based on the problems that had been proposed.		
Fact-finding	Analyzing important information that has been relevant to the problems and analyzing other supporting information (these activities might be performed through group discussion and question and answer sessions among group members).	Teamwork, care, tolerance	
Problem-finding	Finding the key question of the problems that have been proposed (this activity might be performed through group discussion, question and answer sessions among group members and decision-making process).	Teamwork, care, tolerance	
Idea-finding	Finding ideas, as many as possible, that might be used to solve the problems (this activity might be conducted through group discussion, question and answer sessions among group members and decision-making process).	Hard work, responsibility, teamwork	
Solution-finding	Implementing each idea that has been found in order to solve the problems (this activity might be performed through group discussion and task division).	Teamwork and responsibility	
Acceptance- finding	Selecting the best solution in order to solve the problems based on certain criteria (this activity might be performed through an analysis of the strength and the weakness of each solution that has been found, through the presentation of each group member's point of view and final decision-making process).	Tolerance, responsibility and self-confidence	

of a CPS model was hard work and this finding is in accordance with the opinion of Bohan and Bohan (1993) and Loewen (1995) which stated that CPS has been able to trigger students' struggle in accomplishing the given challenges.

Implementation of a CPS model in learning, especially mathematics learning, is one of the efforts to support the character education program that has been designed by the government. Implementation of a CPS model certainly does not touch all the expected character values, so mathematics learning through a CPS model might only train some of the character values mentioned earlier. Thus, the CPS model might not be fully used as one of the main tools to instill character values in students. In other words, the CPS model is just one of the variations in mathematics learning and other learning subjects to support the character education process.

In addition, to enhance the attractiveness of the implementation of the CPS model in learning, it is necessary to innovate in the application of the learning model. Such innovations may be related to a combination of using Information and Communication Technology (ICT), both in the process and in the assessment of learning (Retnawati, 2015b). Thus, in the future, for the CPS model to be more interesting for students and teachers, the implementation of the CPS model could be combined with the use of ICT media such as computers and other supporting devices. Likewise the assessment techniques also need to involve the use of ICT such as Computer-Based Testing (CBT). Retnawati (2015b) argues that the use of CBT is more accurate than Paper and Pencil Testing (PPT). Through computer-based assessment, it is expected to motivate and enhance students' self-confidence, both in mathematics and other subjects.

#### 4 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study and the discussion, the researchers concluded that: (1) the students' HOTS score improved after the CPS model was implemented into the mathematics' learning process; (2) the students' character score improved after the CPS model was implemented into the mathematics' learning process; and (3) the characteristics that might

be trained through the implementation of a CPS model in the mathematics' learning process include hard work, curiosity, responsibility, teamwork, tolerance, care and self-confidence. Based on this conclusion, the researchers would like to provide the following suggestions: (1) a CPS model should be implemented by teachers within their classroom teaching as one of the alternative learning models for the implementation of Curriculum 2013; (2) CPS models might be used by teachers to train students' HOTS, both in mathematics and other subjects; (3) a CPS model might be selected as one of the interventions in character education; and (4) in relation to future studies, there should be a similar study involving a larger population so that generalization might have wider coverage.

The questionnaire that we used in this study:

Parti. Dask Imormation	
Name (Optional):	
Age:	
Gender:	

## Part II. Impacts of HOTS activities on problem-solving skills

Direction: Please rate the extent to which you agree with the following statements regarding the impacts of HOTS activities on problem-solving skills: putting a checkmark (v) to the corresponding column in every item being asked using the scale below:

- 5 Strongly Disagree
- 4 Disagree
- 3 Neutral
- 2 Agree
- 1 Strongly Agree

SCALE	INTERPRETATION
5	Strongly Disagree
4	Disagree
3	Neutral
2	Agree
1	Strongly Agree

Statement	5	4	3	2	1
HOTS activities have improved my problem- solving skills.			T		
HOTS activities have enhanced my critical thinking abilities.					

Statement	5	4	3	2	1
HOTS activities have fostered my creativity in problem-solving.					T
HOTS activities have helped me analyze complex scenarios.					T
HOTS activities have improved my ability to evaluate perspectives.					
HOTS activities have strengthened my decision-making skills.					T
HOTS activities have increased my confidence in solving complex problems.					
HOTS activities have helped me apply knowledge to real-life situations.					T
HOTS activities have improved my ability to work collaboratively in problem-solving tasks.					T
HOTS activities have increased my motivation to engage in problem-solving activities.					
HOTS activities have improved my overall problem-solving skills.					
I would recommend the use of HOTS activities to improve problem-solving skills.					T

# Part III. Most Preferred Hots Activities in Problem-Solving Skills

Direction: Please rate the extent to which you agree with the following statements regarding the most preferred HOTS activities in problem-solving skills putting a checkmark ( $\sqrt{}$ ) to the corresponding column in every item being asked using the scale below:

SCALE	INTERPRETATION
5	Strongly Disagree
4	Disagree
3	Neutral
2	Agree
1	Strongly Agree

Statement	5	4	3	2	1
Project-based learning	$\top$			Γ	T
Creative thinking exercises	T			Γ	
Concept mapping			T	Γ	T
Debate					
Brainstorming			Τ		

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