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THE VALIDITY AND EFFECTIVENESS OF THE REFLECTIVE-METACOGNITIVE LEARNING MODEL TO IMPROVE STUDENTS'S METACOGNITION ABILITY IN INDONESI~~A~~

ABSTRACT

Purpose: The Reflective-Metacognitive Learning (RML) model is a learning model with reflective attributions in every learning ~~phases~~phase to enable a conscious thinking process in order to increase students' metacognition ability through four phases: 1) orientation reflection; 2) organizational reflection; 3) execution reflection; and 4) verification reflection. This study aims to analyse~~ze~~ the validity and effectiveness of the RML model in comparison to the Cognitive-Metacognitive Learning (CML) model developed by Garofalo and Lester.

Methodology: This research is an experimental ~~research~~study that began with the development of the RML ~~Model~~model, adapting Borg and ~~Gall~~Gall's development design~~ consist~~, which consists of: 1) planning, 2) development, and 3) evaluation. A Focus Group Discussion (FGD) ~~from~~with four science education experts was conducted to determine the validity of the RML Model and its supporting devices in terms of content validity and construct validity. The randomized pretest posttest control group design was used to evaluate the effectiveness of the RML model and the Cognitive-Metacognitive Learning (CML) model, which were implemented ~~in~~among 40 ~~students of~~ senior high school ~~which analyzed~~students. Data were analysed descriptively and using inferential statistics~~ by~~, namely independent sample t-~~test~~tests and paired t-~~test~~tests.

Findings: The results ~~were~~ obtained~~:~~ indicated that the RML model was ~~stated very~~highly valid in both ~~in~~ content (3.89) and construct (3.84) validity, metacognition knowledge increased ~~with~~to a high ~~category~~degree (mean of n-gain: 0.76), skill, and metacognition awareness increased ~~in~~to a medium ~~category~~degree (mean of n-gain: 0.66; and 0.4) for the experimental group, while for the control group, metacognition knowledge, skills, and awareness increased ~~with~~to a medium ~~category~~degree (mean of n-gain: 0.6; 0.475; 0.3125~~)~~)), and statistical analysis showed that there was improvement in students' metacognition ability in both groups (p <0.05~~), and~~). It can be concluded that the RML model is valid and more effective than the CML model to increase ~~student's~~students' metacognition ability.

Significance: The RML ~~Models are~~Model is expected to contribute to improving students' metacognition skills, characterized by reflection of thought processes that are at the core of metacognition ability.

Keywords: Learning Model, RML Model, Validity and Effectiveness of RML Model, Metacognition Ability.

INTRODUCTION

Metacognition is an important goal and focus of education in Indonesia and ~~even~~across the world ~~lately~~ (Asy'ari~~,~~ et al., 2016~~) which~~). It can be simply defined as ~~thinking~~the process of thinking about thinking (Lai, 2011) through the conscious evaluation of thought processes ~~consciously~~ (Asy'ari, 2016). Permendiknas (2015) ~~requires~~ advocates that high school students ~~to~~should be able to solve procedural problems that are also components in metacognition, so that ~~students~~they are trained in productive thinking to solve routine and non-routine problems. Anderson ~~&~~and Krathwohl (2001) present metacognition as the highest dimension of knowledge in learning. ~~It shows~~This suggests that metacognition should be ~~learned~~taught, and should become a ~~goal in~~ learning goal. The results of the PISA (Program for International Student Assessment) study in 2012~~ that focusing~~, which focused on reading literacy, mathematics and science~~ show~~ , revealed that Indonesia ranked ~~55~~55th out of 65 countries, while in 2015 it ~~is~~was ranked ~~69~~69th out of 75 countries worldwide. The results of the TIMSS

(Trends in International Mathematics and Science Study) study in 2011 also ~~show~~showed that Indonesian students are ranked low in (1) ability ~~(1)~~ to understand complex information~~,~~; (2) theory, analysis and problem solving~~,~~; (3) the use of tools, procedures and problem-solving~~ problems~~; and (4) conducting an investigation (Indonesian ~~Ministery~~Ministry of Education, 2012). ~~The~~Students' success ~~of students~~ in completing the given learning task depends on ~~students'~~their awareness of the knowledge and skills ~~that applying~~to apply in learning activities (Lai, 2011; Wilson & Bai, 2010; Pantiwati & Husamah, 2017~~) or~~), commonly known as metacognition ability. The result of ~~Muhali~~Muhali's (2013) study ~~on~~involving students in ~~4 (~~four~~)~~ schools in Central Lombok ~~shows~~showed that 6.15% of ~~students'~~ students are categorized as having very good metacognitive awareness~~ is categorized very well~~; 32.31% ~~with~~are in the good category; 51.15% ~~with enough category,~~are categorized as having adequate metacognitive awareness, and the remaining 10.39% ~~of students with less good category~~show poor metacognitive awareness.

Metacognition generally consists of 1) metacognition knowledge; 2) metacognition control and regulation (Pintich, Wolters, & Baxter, 2000); and 3) metacognition assessment and examination (Meijer, Veenman, & Wolters, 2006). Metacognition knowledge is a declarative, procedural, conditional knowledge of cognition (Veenman, 2012), cognitive strategies and variables in tasks or problems faced that affect a person's cognition (Alexander, Schallert, & Hare, 1991; Flavell, 1979). Metacognition is one of the innovative skills in 21^{st} century learning and involves high-level cognition processes that include thinking about knowledge and how to gain that knowledge through a reflective process. In line with that opinion, Thomas (2012) believes that metacognition ~~as~~is the key to ~~follow~~following developments in 21^{st} century science education. The development of science education ~~in that opinion relate~~from this perspective relates to the development of students' science literacy and understanding of the nature of inquiry, the nature of science and concepts in science itself. Metacognitive teaching can enhance learning activities, understanding, attention, motivation, and memory, and ~~reducing~~reduce learning disabilities (Ya-Hui, 2012) through effective processes in the planning, monitoring and evaluation of teaching (Schraw~~,~~ et al., 2012) with the strategic application of declarative, procedural, and conditional knowledge to achieve goals~~,~~ and address problems (Kaberman & Dori, 2008; Schunk in Woolfolk, 2009). Metacognition ability in this research is a high level of thinking ability, consisting of: (1) knowledge of cognition (metacognition knowledge~~)~~): that is, knowledge of the self as ~~learners, include~~a learner, including declarative, procedural, and conditional knowledge (Lai, 2011; Flavell, 1979; Marzano, et 1988: Woolfolk, 2009; Williams & Atkins, 2009; Anderson & Karthwohl, 2010; Louca, 2008); (2) metacognition skills, which are a person's awareness of the control process in learning (Veenman, 2012); and (3) metacognition awareness~~ of~~, which is a person's ability to reflect, understand, and control his learning, including metacognition knowledge and regulation of cognition (planning, information management, monitoring, debugging, and evaluation) (Schraw & Moshman, 1995; Schraw et al., 2006; & Schraw, et al., 2012; Jakobs & Paris, 1987; Kluwe, 1987; Pressley & Harris, 2006).

Curiosity towards cognition and problems faced in teaching metacognition has prompted many researchers to develop and formulate effective and systematic learning models. Polya (1957) proposed four stages of the problem-solving model: 1) Understanding the problem: this includes reading and clarifying problems to identify what is known, what is unknown and objectives; 2) Devising a plan: this stage is the selection strategy and the preparation of plans for ~~solution~~solving problems; 3) Carrying out: after ~~having~~making a plan, then execute this plan and write down the solution; 4) Looking back: when a solution is found, it is necessary to check ~~the~~its legitimacy~~ of the solution to the problem~~. The most common problem with this model is that the problem solver does not fully understand these stages~~ so that the problem solver should~~: thus, he or she needs to try many times using different problem solving strategies to succeed. ~~Futher~~Further, Schoenfield (1983; 1985) ~~with~~developed a problem-solving scheme consisting of several activities: reading, analysis, exploration, planning, implementation, and verification. Schoenfield (1985) identifies three levels of knowledge and needs that are believed to be fulfilled if the person's problem~~-~~-solving performance ~~of a person wants to be known quantitatively~~is quantified. Three levels are: (1) sources (knowledge that can be used on special problems); (2) control (knowledge possessed by a person to be able to choose and implement his knowledge on the problem); and (3) a belief system (self-perception, environment, topics, and/or calculations that may affect one's needs). Kroll (1988~~),~~) extends Schoenfield's problem-solving scheme to provide an overview of the monitoring and procedures ~~or ways that one uses~~used during the group problem-solving process. In particular, Kroll (1988) categorizes the monitoring activities into ~~2 (~~two~~)~~ types~~ ie~~: (1) the type of statement submitted by a person or ~~one~~ member ~~in the~~of a cooperative group ~~who solve~~solving the problem given, (2) the steps in problem solving~~ that is~~: namely, orientation, organization, implementation and verification. Kroll (1988) specifies ~~4 (~~four~~)~~ basic types of ~~statements~~statement: self-reflection,~~ and~~ group, procedure, and overall assessment.

The problem-solving scheme is the basis for Garofalo and Lester's (1985) development of the cognitive-metacognitive learning (CML) model~~ by Garofalo & Lester (1985) by accommodating~~, which accommodates Sternberg's (1985) metacomponents~~ which include~~, namely planning, monitoring, and evaluating the problem-solving process through processes: (1) identifying ~~problems~~the problem; (2) ~~describe~~describing or ~~know~~knowing the nature or circumstances of the problem; (3) ~~prepare~~preparing the mental and physical ~~needs~~requirements to solve the problem; (4) ~~determine~~determining how information is collected; (5) ~~prepare~~preparing the troubleshooting steps; (6) ~~combine~~combining these steps with the right strategy to solve the problem; (7) ~~monitor~~monitoring the progress of problem solving during the process; (8) ~~evaluate~~evaluating solutions when troubleshooting is resolved.

Pugalee (2004) notes ~~the CML model by~~ that Garofalo and ~~Lester~~ Lester's CML model consists of four categories or phases of problem solving~~ that are~~: (1) the orientation stage, which includes~~:~~ reading/rereading, introduction and presentation of parts, analysis of conditions and information, and assessment ~~to~~of the difficulty level of questions; (2) the organizational stage, which includes: identification of intermediate and major~~ / ~~/end targets, creating and implementing global plans, and organization of data; (3) the execution stage, which includes: establishing local objectives, making calculations, monitoring objectives, and transferring plans; (4) the verification stage, which includes evaluation of ~~decision~~decisions and decision results. ~~The~~However, the cognitive-metacognitive model ~~has a lack of~~lacks reflection as the core of metacognition itself. Reflection or evaluation activities are only done at the end of the learning – that is, at the verification stage~~,~~ – and also decision-making is not measured or emphasized in the learning process. Student decision-making skills in learning are only demonstrated through the performance/implementation of a previously designed problem-solving strategy. This statement is reinforced by the results of Pugalee's (2004) study~~ that~~, which found difficulties ~~when~~with the implementation in that students generally did not verify activities in the previous stage. ~~It~~This issue can be ~~solved~~resolved by doing reflection activities ~~at~~as part of each phase of learning~~ phases~~.

Later, Yimer and Ellerton (2009) developed a problem-solving model with the phases of engagement, transformation-formulation, implementation, evaluation, and ~~internalitation~~internalization by inserting reflection activities ~~on~~into the five phases of the problem-solving model they formulated. The details of these five phases of problem ~~solving by Yimer and Elerton~~ are as follows: 1) Engagement, which includes: Initial understanding (noting the main idea, drawing); Information analysis (introduction of information, ~~identify~~identifying key ideas of relevant information to solve problems, ~~relate~~relating them to specific mathematical domains); Reflection on the problem (assessing familiarity or recalling ~~the same problem~~similar problems previously solved, assessing the degree of difficulty, assessing the knowledge one needs in relation to the problem); 2) Transformation-Formulation, which includes: Exploration (using a particular case or number to visualize a problem situation); Conjecturing or hypothesizing (based on specific observations and previous experiences); Reflection on alleged or ~~exploration~~explored feasibility; ~~Formulate~~Formulating a plan (~~design~~designing a good strategy to test allegations or ~~design~~designing a global or local plan); Reflections on the feasibility of the plan based on key features of the problem; 3) Implementation, which includes: Exploration of key features of the plan; ~~Assess~~Assessing the plan with the conditions and requirements set out by problem; ~~Implement~~Implementing the plan (doing activities both using computer and by way of ~~analyzed~~analysis); Reflection on the suitability of activities~~ / ~~/actions; 4) ~~The evaluation~~Evaluation, which includes: Rereading the problem to evaluate whether or not the result has answered the question on the problem~~ or not; Assess~~; Assessing plans related to consistency with key features and possible errors in calculation or analysis; ~~Assess~~Assessing the reasonableness of results; ~~Make~~Making a decision to accept or reject the solution; 5) Internalization, which includes: Reflection on the whole process of problem solving; ~~Identify~~Identifying important features in the process; ~~Evaluate~~Evaluating the problem-solving process for adaptation in other situations, different ways and features of the solution; Reflections on the mathematical precision involved, one's confidence in the process, and the level of satisfaction. The reflection path in the Troubleshooting Model (Yimer & Ellerton, 2009) is presented in Figure 1 below.

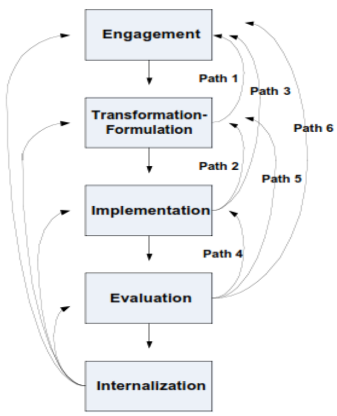

Figure 1. Cognitive Process Flow (Reflection) Problem Solving Model (Yimer & Ellerton, 2009)

~~Processes~~The processes in this model ~~are like repeating~~replicate the weaknesses of the Polya problem solving model~~ that~~, which Fernandez, Hadaway ~~&~~and Wilson (1994) regarded as a back~~-~~-and -forth process, making it difficult for students to follow the lesson. Fernandez, Hadaway & Wilson (1994) critiqued ~~the ~~Polya's problem-solving model by providing ~~problem-solving~~examples of models that emphasize the process of cognitive awareness, or what other educators such as Schoenfeld and Flavell ~~calling~~call metacognition, emphasizing ~~some behaviors~~certain behaviours such as predicting, planning, reviewing, selecting, and checking to help ~~someone~~individuals to succeed in problem-solving situations by using ~~his or her~~their ability to identify and work with good strategies (Pugalee, 2004). Metacognition basically emphasizes the ability to ~~analyze~~analyse the characteristics of problems encountered, such as considering content, context, and variable structure on issues to formulate ~~inference~~and infer the difficulty of tasks and resources that can be used in problem solving.

Learning activities to make ~~an ~~meaningful information are closely related to reflection by reminding students of the initial knowledge and simulating the interrelation of teaching materials with surrounding phenomena. Arends (2012~~),~~) states that activities to teach students ~~in~~about interpreting the teaching materials used can be facilitated through ~~the ~~orientation activities~~ in learning~~. Students and teachers are trained to assess themselves using self-checklists and fill in self-reflection journals~~,~~ and peer-reviewed checklists ~~in making~~to assess their instructional planning and teaching

~~performances~~performance in reflection-oriented teaching (Ratminingsih, Artini, & Patmadewi, 2017). ~~Teacher's~~Teachers' role in reflection-based learning is emphasized to demonstrate both regular capability and authentic reflection in the ~~teaching process in the~~ classroom teaching (Sellars, 2012). The reflection approach in learning plays a role in verifying activities and attitudes with the aim of increasing ~~such activities and attitudes~~these aspects for further learning (Conley et al., 2010). Reflection is built on the day-to-day experiences integrated into learning (Borich, 2000). Reflection in learning can also help teachers to ~~know~~assess the level of students' cognitive regulation ~~that students have.~~. In line with that statement, Flavell and Brown (in Herscovitz, Keberman, Saar, & Dori, 2012) ~~state~~see metacognition as a consciousness and a person's reflexes ~~to~~in the process of self-cognition, which involves self-regulation and the coordination of conscious learning tasks. Further, Veenman (2012) explains that reflection can be used to obtain the student's self-instruction production system. Anderson (1996~~) and~~; Anderson et al ~~(~~, 1997) ~~describe~~describes three stages of student skill acquisition. The first stage~~,~~ – cognition~~, is a~~ – comprises declarative knowledge of the conditions and activities associated with verbal descriptions of procedures performed in the stages of problem solving. ~~The~~In the second ~~stage~~, associative~~,~~ stage, the verbal description that has been ~~possessed~~generated is then poured in a procedure that traces step by step. Procedures identified incorrectly in the first stage (cognition) are eliminated at this stage, so that the execution process can be optimized. The last stage is autonomy ~~(autonomy),~~; this stage is the most difficult ~~stage~~ to ~~be achieved~~achieve because the procedures ~~are~~must be prepared and applied ~~must be done~~ independently (Nelson, 1996). Reflection is needed to achieve this stage~~,~~; the results of metacognition activities should be reflected in their conformity with metacognition knowledge (Vennman, 2012).

Based on the above description, ~~the development of~~a metacognition learning model ~~which~~ was developed, adapted from Garofalo ~~&~~and Lester (1989~~);~~) and Yimer ~~&~~and Elerton (2009). The CML model basically includes all the problem~~-~~-solving phases ~~of~~proposed by Yimer ~~&~~and Ellerton (2009), but ~~do~~does not divide the ~~activity~~activities in each phase into reflection activities at each of the learning stages ~~that~~, which are at the core of metacognition itself, which is a reflection of cognitive processes or ~~evaluating the~~evaluation of students' thinking ~~process of students.~~processes. Reflection or evaluation activities are only done at the end of the learning; that is, at the ~~stage of~~ verification stage. Schoenfeld (in Toit & Kotze, 2009~~)~~)), on the other hand, defines metacognition as the ability and control of cognitive function, meaning one's awareness of cognition and how to regulate cognitive processes during problem solving ~~a problem~~. The idea for the development of ~~developing~~the RML model is presented in Figure 2 below.

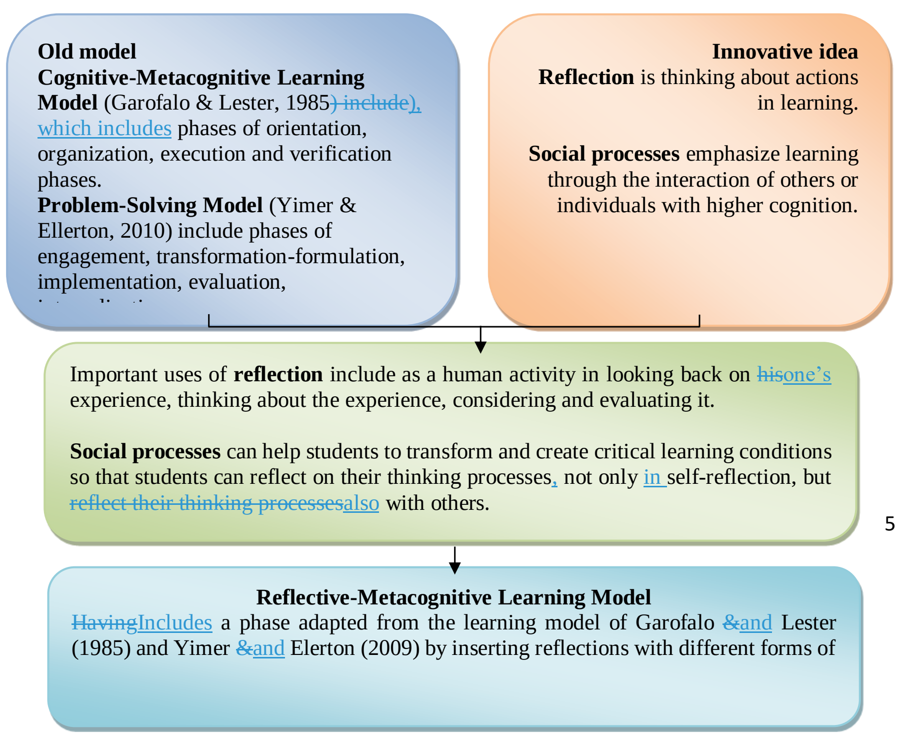

Figure 2. The idea ~~of~~for developing a reflective-metacognitive learning model

The Reflective-Metacognitive Learning (RML) model is a learning model with reflective attributions in each learning ~~stages~~stage to enable a conscious thinking process to increase students' metacognition ability through four phases: (1) Orientation Reflection; (2) Organizational Reflection; (3) Execution reflection; and (4) Verification Reflection. Formulation of RML Models based on empirical and theoretical support that accommodate the CML model (Garofalo and Lester, 1985) and the problem-solving model (Yimer & Ellerton, 2009). The differences ~~of~~between the problem solving model by Yimer and Ellerton (2009), the CML model by Garofalo and Lester (1989) ~~with~~and the RML model are presented in Table 1 below.

Table 1. Differences ~~of~~between the Problem Solving Model ~~by~~ (Yimer & Ellerton ~~(~~, 2010), the CML Model ~~by~~ (Garofalo & Lester ~~(~~, 1985) ~~with~~and the RML Model

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		**Problem-Solving Model (Yimer & Ellerton (2009)**		**Reflective-Metacognitive Learning**	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
Phase 1 Orientation: encompasses strategies for understanding, ~~analyzing~~analysing information and conditions, evaluating familiarity with an initial task and presentation, assessing the difficulties of problems and hopes for success. This phase familiarizes students ~~to become familiar~~ with problem situations.	A. reading/ rereading, B. introduction and presentation of parts, C. analysis of conditions and information, and D. assessment of the difficulty level of the problem.	**Phase 1 ~~Engagement:~~** ~~Initial~~**Engagement**Initial confrontation and problem recognition.	A. Initial understanding (noting main ideas, making pictures), B. Information analysis (information recognition, identifying key information ideas that are relevant to solving problems, relating them to a particular mathematical domain), C. Reflection on the problem (assessing familiarity or remembering whether the same problem ~~that was~~has been solved	**Phase 1 Orientation reflection:** Strategies needed to assess and understand problems	A. Provide learning objectives B. Information and condition analysis C. Assessing the intimacy with the task D. ~~Assess~~Assessing the difficulty level of the problem and the opportunity to successfully solve the problem E. Reflection of orientation activities by providing conflict cognitive phenomena.

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
			previously ~~solved~~, assessing the level of difficulty, assessing the knowledge ~~needed~~that needs to be related to the problem).		
Phase 2 Organization Identifying key objectives, global planning and local planning needed to complete the global plan.	A. Identification of intermediate and ultimate/final goals, B. Creating and implementing global plans, and C. Organization of data.	**Phase 2 Transformation-Formulation** ~~:~~ Transform the initial involvement for exploration and formal plans.	A. Exploration (using certain cases or numbers ~~for visualizing~~to visualise problem situations), B. Conjecturing or hypothesizing (based on specific observations and prior experience), C. Reflection on alleged or exploration feasibility, D. ~~Formulate~~Formulation of plans (design strategies to test guesses or design global or local plans), E. Reflection on the feasibility of the plan based on the key features of the problem.	**Phase 2 Organizational Reflection:** Identify the main goals and objectives, general and specific planning needed to complete the general plan.	A. Identify sub goals and ultimate goals B. Make a general plan C. Data organization D. Reflection through the presentation of an anomalous phenomenon that allows students to organize activities in this phase.
Phase 3 Execution: Includes the achievement of local actions, monitoring	A. Hold local destinations B. Make calculations~~,~~ C. Monitoring objectives,	**Phase 3 Implementation:** Monitoring activities on the plan and exploration.	A. Exploration of key features of the plan, B. Assessing plans with conditions and requirements	**Phase 3 Execution Reflection:** Implement special planning, monitor the	A. Implementing a particular plan B. Monitoring progress of implementation of particular

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
the progress of global and local plans, and assessing the decisions of performance (accuracy and fluency in carrying out planning in phase two).	D. Transfer of plans.		set based on problems, C. Implement the plan (doing activities using a computer or analyzed), D. Reflection on the suitability of activities / actions.	progress of general and particular plans, and assess decisions.	and general plans ~~implementation~~ C. Make/formulate decisions D. Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Phase 4 Verification~~:~~ Includes evaluation of decisions and results of plans executed	A. Evaluating the orientation and organizational phases, B. Evaluate execution.	**Phase 4 Evaluation:** Assess the suitability of plans, actions, and solutions.	A. Reread the problem, assess whether or not the results match ~~or not with~~ the question, B. Assess the consistency of the plan with the main features and possible errors in the calculation or analysis, C. ~~Assessing~~Assess the fairness of results, D. Make a decision to accept or reject a solution, E. Reflection on the entire problem solving process.	**Phase 4 Verification Reflection:** Evaluation of decisions and results of plans executed and decision making.	A. Final decision~~-~~-making~~,~~ B. Reflection of activities through the presentation of new phenomena that are still related to be solved.
		Phase 5 Internalization:	A. Identify important		

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		**Problem-Solving Model (Yimer & Ellerton (2009)**		**Reflective-Metacognitive Learning**	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
		reflection of the level of depth and other qualities of the problem solving process.	features in the process, B. Evaluate the problem solving process for adaptation ~~in~~to other situations, C. Reflection on accuracy, confidence in the process, and level of satisfaction.		

The RML model is characterized by different and non-recurrent reflection activities in each phase of the cognitive metacognition learning model~~ with different and non-recurrent reflection activities~~, such as: (1) presentation of conflict phenomena in the first phase, (2) presentation of anomalous phenomena in the second phase, (3) internalization activities in the third phase, and (4) presentation of new phenomena that are still related in the fourth phase. Reflection through different forms of presentation in each phase of learning is expected to train students to be reflective and independent learners, who can develop knowledge through consciously trained skills. Cowan (1998) provides an example of how reflection works in the thinking process~~,~~: students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, ~~for example~~such as the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and what needs to be done to solve the problem (Ong, 2010). Reflection has a close relationship with students' ~~metacognition~~metacognitive abilities~~,~~; Veenman et al., (2006) states that reflection and metacognition have similarities in ~~emphasizing~~emphasising understanding, improving processes~~,~~ and learning outcomes, and focusing on effective student attention.

This study aims to ~~analyze~~analyse the validity and effectiveness of Reflective-Metacognitive Learning (RML) models. The objectives of the study are as follows: (1) analyze the validity of RML models and supporting devices; (2) ~~analyze~~analyse the effectiveness of the model developed by comparing the RML Model and Garofalo and Lester's (1985) Cognitive-Metacognitive Learning ~~(CML)~~ model ~~by Garofalo & Lester (1985)~~ in the implementation phase of learning for ~~6 (~~six~~)~~ meetings ~~in improving~~to improve metacognition skills (metacognition knowledge, metacognition skills, and metacognition awareness) among senior high school students in Indonesia. The results of this study are useful in increasing ~~the~~educators' knowledge ~~of educators~~ related to a more interactive and effective learning model to improve students' ~~metacognition~~ metacognitive ability by reflecting on the thinking process as the core of each phase of the RML Model. In line with this statement, Webb ~~&~~and Moallem (2016) ~~states~~state that metacognitive (reflective) questions that are used as ~~feed-backs~~feedback in learning can improve students' learning achievement. In addition, teaching metacognition ability can bring out the students' original ~~potentials~~potential so that they can ~~form a person~~become individuals who ~~is~~are rich in original ideas in accordance with ~~the students'~~their potential. Further, Abdullah (2016) explained that the core purpose of education is to ~~make~~enable students~~ able~~ to learn independently. Metacognition as a conscious process of knowledge processing is needed to achieve that goal.

METHODOLOGY

This research is an experimental ~~research~~study with the randomized pretest-posttest control group design in 40 ~~students of~~ high school ~~that~~students, who were divided into ~~20 students in the~~ an experimental group (20 students) and ~~20 students in the~~ a control group~~. Descriptive~~ (20 students). The descriptive analysis and inferential statistics conducted in this research are~~:~~ independent sample t~~-test,~~-tests and Mann-Whitney U test. This research began with the development of the RML Model, adapting Borg and ~~Gall~~Gall's development design~~ consist of~~, which comprised: 1) planning, 2) development, and 3) evaluation~~, the~~. The RML model developed meets ~~3 (~~three~~)~~ quality product criteria, namely: validity, practicality, and effectiveness (Nieveen, 1999). A Focus Group Discussion (FGD) ~~from~~was conducted with four science education experts ~~was conducted~~ to determine the validity of the RML model and its supporting devices in terms of: 1) need; 2) state of the art; 3) empirical support and theoretical support ~~of~~for RML model development; 4) rationality of ~~RML model~~the phases of construction of the RML model; 5) suitability of the RML model's objectives and impacts according to the need for 21st century competence; 6) Learning Environment and Social Systems in RML model; 7) Principle of Reaction in RML model in terms of the purpose of developing the model and equity with its principles of metacognition and reflection~~ principles in the model~~; and 8) Support System in RML Model. Eight aspects of expert assessment in the FGD ~~accommodate~~accommodated the content validity and construct validity criteria of the RML Model and ~~its'~~its devices~~ developed~~.

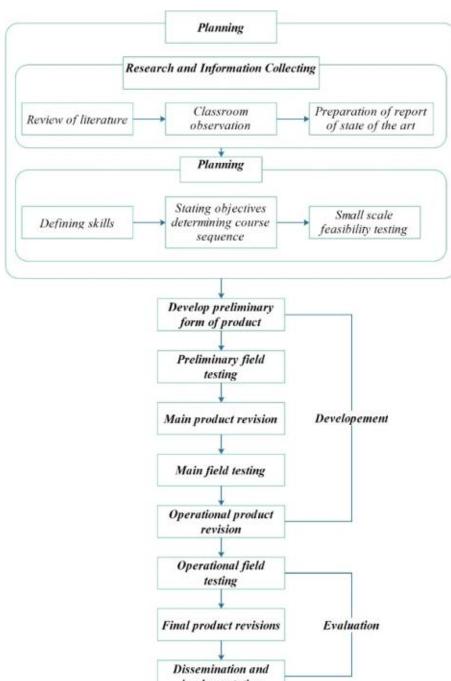

Figure 3. Borg and Gall's (1983) development research flows.

~~Validity Product (~~Validity of Product (Reflective-Metacognitive Learning Model)

The first stage of product development testing ~~is a~~was validation~~ that includes~~, which included two components, namely content validity and construct validity (Nieveen, 1999). The RML Model validation instruments, along with supporting devices~~ are~~, were validated by experts before being used to assess the quality of the RML Model and the devices according to the following validity formula~~,~~: r_α = [(Average Square people - Average Square residual) / (Average Square people + (k-1) Average Square residual)] and Cronbach's alpha $\alpha = k\, r_\alpha / [1+ (k-1)r_\alpha]$ (Malhotra, 2011). The criteria of RML model validity and reliability instruments are shown in Table 2.

Table 2. Validity and reliability of RML model criteria

Check	Scale statistics	Category	
Validity	Single measures interrater correlation coefficient-ICC (rα)	$r_\alpha \le$ r table	Invalid
		$r_\alpha <$ r table	Valid
Reliability	Cronbach's alpha/average measures interrater correlation coefficient-ICC (α)	$\alpha < .6$	Unreliable
		$.6 \le \alpha \le 1.0$	Reliable

The learning model ~~is~~was validated by experts and practitioners who have competence in the field of education. Feedback from validators ~~is~~was used as material for the improvement of the model syntax until a valid model syntax ~~is~~was obtained. Assessment of the validity of the RML model ~~validity~~ and the learning devices used ~~consisted~~was conducted using of ~~4~~four-point scales~~ ie, very~~: i.e., much less valid = 1, less valid = 2, valid = 3, and very valid = 4. Obtained scores from expert assessment of the product development ~~are~~were converted to qualitative data on a four-point scale~~ data~~ (Ratumanan & Lauren, 2011), with criteria as in Table 3 below.

Table 3. Validity Criteria of Model and Learning Devices Based on Average Validator Values

Score Range	Criteria
> 3.6	very valid
2.8 – 3.6	valid
1.9– 2.7	less valid
1.0– 1.8	~~very~~much less valid

The average value of validity and reliability of models and devices supporting the learning model is determined based on the value given by the validator. The reliability of the learning device is calculated using the percentage agreement equation by Emmer and Millett (in Borich, 1994~~), the~~): an instrument is said to be ~~realible~~reliable if it has a percentage agreement of ≥ 75%, or ~~as much as~~a 75% average score from the validator team with a valid category.

***Effectiveness Product* (*Effectiveness of Reflective-Metacognitive Learning Model*)**

This stage ~~is~~was intended to determine the effectiveness of the metacognition learning model developed toward students' metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness) after the learning process. The randomized pretest – posttest control group design was used at the implementation stage of the RML Model. Two groups were required in this method~~ that are actually~~, namely the experimental and control groups. In the experimental group, the researcher gave a pretest, treatment by applying the RML model, and then ~~post-test~~a posttest. Meanwhile, in the control group, the researcher gave a pretest, followed by the treatment by applying the Cognitive-Metacognitive Learning (CML) model (Garofalo & Lester, 1989), and then a posttest. The following is the research design used.

The Randomized Pretest Posttest Control Group Design			
Group	**Pretest**	**Intervention**	**Posttest**
A	*O1*	*X*	*O2*
B	*O3*	*C*	*O4*

(Fraenkel et al, 2011)

Where,

A	: experimental Group
B	: control Group
O1	: pretest of experimental group
O2	: posttest of experimental group
O3	: pretest of control group
O4	: posttest of control group
X	: treatment in experiment group using RML Model
C	: treatment in control group using CML Model

Student metacognition ability data is collected using the following instruments:

1) Metacognition Knowledge Test. The students' metacognition knowledge data was collected using ~~10 items essays~~a ten-item essay test on acid and base materials provided before and after treatment. ~~Metacognition~~The metacognition knowledge test contains ~~3~~three indicators of declarative knowledge, procedural knowledge, and conditional knowledge.
2) Performance test. Student performance ~~is~~was measured using the students' ~~worksheet~~worksheets, given ~~at~~in the first and the last ~~meeting of~~ lesson. The metacognition skills indicators contained in the students' worksheet and measured in this study are: 1) Formulate Learning Objectives, both general and specific (FLO); 2) ~~Formulating~~Formulate Problem and problem~~-~~-solving Hypotheses that are relevant to the formulated learning objectives (FPH); 3) Make a Problem-Solving Plan to prove the hypothesis that has been proposed (PSP); 4) Implement Planning Systematically (IPS); 5) ~~Monitoring~~Monitor the ~~Processes~~Process (MP); 6) ~~Evaluation~~Evaluate the Process (EP); 7) ~~Collecting~~Collect Data (CD); 8) Evaluate Learning Achievement related to the objectives at the beginning of learning activities (ELA).
3) Metacognition Awareness Inventory (MAI). Students' metacognition awareness was measured using the MAI, developed by Schraw and Dennison (1994~~)~~), which was administered before and after the treatment. The indicators contained in the MAI are: planning, information management, monitoring, debugging, evaluation, declarative knowledge, procedural knowledge, and conditional knowledge.

The scores obtained ~~are analyzed~~were analysed and categorized into four criteria, as in Table 4 below.

Table 4. Student Metacognition Ability Criteria

Criteria	Score Range
Very Good	$80 \le P \le 100$
Good	$70 \le P \le 79$
Good Enough	$60 \le P \le 69$
Less Good	$P<60$

The RML ~~model~~model's effectiveness to improve senior high school students' metacognition ability ~~is~~was decided ~~by~~using the normalized gain score, namely: n-gain = (post-test score – pre-test score)/ (maximum score – pre-test score) (Hake, 1999). According to the following criteria: (1) when n-gain > .70 (high); (2) when .30 < n-gain < .70 (moderate); and (3) when n-gain < .30 (high). IBM SPSS Statistics 23 software ~~is~~was used to test the impact of teaching using the RML model ~~teaching~~ toward the improvement of metacognition ability in comparison with the CML Model. Furthermore, in order to ~~analyze~~analyse the differences ~~of~~in the RML ~~model~~model's teaching impact toward metacognition ability in comparison with the CML Model of the two groups, ~~it uses~~an independent sample t test was used. The testing method shall depend on the compatible ~~result~~results of the normality assumption and variant homogeneity tests of n-gain, whereas if the data is not normally distributed, ~~the data~~it is ~~analyzed~~analysed using non-parametric tests (Mann-Whitney test).

RESULTS

1. *Validity of Reflective-Metacognitive Learning Model*

RML Model validation instruments along with supporting devices ~~are~~were validated by ~~3~~three experts with minimum doctoral criteria and ~~have~~ expertise in chemistry (~~1~~one expert) and learning (~~2~~two experts). The validation results of the RML Model validity instrument and the device are presented in Table 5 below.

Table 5. Results of validation of RML Model validity instruments and devices

Item	r_{α}	Category	Cronbach's alpha (α)	Category
1. RML Model	.761	Valid	0.864	Reliable
2. Syllabus	.724	Valid	0.840	Reliable
3. Lesson Plan	.680	Valid	0.809	Reliable
4. Module	.781	Valid	0.877	Reliable
5. Worksheet	.715	Valid	0.834	Reliable
6. Instruments	.871	Valid	0.931	Reliable

Based on the results of the validity and reliability ~~test~~tests in Table 5, it can be stated that the ~~RML model its devices~~ validation ~~instrument~~instruments are valid and reliable to assess the quality of the RML model and its devices. The RML model is a learning model with reflective attribution in each learning stage to enable a conscious thinking process to increase students' metacognition ability through four phases: 1) Orientation Reflection; 2) Organizational Reflection; 3) Execution Reflection; and 4) Verification Reflection. ~~Formulation of RML Models~~Its formulation was based on empirical and theoretical support that ~~accommodate~~accommodates cognitive-metacognitive models (Garofalo & Lester, 1985) and problem-solving models (Yimer & Elerton, 2009). Reflections at the end of each learning phase are achieved through various forms of activities ~~like provide conflict~~, such as providing conflicting cognitive phenomena, ~~anomaly~~anomalous phenomena, internalization (through providing problems or concepts), and ~~provide~~providing new phenomena that are still related to decision making. Reflection plays an important role in teaching metacognition in students, ~~reflection~~and can also play a role in monitoring the knowledge processes that students have. The results of metacognition activities can be general ~~results~~, such as classifying information relevant to the problem at hand, or ~~can be~~ specific ~~results~~, such as finding specific solutions that fit the correct theory or concept to help students to solve the problems at hand (Veenman, 2012). The activities and applications of each learning phase are presented in Table 6 below.

Table 6. Reflective-Metacognitive Learning (RML) Model Phases

Learning Phases	Learning Activities	Applications in Learning Activities
Orientation Reflection	1. Provide learning objectives	• ~~Delivering~~Deliver learning objectives generally.
	2. Information and condition analysis	• Ask students to read information from relevant learning resources.
	3. ~~Assessing the intimacy~~Assess familiarity with the task	• Ask students about the material they are studying.
	4. Assess the difficulty level of the problem and the opportunity to successfully solve the problem	• ~~Asking back to~~Present students with a common problem in learning activities.

Learning Phases	Learning Activities	Applications in Learning Activities
	5. Reflection ~~of~~on orientation activities by providing ~~conflict~~conflicting cognitive phenomena.	• Provide ~~conflict~~conflicting cognitive phenomena to activate students' prior knowledge.
Organizational Reflection	1. Identify sub~~-~~-goals and ultimate goals	• Ask students to identify which sub-goals are the prerequisites that must be known first in order to achieve the ultimate/final goal.
	2. Make a general plan	• Establish general troubleshooting steps that have been identified in phase 1 orientation reflection, which is further downgraded to planning for sub-goals.
	3. Data organization	• Divide the students into groups. • ~~Directing~~Direct students in formulating hypotheses, defining ~~operationally~~operational variables in learning, ~~determining~~determine the problem-solving steps to be used.
	4. Reflection	• Reflection ~~of activities~~ on activities in the organizational ~~reflection~~ phase by presenting anomalous phenomena that enable students to organize activities in this phase.
Execution Reflection	1. Implementing a particular plan	• Ask students to carry out problem-solving planning in accordance with the plan that has been formulated. • Ask students to carefully plan and pay attention to the suitability and relevance of each troubleshooting step. Careful planning demonstrates good knowledge evaluation skills.
	2. Monitoring progress of particular and general plans implementation	• Assess performance of problem-solving implementation based on students' fluency and accuracy of problem-solving.
	3. Make/formulate decisions	• Ask students to formulate decisions by assessing the hypothesis ~~and~~, based on the results of data analysis and information obtained
	4. Reflection	• Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Verification Reflection	1. Final decision~~-~~-making	• Ask students to ~~make~~provide an explanation ~~about~~of the results of the

Learning Phases	Learning Activities	Applications in Learning Activities
		implementation of their problem-solving plan ~~implementation~~. • Ask students to explain the relevance of the results of their problem-solving ~~results~~ to the global goals they ~~have~~previously formulated ~~previously~~.
	2. Reflection	• Provide new phenomena that are still related to solving the problem.

The difference ~~of~~in the cognitive process (reflection) flow in the RML Model ~~with the~~ compared to Yimer and Ellerton's (2009) problem-solving model ~~developed by Yimer & Ellerton (2009)~~ is evident from Figure 4 below.

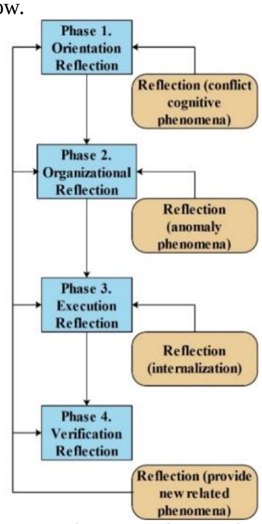

Figure 4. Cognitive Process Flow (Reflection) of the Reflective-Metacognitive Learning Model

Validation of the reflective-metacognitive learning model and supporting tools includes two components: content validity and construct validity. Content validity includes all components of the learning model and the tools should be based on ~~the~~ state-of-the-art ~~knowledgment~~knowledge. Components assessed ~~in~~for content validity are the development and design needs of RML models and devices based on current knowledge ~~that~~, which are generally categorized as highly valid. The results of this assessment are based on RML model development objectives to improve students' metacognition skills as needed according to the competencies of ~~the~~ 21st century major skill graduates and the applicable school curriculum requirements.

~~Expert~~The expert validators involved in this activity ~~are~~were competent experts in chemistry learning, ~~understanding~~who understand the 2013 curriculum (Curriculum of Education in Indonesia~~),~~) and are active in classroom learning activities as well as teacher training activities ~~of school teachers. Validator validates~~. Validators validated the model and its supporting devices by providing an objective assessment ~~by~~, giving a check mark (√) to the number corresponding to the given statement with the following criteria: Invalid (score 1); Less Valid (score 2); Valid (score 3); Very Valid (score

4). The RML Model validation results, along with the devices, as presented in Table 6 ~~are~~, were found to be valid ~~either~~ in both content ~~or~~and construct validity with ~~reliable category~~strong reliability.

Table 6. Expert ~~Validity~~Validation of RML Model.

Item	Content Validity		Construct Validity		Reliability
	Score	Category	Score	Category	
1. RML Model	3.89	Very Valid	3.84	Very Valid	.94
2. Syllabus	3.75	Very Valid	3.85	Very Valid	.96
3. Lesson Plan	3.87	Very Valid	3.96	Very Valid	.97
4. Module	3.81	Very Valid	3.88	Very Valid	.96
5. Worksheet	3.83	Very Valid	3.84	Very Valid	.96
6. Instruments	3.90	Very Valid	3.975	Very Valid	.98

The RML Model validation result is proven empirically from learning implementation as ~~much as 6~~over the course of six meetings that have been executed (3.9) very well. This criterion was observed from the percentage of the average mode of values in the 'very ~~good~~good' category and increased in each learning meeting. The result is ~~linear~~in line with ~~student response~~students' responses to learning using the RML Model, which overall ~~86.43% give~~gives a very strong response~~.~~ at 86.43%.

2. *Effectiveness of Reflective-Metacognitive Learning Model*

a. Metacognition Knowledge

The achievement of metacognition knowledge and n-gain is based on ~~3~~three indicators ~~i.e.:~~: declarative knowledge (DK), procedural knowledge (PK), and conditional knowledge (CK~~)~~), as presented in Table 6. Data ~~of~~on students' metacognition knowledge ~~analyzed~~were analysed using the Kolmogorov-Smirnov test to determine the normality and Levene test to determine the homogeneity of data variance obtained. ~~Based on the~~These test ~~result, it is known~~results reveal that the students' metacognition knowledge is normally distributed (Asymp Sig. 2-tailed: 0.2> 0.05~~),~~) and homogeneous (Sig: 0.421> 0.05), so an independent sample test (t-test) was used to analysis the improvement of students' metacognition knowledge before and after learning.

Table 7. Results of pre-test and post-test of students' metacognition knowledge

Group	N	Scores	Metacognition Knowledge Indicators			Mean	SD	p
			DK	PK	CK			
Experiment	20	Pre-test	32.12	45.75	32.44	34.2920		
		Post-test	89.66	82.8	86.89	84.4170	4.05841	.000
		n-gain	0.85	0.67	0.80			
Control	20	Pre-test	30.25	39.50	31.50	33.7505		
		Post-test	82.38	68.13	70.00	73.5000	5.48907	.000
		n-gain	0.75	0.47	0.56			

Based on the ~~data~~results of this analysis ~~results~~, as presented in Table 7, it can be seen that students' metacognition knowledge ~~is increase~~has increased after learning. ~~Improvement of~~The improvement in students' metacognition knowledge is significant for both groups, ~~where~~but the improvement ~~of~~in the experimental group is better (mean~~:~~ = 84.4170) than that in the control ~~groups~~group (mean~~:~~ = 73.5000). In order for a student to have good metacognition knowledge, ~~students~~he or she must be proficient in certain cognitive skills, namely~~:~~ declarative knowledge, procedural knowledge, and conditional knowledge~~. Metacognition involves~~, which are the three kinds of knowledge~~: (1) declarative~~ involved in metacognition. Declarative knowledge is knowledge about ~~one's self~~oneself as ~~learners,~~a learner and about factors affecting learning and memory, as well as the skills, strategies, and resources needed to do a task (know what to do); ~~(2)~~ procedural knowledge ~~or know~~involves knowing how to use ~~the~~a certain strategy; and ~~(3)~~ conditional knowledge ~~to ensure~~

~~completion of tasks (know~~involves knowing when and why to apply certain procedures and strategies~~)~~ ~~(~~ to ensure the completion of tasks (Bruning, Scrhraw, Norby, & Ronning, 2004, in Woolfolk, 2009). Metacognition knowledge is thus the strategic application of declarative, procedural, and conditional knowledge to achieve goals and overcome problems (Schunk in Woolfolk, 2009).

The ~~effectiveness of~~ RML model is more effective in improving ~~student~~students' metacognition knowledge ~~that better than~~compared to the CML model ~~supported~~, as demonstrated by the results of the n-gain analysis ~~results, as shown in~~ (Table 6 ~~we~~). We know that the n-gain of students' metacognition knowledge ~~on~~in the experimental group for each metacognition knowledge indicator is better (DK: 0.85; PK: 0.67; and CK: 0.8) than the n-gain of students' metacognition knowledge ~~on~~in the control group (DK: 0.75; PK: 0.47; and CK: 0.56). The results of the analysis show that the scores obtained by students before and after learning using the RML model ~~was~~were significantly ~~difference~~different.

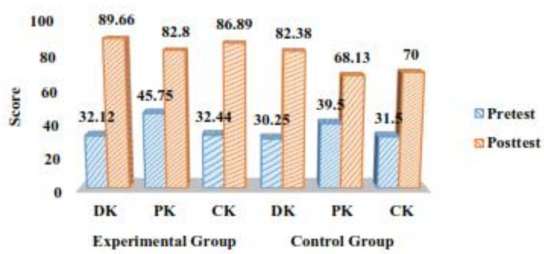

Figure 5. ~~Results of pre-test and post-test of students'~~Students' metacognition knowledge (pre-test and post-test)

Figure 5 shows that the most significant impact is seen in the DK (0.85) and CK (0.8) indicators in the experimental group, with a high category, while in the control group ~~only~~, the DK (0.75) indicator ~~have~~had the most significant improvement. The RML model is more effective ~~to~~in increasing students' metacognition knowledge on ~~each indicator, it can happen~~all three indicators, which is likely to be because of reflection on each phase of learning. ~~Provide conflict~~The provision of conflicting cognitive phenomena, ~~anomaly~~anomalous phenomena, internalization (through providing problems or concepts), and ~~provide~~ new phenomena that are still related to decision-making as a form of learning reflection ~~so that~~enables students to review the purpose and analysis of the material ~~on~~in the readings presented and ~~allow students~~ to understand more deeply ~~about~~ the material used as initial knowledge to learn the next set of material. In the line with that opinion, Cowan (1998) states that students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, ~~for example~~such as in the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and working out what needs to be done to solve ~~the problem~~them (Ong, 2010). Providing ~~conflict~~conflicting cognitive phenomena creates a state of imbalance in ~~student~~students' thinking, which teachers can use to encourage ~~student~~students' interest in solving problems (Mischel, 2007). The ~~conflict~~conflicting cognitive phenomenon can promote the monitoring of knowledge in the thinking process and reflecting on students' initial knowledge (Thomas, 2012). Students' procedural knowledge ~~becomes~~as an indicator of metacognition knowledge ~~that has~~showed a less significant increase, although it ~~is~~was still in ~~good~~the 'good' category for both classes. The ~~result~~results of the Independent sample t-test also ~~shows~~show that students' metacognition knowledge ~~on the experiment group and control group~~ is significantly different (p~~:~~ < .000) between the experimental group and the control group, as presented in Table 8 below.

~~Tabel~~Table 8. Independent sample t test of students' metacognition knowledge

Group	N	sig	t	df	p

Posttest of ~~exsperiment~~experimental and control groups	40	.772	6.064	38	.000

The ~~effectiveness of the~~ RML model and the learning devices developed ~~that~~, which accommodate the three components of metacognition ability ~~ie:~~ (metacognition knowledge, metacognition skills, and metacognition awareness ~~can~~), have thus been shown to be ~~stated better in~~more effective at improving students' metacognition knowledge ~~(p:~~than the CML model (p = .000). In order ~~for a student~~ to have good metacognition knowledge, students must be proficient in certain cognitive skills, namely~~:~~ declarative knowledge, procedural knowledge, and conditional knowledge (Woolfolk, 2009). McCormick stated that students can be taught a strategy of assessing ~~his/her~~their own understanding by finding out how much time it takes to learn something and choosing an effective action plan for learning or working on a problem (Slavin, 2011). Oxford (1990) classifies some metacognitive strategies ~~i.e~~as follows: 1) Centralize student learning; 2) ~~Arranging~~Arrange and plan lessons ~~planning~~; 3) Evaluate learning. Another metacognitive strategy is the ability to predict what might happen or mention something rational and irrational.

Teaching metacognitive strategies to students can produce a clear improvement in student achievement (Alexander, Graham & Harris; Hattie et al., in Slavin, 2011). Students can learn to think through their own thinking processes and apply certain learning strategies to think themselves through difficult tasks (Butler & Winne; Pressley, Harris & Marks; Schunk in Slavin, 2011). The self-questioning strategy is very effective (Zimmerman in Slavin, 2011). A self-questioning strategy is a learning strategy that asks students to ask themselves about who, what, where, and how students read the material (Slavin, 2011). ~~This means students~~Students can be taught these strategies by conditioning learning according to the criteria described previously.

Inquiry activities that integrate the process skills are also carried out in the activities of the RML ~~Models~~model and ~~it~~are very ~~well~~effective to raise awareness of the strategies used and positively affect student performance (Pressley, Borkowski, & Schneider, 1987; McCormick, 2003). Crowly, Shrager, ~~&~~and Siegler (1997) ~~describe~~described the associative stages and metacognitive mechanisms in strategies that emphasize the discovery process, which has an important role in students' procedural knowledge. Siegler and Jenkins (in Waters and Kunnmann ~~(~~, 2010) further explained that discovery processes in learning can increase students' awareness of their knowledge and accelerate the generalization process of student information.

The RML Model ~~that~~, which emphasizes evaluative reflection activity using ~~the phenomenon~~phenomena that are directly related to ~~student~~students' social ~~aspect~~aspects, can be declared effective to increase knowledge of student metacognition. Moon (2004) argues that reflection is a key component of learning, while Fook (in Hickson, 2011) further argues that evaluative reflection emphasizes ~~on~~ thinking ~~of~~about what has been done and elaborating based on the evaluation results to anticipate possible future problems. Further, Hoyrup (2004) suggests that evaluative reflection must be integrated with social aspects and can be measured at a time when one is able to understand and validate the assumptions formulated. The reflection process in the RML model serves to prevent students from repeating possible mistakes ~~in~~from the previous learning process. In line with that statement, Carrol (2010) states that reflecting on processes that have been done in everyday activities is essential to avoid the lack of ideas and ~~repeat~~repetition of mistakes in routine activities.

b. Metacognition Skills

~~The results of students'~~Students' metacognition skills showed ~~a~~ good improvement~~, the~~. The indicators of students' metacognition skills that were measured in this study ~~such as~~comprised the following: 1) ~~Formulate~~Formulating Learning Objectives, both general and specific (FLO); 2) Formulating Problem and problem~~-~~solving Hypotheses relevant to the formulated learning objectives (FPH); 3) ~~Make~~Making a Problem-Solving Plan to prove the hypothesis that has been proposed (PSP); 4) ~~Implement~~Implementing Planning Systematically (IPS); 5) Monitoring the Processes (MP); 6) ~~Evaluation~~ Evaluating the Process (EP); 7) Collecting Data (CD); 8) ~~Evaluate~~Evaluating Learning

Commented [Rev1]: This is repeated from the previous paragraph

Achievement ~~related~~in relation to the objectives at the beginning of the learning ~~activities~~activity (ELA). Data ~~of~~on students' metacognition skills were ~~analyzed~~analysed using the Kolmogorov-Smirnov test to determine normality and the Levene test to find ~~out~~ the homogeneity of ~~data~~ variance obtained. ~~Based on the result of the test, it is known~~These tests revealed that the students' metacognition skill data ~~are~~were normally distributed (p> 0.05) but not homogenous (~~Sig~~p <0.05) for both the experimental group and the control group, so ~~that statistical analysis of~~ a paired t test was used to ~~know~~examine the significance of students' metacognition skills improvement before and after learning using the RML model (~~experiment~~experimental group) and the CML model (control group). The ~~result using~~results of the paired t test of students' metacognition ~~skill~~skills in ~~experiment~~the experimental and control groups ~~is~~are presented in Table 9 below.

Table 9. ~~The pre~~Pre-test and post-test result of students' metacognition skills

Variable Pair	N	Score	~~Exsperimen~~Exsperimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
FLO	20	Pretest	43.75	19.86799	.000	53.75	11.47079	.000
		Posttest	93.75			78.75		
		n-gain	0.9			0.5		
FPH	20	Pretest	32.50	11.47079	.000	47.50	9.15869	.000
		Posttest	82.50			76.25		
		n-gain	0.7			0.5		
PSP	20	Pretest	46.25	15.12013	.000	53.75	9.15869	.000
		Posttest	85.00			77.50		
		n-gain	0.7			0.5		
IPS	20	Pretest	55.00	15.17442	.000	62.50	14.67857	.000
		Posttest	92.50			78.75		
		n-gain	0.8			0.4		
MP	20	Pretest	60.00	17.90876	.000	60.00	16.42367	.000
		Posttest	78.75			75.50		
		n-gain	0.5			0.4		
EP	20	Pretest	61.25	12.76044	.000	61.25	13.07871	.000
		Posttest	75.00			81.25		
		n-gain	0.4			0.5		
CD	20	Pretest	60.00	14.28101	.000	60.00	16.77051	.000
		Posttest	92.50			81.25		
		n-gain	0.8			0.5		
ELA	20	Pre-test	51.25	12.76044	.000	51.25	12.76044	.000
		Post-test	75.00			75.00		
		n-gain	0.5			0.5		

A Mann-Whitney U test was used to compare students' metacognition skills between the two groups, as shown in Table 10. The ~~result~~findings reveal that the metacognition skills of students ~~'metacognition skills comparison statistical test in both groups is also presented in Table 10 which shows the students' metacognition skill which is~~ taught using the RML model were better (mean rank: 27.32) than ~~the student' metacognition skill which is~~those of students taught using the CML model (mean rank: 13.68~~) and is significantly different (~~). This difference was significant at p ~~:~~≤ .000~~)~~.

Table 10. Mann-Whitney U test of students' metacognition skills

Group	N	Mean Rank	p
Experiment	20	27.32	.000
Control	20	13.68	

The improvement of students' metacognition skills in the experimental class ~~can't~~cannot be separated from the integration of ~~constructivism~~constructivist views ~~that~~, which, in this study, can be realized by facilitating students to learn by providing ~~student worksheet~~worksheets as a guide for measuring/observing or experimenting and conducting discussions. Students are given the opportunity to interact with the material they learn through observation or practicum, discussions, and ~~provide~~ opportunities ~~for students~~ to think about the results of these observations~~ or~~, practicum~~,~~ and ~~the results of discussion, so that through these~~discussions. These activities are expected to develop the science process skills to improve understanding of the material or the concept ~~he or she learns.~~being learned. This result also shows that the material contained in the students' ~~worksheet~~worksheets is in ~~accordance~~keeping with the environmental context often encountered by the students and ~~in accordance~~ with the material contained in both ~~in~~ the syllabus and the lesson plan, so that ~~really~~it can provide genuine support for the achievement of basic competence and facilitate students' metacognition awareness. ~~Differences~~The differences in the improvement of students' metacognition skills~~ were~~, as obtained through the scores for pretest and posttest activities, are presented in Figure 6.

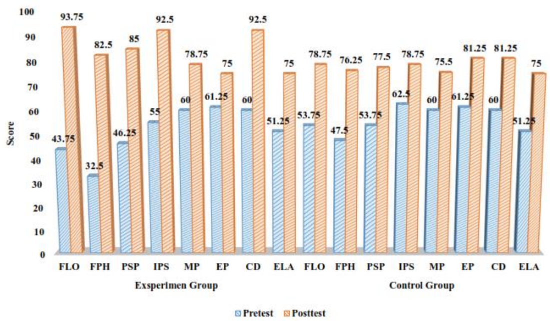

Figure 6. ~~Results of students'~~Students' metacognition skills (pretest and posttest)

~~The result of students'~~Students' metacognition knowledge is directly proportional to ~~the~~ students' metacognition skills and activities, ~~where the metacognition skills and activities~~ which are related to ~~the~~ students' procedural knowledge~~ are indicator~~. Indicator 6, examining the planning process either individually or in groups (N-gain: 0.4) in the experimental group, and indicator 4, systematic planning (N-gain: 0.4) in the control group experienced ~~a~~ significantly less improvement than other skills and activities, but this improvement was still ~~well~~ categorized as good. The integration of contextual phenomena as reflections in the RML model ~~becomes~~is an important attribution that plays a role in improving students' metacognition skills. Lee (2006) stated that the contextual approach is ~~very necessary~~vital in learning, ~~providing~~ provided that the contextual problem has two virtues: that is, to improve students' learning motivation so that ~~students give~~they have positive responses to the learning and ~~give~~to provide a good understanding ~~on~~of the material being taught. Brum ~~&~~and McKane (1989) ~~states~~stated that learning science, including chemistry, cannot be separated from the ability to make observations, formulate testable hypotheses, ~~the ability to~~ induce and deduce, and design and execute experiments to ~~prove~~test hypotheses. These activities are contained in the students' worksheet so that students' metacognition skills can be improved. In line with that opinion, Nur (2011) stated that ~~in~~ student learning activities should ~~be emphasized to do~~place more emphasis on scientific activities such as ~~formulate~~formulating questions, ~~hypothesize, observe, analyze~~hypothesising, observation, analysis and ~~conclude~~conclusion so that the material studied becomes more meaningful. The RML model~~ that~~, which emphasizes reflection processes in each phase, has an important role in improving students' metacognition skills by accommodating scientific activities. ~~The~~This statement is reinforced by Bennet et.al~~.~~, (2016~~)~~), who argued that reflection is an essential part of developing students' evaluative-reflective skills in the context of experiential-oriented learning.

c. Metacognition Awareness

Metacognition awareness is related to activities that help a person to control his or her mind and ~~learn~~learning. The metacognition awareness in this study includes metacognition knowledge and cognitive regulation, contained in the 52-‑item ~~of~~ metacognition awareness questionnaire developed by Schraw and Dennison (1994~~)~~), which contains ~~8~~eight aspects: 1) declarative knowledge (DK~~),~~); 2) procedural knowledge (PK~~),~~); 3) conditional knowledge (CK~~),~~); 4) planning (P~~),~~); 5) information management ~~system~~systems (IMS~~),~~); 6) monitoring (M~~),~~); 7) debugging (D~~),~~); and 8) evaluating (E~~)~~). ~~The result of normality and homogeneity test of students'~~). Students' metacognition awareness indicators are ~~stated~~were found to be normally distributed and homogeneous, so ~~that the~~an independent sample t test ~~is done~~was used to ~~know~~investigate the difference ~~of~~in students' metacognition awareness ~~in~~between the control group and the experimental group before and after the learning, as presented in Table 11 below.

Table 11. The pretest and posttest result of students' metacognition awareness

Variable	N	Score	~~Exsperimen~~Exsperimental Group				Control Group			
			Mean	**sig**	**t**	**p**	**Mean**	**sig**	**t**	**p**
		Pretest	55.75	.192	-5.885	.000	51.75	.649	-8.535	.000
DK	20	Posttest	72.25				68.75			
		n-gain	0.4				0.4			
		Pretest	54.50	.192	-6.962	.000	51.00	.083	-6.798	.000
PK	20	Posttest	67.00				63.50			
		n-gain	0.3				0.3			
		Pretest	50.63	.631	-7.504	.000	50.78	.893	-9.221	.000
CK	20	Posttest	69.53				65.47			
		n-gain	0.4				0.3			
		Pretest	54.10	.131	-5.702	.000	50.89	.145	-7.956	.000
P	20	Posttest	68.21				64.46			
		n-gain	0.3				0.3			
		Pretest	50.00	.193	-6.777	.000	50.55	.624	-6.668	.000
IMS	20	Posttest	68.19				63.19			
		n-gain	0.4				0.3			
		Pretest	49.64	.407	-7.614	.000	51.25	.258	-7.304	.000
M	20	Posttest	68.21				64.46			
		n-gain	0.4				0.3			
		Pretest	52.00	.588	-6.623	.000	50.75	.189	-6.484	.000
D	20	Posttest	70.50				64.50			
		n-gain	0.4				0.3			
		Pre-test	51.45	.480	-6.331	.000	50.20	.364	-8.806	.000
E	20	Post-test	70.00				64.99			
		n-gain	0.4				0.3			

Table 12 also shows that ~~students'~~the metacognition awareness ~~being~~of students taught using the RML model was better (mean rank: 26.05) than ~~students' metacognition awareness~~that of students who were taught using the CML Model (mean: 14.05) and ~~significantly different~~that this difference was significant (p~~:~~ < .027).

~~Tabel~~Table 12. Mann-Whitney U test of students' metacognition awareness

Group	N	Mean Rank	p
Experiment	20	26.95	.000
Control	20	14.05	

Findings related to metacognition knowledge~~,~~ and metacognition skills~~,~~ were confirmed ~~on~~regarding students' metacognition awareness. Figure 7 shows that students ~~are~~were still unaware of the procedural knowledge they ~~have~~had (PK~~,~~; n-gain~~:~~ = 0.3), and that the results ~~have~~had an effect on the students' belief in ~~the~~their planning ~~of the students~~ (P~~,~~; n-gain~~:~~ = 0.3) so that the process of monitoring or examining the processes ~~which~~was performed well but not maximally (M~~,~~; n-gain~~:~~ = 0.3). ~~The~~These results ~~occur~~occurred in the experimental class as well as the control class, but generally the students' metacognition awareness is still ~~well~~ categorized as good.

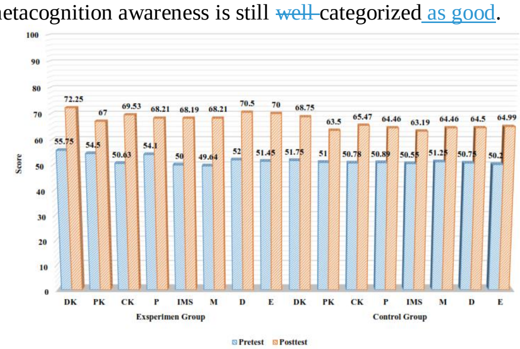

Figure 7. ~~The results of students'~~Students' metacognition awareness (pretest and posttest)

~~Learning~~The learning activities from beginning to end emphasize ~~students to train~~training and ~~cultivate~~cultivating students' metacognition knowledge and skills. Yusnaeni et al. (2018) ~~state~~stated that the implementation of metacognitive strategies related to awareness ~~in~~of monitoring cognitive strategies to achieve specific goals can improve students' thinking skills. This is illustrated in the model phases applied to the learning devices. The impact of learning using the RML model is seen in students' attitude toward the science or information possessed. Such attitudes can be monitored ~~which~~, according to Flavell (1979~~)~~), through actions and interactions between four components: (a) metacognitive knowledge, (b) metacognitive experiences, (c) objectives (or tasks), and (d) actions (or strategy~~) ".~~). Metacognitive knowledge is used to regulate thought and learning (Brown, 1987; Nelson, 1996, in Woolfolk, 2009). Essential skills for metacognition include planning, monitoring, and evaluating (Woolfolk, 2009). Planning includes the students' ability to determine the time needed to ~~do~~perform a task, ~~choose~~ the strategy ~~used~~to use, how to begin, the resources needed, the sequence followed, what needs attention, and so on. Monitoring is real-time awareness about "how students work". These criteria ~~described have been contained in~~are encompassed within the entire learning process so that metacognition awareness can be stated to be increased after learning using the RML model.

The RML model ~~that~~, which emphasizes evaluative reflection activities using the provision of phenomena that are directly related to ~~students 'social~~ students' social aspects, can be declared to be effective to improve students' metacognition skills. Fauzi ~~&~~and Hussain (2016) stated that the more closely the learning ~~relation with~~is related to the social context, the more reflective students are in learning, ~~besides,~~and that the emphasis on the reflection processes in each phase has an important role in improving students' skills by accommodating scientific activities. ~~The~~This statement was reinforced by Bennet et~~.~~ al. (2016~~)~~), who argued that reflection is an essential part of developing evaluative reflections ~~of students~~ in the context of learning oriented to scientific ~~experiment~~experimental activities. Reflection in learning is not only important in learning chemistry ~~learning~~, but in learning science in general, as it can help teachers to ~~know~~identify the level of regulation of cognition possessed by students. In line with this statement, Flavell ~~&~~and Brown (in Herscovitz et al., 2012) ~~states~~defined metacognition as a person's awareness and reflection on the process of self-cognition, which involves self-regulation and coordination of conscious learning tasks. Veenman (2012) further explained that reflection can be used to obtain a student's self-instruction production system. ~~The good~~Good science learning~~, essentially~~ should always pay attention to ~~the~~students' psychological aspects ~~of students~~ in the learning process, in terms of both ~~aspects of psychological~~ cognitive development and ~~aspects of~~ social psychology. ~~Four~~The four phases of the RML ~~models~~model are: (1) orientation reflection, (2) organizational reflection, (3) execution reflection, and (4) verification reflection, which is developed based on the consideration of the abovementioned psychological aspects ~~as described~~and is very feasible as an alternative solution in chemistry learning in particular and learning science in general, with reflection activities ~~as spirit in~~ forming a central element of every phase of learning. This statement is in line with Dewey, who argued that important attitudes in reflection, namely open thinking, enthusiasm, and responsibility, not only can bridge the three components of metacognition to be taught to students (Loughran, 2005), but have also become social aspects that are also expected to be developed in ~~every~~all science teaching ~~of science~~ at every level of education (Education Ministry of Indonesia, 2013).

CONCLUSION

Based on the ~~result~~results and discussion, it can be concluded that: (1) the RML model is a learning model to facilitate students' metacognition ability, which has four phases, namely orientation reflection, organizational reflection, execution reflection, and verification reflection, with ~~characteristics~~characteristic reflection activities at each phase of learning through ~~the~~ providing ~~conflict~~conflicting cognitive phenomena in the first phase, ~~anomaly~~anomalous phenomena in the second phase, the internalization process in the third phase, and ~~provide~~ new phenomena that are still related to the learning material in the fourth phase; (2) ~~The RML Model was~~It can be stated ~~very~~that the RML model is highly valid both in terms of both content (3.89) and construct (3.84~~);~~) validity; (3) metacognition knowledge ~~increased with~~showed a high ~~category~~increase (mean ~~of~~ n-gain~~:~~ = 0.76), while skill~~,~~ and metacognition awareness ~~increased in~~showed a medium ~~category~~increase (mean ~~of~~ n-gain~~:~~ = 0.66~~;~~ and 0.4 respectively) for the experimental group, while for the control group, metacognition knowledge, skills, and awareness ~~increased with~~showed a medium ~~category~~increase (mean ~~of~~ n-gain~~:~~ = 0.6; 0.475; 0.3125, respectively) and statistical analysis showed that there was improvement in students' metacognition ability in both groups ($p < 0.05$~~), and~~). It can thus be concluded that the RML model is valid and more effective than the CML model to increase ~~student's~~students' metacognition ability.

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THE VALIDITY AND EFFECTIVENESS OF THE REFLECTIVE-METACOGNITIVE LEARNING MODEL TO IMPROVE STUDENTS'S METACOGNITION ABILITY IN INDONESIA

By the author(s):

Muhali, Leny Yuanita, Muslimin Ibrahim

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Malaysian Journal of Learning and Instruction (MJLI)

Manuscript Evaluation Form (Reviewer B)

Title of Paper:

A. **Details of comments** ***(please fill in where appropriate and use a separate page if necessary)***

No.	Item	Refer to page(s)	Comments (Please make comments specific in order to assist corrections)	Author's Explanation/ Rebuttal	Page and Paragraph No. of Revised version
1	**Does the title accurately reflect the content of the paper?**	**1**	It must be stressed here that the overall idea of the article is on comparing RML to CML. This however was not translated in the title. In addition, as the data obtained for the study was collected (presumably) from Indonesia, it would be good to include 'Indonesia' in the title.	The suggestion of the reviewer related to the addition of the country where the study (Indonesia) has been written in the title. Related to the addition of the idea of comparing RML with CML, it has been described in the abstract.	**Pp 1 dalam judul**
2	**Is the abstract sufficiently concise and informative?**	**1**	The author(s) have followed the format set by the journal. However, the write up of the abstract could still be improved. For example, at the Purpose - the author(s) may straight away write "This study aims to analyze the validity and effectiveness of Reflective-Metacognitive Learning (RML) Model in comparison to the Cognitive-Metacognitive Learning (CML) Model by Garofalo and Lester (1989)". Apart from that, there is a need for the abstract language to be edited for clarity.	The reviewer's suggestion related to the clarity of the research objectives, namely the comparison of the effectiveness of RML with CML has been included in the abstract	**Pp 1**
3	**Is the purpose clearly stated in the introduction?**		No	The research objectives have been presented in detail in the introduction	**5**
4	**Is the organization of the content acceptable?**		Need some improvement	We have fixed it according to the reviewer's suggestion	**2-9**
5	**Is the literature review**		No. The information and the previous knowledge	We have fixed it according to the reviewer's	**5-8**

	satisfactory?		included in this section hugely emphasis on the development of metacognition as a body of knowledge. However, there are some confusing information being mixed up with the article's said purpose. For example, it was established earlier on that the study aimed towards providing an analysis of the validity and effectiveness of Reflective-Metacognitive Learning (RML) Model in comparison to the Cognitive-Metacognitive Learning (CML) Model. However, the literature on this was only discussed in two-paragraph at page 5. What was expected to be included in the literature would some details on the development of metacognitive learning approach and CML, how that influence the building block of RML, and advantages (and/or disadvantages) of CML. In addition, the information in this section should include those studies which had utilized CML or some other model similar to CML.	suggestion	
6	**Is the methodology appropriate?**		Partially. In this study, the researcher(s) had compared the effectiveness of RML model to CML. It is understandable that the study had divided the subjects into 2 groups - experimental and control group. However, I strongly believe that there is a need for a neutral group to be included to really show and proves that the current education system implemented in Indonesia did not really emphasis on students' metacognitive abilities. Furthermore, there are questions over those selected 'experts' as their task seemed to be solely on the evaluation of RML. This raised a question of validity of data as were they also an expert of CML. Were they able to differentiate the significant changes in terms of approaches that are different between RML and CML? This brings me to the 'So what?' factor of a good research - what is the study's contribution and what is new being brought about?	In this section the control group is not used, because the main purpose of this study is to see the contribution of reflection activities on RML models using previous models that relate and specifically teach metacognition as a control.	
7	**Are there any discrepancies in facts and figures?**		No		

8	**Are the interpretation and conclusion of this paper appropriate?**		No. There is only one sentence and there is no real attempt to discuss the findings obtained in this article.	We have fixed it according to the reviewer's suggestion	**22**
9	**Does this article make a contribution to knowledge in the field?**		Novelty and originality The study and the data presented in this article is genuine and timely. As the study focuses on improving students' metacognitive ability, the study may contribute hugely in improving learning in Indonesia. 2. Importance and impact The study is important as it may create to better the practice of teaching. As teachers learn about the RML, teacher may create better teaching lessons for their students. 3. Relevance to the Body of Knowledge As it is, the new model may prove to be a better version of the well-known CML. This thus contribute to the development of metacognition.	We have fixed it according to the reviewer's suggestion	**5-8**

D. Other comments

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Malaysian Journal of Learning and Instruction (MJLI)

Manuscript Evaluation Form (Reviewer C)

Title of Paper:

A. **Details of comments** ***(please fill in where appropriate and use a separate page if necessary)***

No.	Item	Refer to page(s)	Comments (Please make comments specific in order to assist corrections)	Author's Explanation/ Rebuttal	Page and Paragraph No. of Revised version
1	**Does the title accurately reflect the content of the paper?**		Yes		
2	**Is the abstract sufficiently concise and informative?**		Yes		
3	**Is the purpose clearly stated in the introduction?**		Partially, need to clarify whether the RML model is a learning model that can be applied generally for any given lesson implementation or it is a model of learning that must involve problem solving activity.	We have fixed it according to the reviewer's suggestion	**8-9**
4	**Is the organization of the content acceptable?**		Yes		
5	**Is the literature review satisfactory?**		There is a lot of technical jargon with several terms used that have overlapping meanings. Many terms are not discussed but rather just presented as per the source. The organisation does not provide for a smooth read. Since the author has defined metacognition as in paragraph 3 of page 2, the discussion of the formulation of RML model	We have fixed it according to the reviewer's suggestion	**6-8**

			should map the definition used with the phases of the RML model and at the same time relate the RML model to other CML and other learning models that focus on developing metacognition.		
6	**Is the methodology appropriate?**		Partially, I would recommend declaring the overall research design as Research and Development according to the Borg and Gall model rather than stating it as an experimental research at the outset. The experimental design is part of the evaluation phase of Borg and Gall R&D design and thus can be stated as such to determine the effectiveness of the RML model in developing metacognition. Need to clarify the theoretical basis for the eight aspects of the content and construct validity of the RML Model and its devices. How was the 'devices' validated? Were the same eight aspects used for the validation of the 'devices'? Need to further clarify what model and its devices 'reliability' mean. How does the reliability of model and devices relate to the reliability of an instrument? (since the article mentioned the reliability of an instrument). Need to justify the use of n-gain in calculating the changes in the metacognition score. In the results section, t-test was used to test the hypothesis but was not described in the methodology section. Also, calculating the effect size would provide for a more insightful interpretation of result as it is more popular among education researchers ? n-gain is basically popular in physics education research.	We have fixed it according to the reviewer's suggestion	10, 12
7	**Are there any discrepancies in facts and figures?**		None that I can detect		
8	**Are the interpretation and conclusion of this paper appropriate?**		Need to discuss more on why the RML model leads to better results compared to the CML model since both models explicitly incorporate some aspects of metacognition in the learning process. CML has its strengths but now the author claims that RML is a better model due to incorporating 'reflection' in every phase of	We have fixed it according to the reviewer's suggestion	**15-22**

			learning. Discussion need to highlight more on this point rather than elaborating on the overall strengths of what is common for both models. And how do the 'devices' support reflection. Does the CML model has its own devices? What are the similarities and differences between the set of devices for the RML model and the CML model? Does 'reflection' in every phase being incorporated in the 'devices'? Did the act of 'reflection' actually contributed to a better result or perhaps there are other factors that did it? This part was not convincing enough. Perhaps specific examples of how reflection is embedded in each phase of the learning and in each devices need to be provided.		
9	**Does this article make a contribution to knowledge in the field?**		Yes it does. The paper described a structured way of incorporating reflective thinking into the phases of learning to ensure thinking is embedded during learning and thus the development of thinking is not left to chance.	We have fixed it according to the reviewer's suggestion	**5-8**

D. Other comments

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THE VALIDITY AND EFFECTIVENESS OF THE REFLECTIVE-METACOGNITIVE LEARNING MODEL TO IMPROVE STUDENTS'S METACOGNITION ABILITY IN INDONESIA

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ABSTRACT

Purpose: This study aims to (1) analyse the validity of the Reflective-Metacognitive Learning (RML) Model reviewed from content validity and construct validity; and (2) analyse the effectiveness of the RML Model in comparison with Cognitive-Metacognitive Learning (CML) Model developed by Garofalo and Lester by compare the improvement of students' metacognition knowledge, metacognition skills, and metacognition awareness after learning process.

Methodology: This research is an experimental study that began with the development of RML model adapting Borg and Gall's development design, which consists of: 1) planning, 2) development, and 3) evaluation. A Focus Group Discussion (FGD) with four science education experts was conducted to determine the validity of the RML Model and its supporting devices in terms of content validity and construct validity. The randomized pretest posttest control group design was used to evaluate the effectiveness of the RML Model and the CML Model, which were implemented among 40 senior high school students. Data were analysed descriptively and using inferential statistics, namely independent sample t-tests and Mann-Whitney U tests.

Findings: The results obtained indicated that (1) the RML Model was highly valid in both content (3.89) and construct (3.84) validity, (2) metacognition knowledge increased to a high degree (mean of n-gain: 0.76), skill, and metacognition awareness increased to a medium degree (mean of n-gain: 0.66; and 0.4) for the experimental group (tought using RML Model), while for the control group (tought using CML Model) increased to a medium degree (mean of n-gain: 0.60 of metacognition knowledge; 0.475 of metacognition skills; 0.3125 of metacognition awareness), and statistical analysis showed that there was improvement in students' metacognition ability in both groups ($p < 0.05$). It can be concluded that (1) the RML model is valid and (2) the RML Model more effective than the CML Model to increase students' metacognition ability.

Significance: The RML Models is expected to contribute to improving students' metacognition skills, characterized by reflection of thought processes that are at the core of metacognition ability.

Keywords: Learning Model, RML Model, Validity of RML Model, Metacognition Ability, Effectiveness of RML Model and CML Model.

INTRODUCTION

Metacognition is an important goal and focus of education in Indonesia and across the world (Asy'ari, et al., 2016). It can be simply defined as the process of thinking about thinking (Lai, 2011) through the conscious evaluation of thought processes (Asy'ari, 2016). Permendiknas (2015) advocates that high school students should be able to solve procedural problems that are also components in metacognition, so that they are trained in productive thinking to solve routine and non-routine problems. Anderson & Krathwohl (2001) present metacognition as the highest dimension of knowledge in learning. This suggests that metacognition should be taught, and should become a learning goal. The results of the PISA (Program for International Student Assessment) study in 2012, which focused on reading literacy, mathematics and science, revealed that Indonesia ranked 55th out of 65 countries, while in 2015 it was ranked 69th out of 75 countries worldwide. The results of the TIMSS (Trends in International Mathematics and Science Study) study in 2011 also showed that Indonesian students are ranked low in (1) ability to understand complex information; (2) theory, analysis and problem solving; (3) the use of tools, procedures and problem-solving; and (4) conducting an investigation (Indonesian Ministry of Education, 2012). Students' success in completing the given learning task depends on their awareness of the knowledge and skills apply in learning activities (Lai, 2011; Wilson & Bai, 2010; Pantiwati & Husamah, 2017), commonly known as metacognition ability. The result of Muhali's (2013) study involving students in four schools in Central Lombok showed that 6.15% of students are categorized as having very good metacognitive awareness; 32.31% are in the good category; 51.15% are categorized as having adequate metacognitive awareness, and the remaining 10.39% show poor metacognitive awareness.

Metacognition generally consists of 1) metacognition knowledge; 2) metacognition control and regulation (Pintich, Wolters, & Baxter, 2000); and 3) metacognition assessment and examination (Meijer, Veenman, & Wolters, 2006). Metacognition knowledge is a declarative, procedural, conditional knowledge of cognition (Veenman, 2012), cognitive strategies and variables in tasks or problems faced that affect a person's cognition (Alexander, Schallert, & Hare, 1991; Flavell, 1979). Metacognition is one of the innovative skills in 21st century learning and involves high-level cognition processes that include thinking about knowledge and how to gain that knowledge through a reflective process. In line with that opinion, Thomas (2012) believes that metacognition is the key to following developments in 21st century science education. The development of science education from this perspective relates to the development of students' science literacy and understanding of the nature of inquiry, the nature of science and concepts in science itself. Metacognitive teaching can enhance learning activities, understanding, attention, motivation, and memory, and reduce learning disabilities (Ya-Hui, 2012) through effective processes in the planning, monitoring and evaluation of teaching (Schraw, et al., 2012) with the strategic application of declarative, procedural, and conditional knowledge to achieve goals, and address problems (Kaberman & Dori, 2008; Schunk in Woolfolk, 2009). Metacognition ability in this study is a high level of thinking ability, consisting of: (1) knowledge of cognition (metacognition knowledge): that is knowledge of the self as learner, including declarative, procedural, and conditional knowledge (Lai, 2011; Flavell, 1979; Marzano, et 1988: Woolfolk, 2009; Williams & Atkins, 2009; Anderson & Karthwohl, 2010; Louca, 2008); (2) metacognition skills, which are a person's awareness of the control process in learning (Veenman, 2012); and (3) metacognition awareness, which is a person's ability to reflect, understand, and control his learning, including metacognition knowledge and regulation of cognition (planning, information management, monitoring, debugging, and evaluation) (Schraw & Moshman, 1995; Schraw et al., 2006; & Schraw, et al., 2012; Jakobs & Paris, 1987; Kluwe, 1987; Pressley & Harris, 2006).

Curiosity towards cognition and problems faced in teaching metacognition has prompted many researchers to develop and formulate effective and systematic learning models. Polya (1957) proposed four stages of the problem-solving model: 1) Understanding the problem: This includes reading and clarifying problems to identify what is known, what is unknown and objectives; 2) Devising a plan: this stage is the selection strategy and the preparation of plans for solving problems; 3) Carrying out: after making a plan, then execute this plan and write down the solution; 4) Looking back: when a solution is found, it is necessary to check its legitimacy. The most common problem with this model is that the problem solver does not fully understand these stages: thus, he or she needs to try many times using different problem solving strategies to succeed. Further, Schoenfield (1983; 1985) with a problem-solving scheme consisting of several activities: reading, analysis, exploration, planning, implementation, and verification. Schoenfield (1985) identifies three levels of knowledge and needs that are believed to be fulfilled if the person's problem-solving performance is quantified. Three levels are: (1) sources (knowledge that can be used on special problems); (2) control (knowledge possessed by a person to be able to choose and implement his knowledge on the problem); and (3) a belief system (self-perception, environment, topics, and/or calculations that may affect one's needs). Kroll (1988) extends Schoenfield's problem-solving scheme to provide an overview of the monitoring and procedures used during the group problem-solving process. In particular Kroll (1988) categorizes the monitoring activities into two types: (1) the type of statement submitted by a person or member of a cooperative group solving the problem given, (2) the steps in problem solving namely: orientation, organization, implementation and verification. Kroll (1988) specifies four basic types of statement: self-reflection, group, procedure, and overall assessment.

The problem-solving scheme is the basis for Garofalo & Lester (1985) development of the cognitive-metacognitive learning (CML) model which accommodates Sternberg's (1985) metacomponents namely planning, monitoring, and evaluating the problem-solving process through processes: (1) identifying the problems; (2) describing or knowing the nature or circumstances of the problem; (3) preparing the mental and physical requirements to solve the problem; (4) determining how information is collected; (5) preparing the troubleshooting steps; (6) combining these steps with the right strategy to solve the problem; (7) monitoring progress of problem solving during the process; (8) evaluating solutions when troubleshooting is resolved.

Pugalee (2004) notes that Garofalo and Lester's CML model consists of four categories or phases of problem solving: (1) the orientation stage which includes reading/rereading, introduction and presentation of parts, analysis of conditions and information, and assessment to the difficulty level of questions; (2) the organizational stage which includes: identification of intermediate and major/end targets, creating and implementing global plans, and organization of data; (3) the execution stage, which includes: establishing local objectives, making calculations, monitoring objectives, and transferring plans; (4) the verification stage, which includes evaluation of decisions and decision results. However, the CML model lacks of reflection as the core of metacognition itself. Reflection or evaluation activities are only done at the end of the learning that is at the verification stage and also decision-making is not measured or emphasized in the learning process. Student decision-making skills in learning are only demonstrated through the performance/implementation of a previously designed problem-solving strategy. This statement is reinforced by the results of Pugalee's (2004) study, which found difficulties with the implementation in that students generally did not verify activities in the previous stage. This issue can be resolved by doing reflection activities as part of each phase of learning.

Later, Yimer and Ellerton (2009) developed a problem-solving model with the phases of engagement, transformation-formulation, implementation, evaluation, and internalization by inserting reflection activities into the five phases of the problem-solving model they formulated. The details of these five phases of problem solving are as follows: 1) Engagement, which includes: Initial understanding (noting the main idea, drawing); Information analysis (introduction of information, identifying key ideas of relevant information to solve problems, relating them to specific mathematical domains); Reflection on the problem (assessing familiarity or recalling similar problems previously solved, assessing the degree of difficulty, assessing the knowledge one needs in relation to the problem); 2) Transformation-Formulation, which includes: Exploration (using a particular case or number to visualize a problem situation); Conjecturing or hypothesizing (based on specific observations and previous experiences); Reflection on alleged or explored feasibility; Formulating a plan (designing a good strategy to test allegations or designing a global or local plan); Reflections on the feasibility of the plan based on key features of the problem; 3) Implementation, which includes: Exploration of key features of the plan; Assessing the plan with the conditions and requirements set out by problem; Implementing the plan (doing activities both using computer and by way of analysis); Reflection on the suitability of activities/actions; 4) Evaluation, which includes: Rereading the problem to evaluate whether or not the result has answered the question on the problem; Assessing plans related to consistency with key features and possible errors in calculation or analysis; Assessing the reasonableness of results; Making a decision to accept or reject the solution; 5) Internalization, which includes: Reflection on the whole process of problem solving; Identifying important features in the process; Evaluating the problem-solving process for adaptation in other situations, different ways and features of the solution; Reflections on the mathematical precision involved, one's confidence in the process, and the level of satisfaction. The reflection path in the Troubleshooting Model (Yimer & Ellerton, 2009) is presented in Figure 1 below.

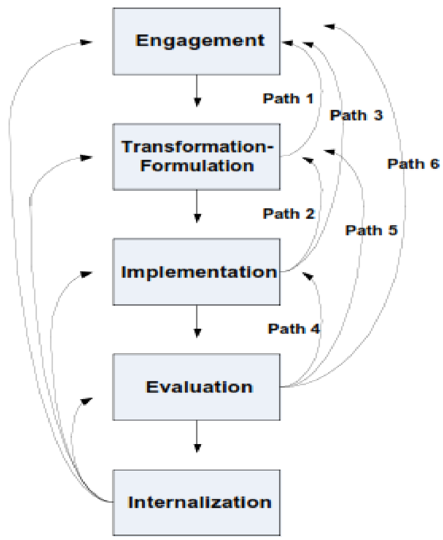

Figure 1. Cognitive Process Flow (Reflection) Problem Solving Model (Yimer & Ellerton, 2009)

The processes in this model replicate the weaknesses of the Polya problem solving model which Fernandez, Hadaway & Wilson (1994) regarded as a back-and-forth process, making it difficult for students to follow the lesson. Fernandez, Hadaway & Wilson (1994) critiqued Polya's problem-solving model by providing examples of models that emphasize the process of cognitive awareness, or what other educators such as Schoenfeld and Flavell call metacognition emphasizing certain behaviours such as predicting, planning, reviewing, selecting, and checking to help individuals to succeed in problem-solving situations by using their ability to identify and work with good strategies (Pugalee, 2004). Metacognition basically emphasizes the ability to analyse the characteristics of problems encountered such as considering content, context, and variable structure on issues to formulate and infer the difficulty of tasks and resources that can be used in problem solving.

Learning activities to make meaningful information are closely related to reflection by reminding students of the initial knowledge and simulating the interrelation of teaching materials with surrounding phenomena. Arends (2012) states that activities to teach students about interpreting the teaching materials used can be facilitated through orientation activities. Students and teachers are trained to assess themselves using self-checklists and fill in self-reflection journals, and peer-reviewed checklists to assess their instructional planning and teaching performance in reflection-oriented teaching (Ratminingsih, Artini, & Patmadewi, 2017). Teachers' role in reflection-based learning is emphasized to demonstrate both regular capability and authentic reflection in the classroom teaching (Sellars, 2012). The reflection approach in learning plays a role in verifying activities and attitudes with the aim of increasing these aspects for further learning (Conley et al., 2010). Reflection is built on the day-to-day experiences integrated into learning (Borich, 2000). Reflection in learning can also help teachers to assess the level of students' cognitive regulation. In line with that statement, Flavell and Brown (in Herscovitz, Keberman, Saar, & Dori, 2012) see metacognition as a consciousness and a person's reflexes in the process of self-cognition, which involves self-regulation and the coordination of conscious learning tasks. Further Veenman (2012) explains that reflection can be used to obtain the student's self-instruction production system. Anderson (1996); Anderson et al (1997) describes three stages of student skill acquisition. The first stage cognition comprises is a declarative knowledge of the conditions and activities associated with verbal descriptions of procedures performed in the stages of problem solving. In the second, associative stage, the verbal description that has been generated is then poured in a procedure that follows step by step. Procedures identified incorrectly in the first stage (cognition) are eliminated at this stage, so that the execution process can be optimized. The last stage is autonomy, this stage is the most difficult to achieve because the procedures must be prepared and applied independently (Nelson, 1996). Reflection is needed to achieve this stage, the results of metacognition activities should be reflected in their conformity with metacognition knowledge (Vennman, 2012).

Based on the above description, a metacognition learning model was depeloved, adapted from Garofalo & Lester (1989) and Yimer & Elerton (2009). The CML model basically includes all the problem-solving phases proposed by Yimer & Ellerton (2009), but does not divide the activities in each phase into reflection activities at each of the learning stages, which are at the core of metacognition itself, which is a reflection of cognitive processes or evaluation of students' thinking processes. Reflection or evaluation activities are only done at the end of the learning: that is, at the verification stage. Schoenfeld (in Toit & Kotze, 2009), on the other hand, defines metacognition as the ability and control of cognitive function, meaning one's awareness of cognition and how to regulate cognitive processes during problem solving. The idea for the development of RML Model is presented in Figure 2 below.

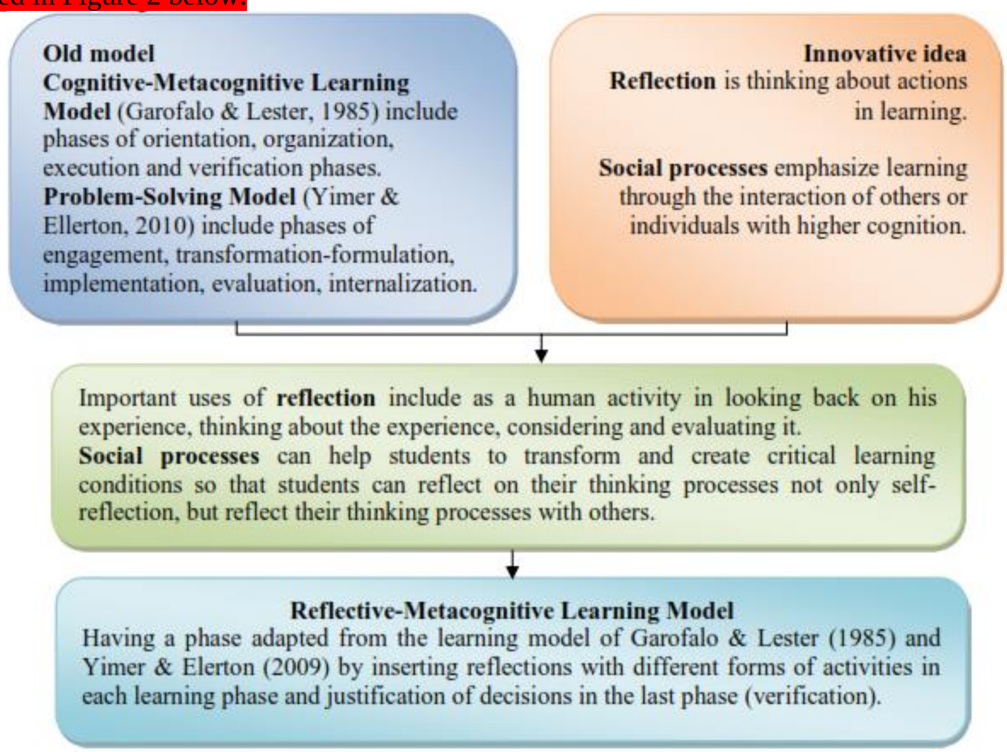

Figure 2. The idea for developing a reflective-metacognitive learning model

The Reflective-Metacognitive Learning (RML) Model is a learning model with reflective attributions in each learning stage to enable a conscious thinking process to increase students' metacognition ability through four phases: (1) Orientation Reflection; (2) Organizational Reflection; (3) Execution reflection; and (4) Verification Reflection. Formulation of RML Models based on empirical and theoretical support that accommodate the CML model (Garofalo and Lester, 1985) and the problem-solving model (Yimer & Ellerton, 2009). The differences between the problem solving model by Yimer and Ellerton (2009), the CML model by Garofalo and Lester (1989) and the RML model are presented in Table 1 below.

Table 1. Differences between the Problem Solving Model Yimer & Ellerton (2009), the CML Model Garofalo & Lester (1985) and the RML Model

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
Phase 1 Orientation: encompasses strategies for understanding, analysing information and conditions, evaluating familiarity with an initial task and presentation, assessing the difficulties of problems and hopes for success. This phase familiarizes students with problem situations.	A. reading/ rereading, B. introduction and presentation of parts, C. analysis of conditions and information, and D. assessment of the difficulty level of the problem.	**Phase 1 Engagement:** Initial confrontation and problem recognition.	A. Initial understanding (noting main ideas, making pictures), B. Information analysis (information recognition, identifying key information ideas that are relevant to solving problems, relating them to a particular mathematical domain), C. Reflection on the problem (assessing familiarity or remembering whether the same problem has been solved previously, assessing the level of difficulty, assessing the knowledge that needs to be related to the problem).	**Phase 1 Orientation reflection:** Strategies needed to assess and understand problems	A. Provide learning objectives B. Information and condition analysis C. Assessing the intimacy with the task D. Assessing the difficulty level of the problem and the opportunity to successfully solve the problem E. Reflection of orientation activities by providing conflict cognitive phenomena.
Phase 2 Organization Identifying key objectives, global planning and local planning needed to complete the	A. Identification of intermediate and ultimate/final goals, B. Creating and implementing global plans, and C. Organization	**Phase 2 Transformation-Formulation:** Transform the initial involvement for exploration and formal plans.	A. Exploration (using certain cases or numbers to visualise problem situations), B. Conjecturing or hypothesizing (based on specific observations and prior experience),	**Phase 2 Organizational Reflection:** Identify the main goals and objectives, general and specific planning	A. Identify sub goals and ultimate goals B. Make a general plan C. Data organization D. Reflection through the presentation

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
global plan.	of data.		C. Reflection on alleged or exploration feasibility, D. Formulation of plans (design strategies to test guesses or design global or local plans), E. Reflection on the feasibility of the plan based on the key features of the problem.	needed to complete the general plan.	of an anomalous phenomenon that allows students to organize activities in this phase.
Phase 3 Execution: Includes the achievement of local actions, monitoring the progress of global and local plans, and assessing the decisions of performance (accuracy and fluency in carrying out planning in phase two).	A. Hold local destinations B. Make calculations, C. Monitoring objectives, D. Transfer of plans.	**Phase 3 Implementation:** Monitoring activities on the plan and exploration.	A. Exploration of key features of the plan, B. Assessing plans with conditions and requirements set based on problems, C. Implement the plan (doing activities using a computer or analyzed), D. Reflection on the suitability of activities / actions.	**Phase 3 Execution Reflection:** Implement special planning, monitor the progress of general and particular plans, and assess decisions.	A. Implementing a particular plan B. Monitoring progress of implementation of particular and general plans C. Make/formulate decisions D. Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Phase 4 Verification: Includes evaluation of decisions and results of plans executed	A. Evaluating the orientation and organizational phases, B. Evaluate execution.	**Phase 4 Evaluation:** Assess the suitability of plans, actions, and solutions.	A. Reread the problem, assess whether or not the results match the question, B. Assess the consistency of the plan with the main features and possible errors in the calculation or analysis,	**Phase 4 Verification Reflection:** Evaluation of decisions and results of plans executed and decision making.	A. Final decision making, B. Reflection of activities through the presentation of new phenomena that are still related to be solved.

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
			C. Assess the fairness of results, D. Make a decision to accept or reject a solution, E. Reflection on the entire problem solving process.		
		Phase 5 Internalization: reflection of the level of depth and other qualities of the problem solving process.	A. Identify important features in the process, B. Evaluate the problem solving process for adaptation to other situations, C. Reflection on accuracy, confidence in the process, and level of satisfaction.		

. The RML model is characterized by different and non-recurrent reflection activities in each phase of the CML model, such as: (1) presentation of conflict phenomena in the first phase, (2) presentation of anomalous phenomena in the second phase, (3) internalization activities in the third phase, and (4) presentation of new phenomena that are still related to the fourth phase. Reflection through different forms of presentation in each phase of learning is expected to train students to be reflective and independent learners, who can develop knowledge through consciously trained skills. Cowan (1998) provides an example of how reflection works in the thinking process, students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, such as the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and what needs to be done to solve the problem (Ong, 2010). Reflection has a close relationship with students' metacognition abilities, Veenman et al., (2006) states that reflection and metacognition have similarities in emphasising understanding, improving processes, learning outcomes, and focusing on effective student attention.

This study aims to analyse the validity and effectiveness of Reflective-Metacognitive Learning (RML) models. The objectives of the study are as follows: (1) analyze the validity of RML models and supporting devices; (2) analyse the effectiveness of the model developed by comparing the RML Model and Garofalo & Lester's (1985) Cognitive-Metacognitive Learning Model in the implementation phase of learning for six meetings to improve metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness) among senior high school students in Indonesia. The results of this study are useful in increasing educators' knowledge related to a more interactive and effective learning model to improve students' metacognition ability by reflecting on the thinking process as the core of each phase of the RML Model. In line with this statement, Webb & Moallem (2016) state that metacognitive (reflective) questions that are used as feedbacks in learning can improve students' learning achievement. In addition, teaching metacognition ability can bring out the students' original potential so that they can become individuals who are rich in original ideas in accordance with their potential. Further, Abdullah (2016) explained that the core purpose of education is to enable students to learn independently. Metacognition as a conscious process of knowledge processing is needed to achieve that goal.

METHODOLOGY

This research is an experimental study with the randomized pretest-posttest control group design in 40 high school students, who were divided into an experimental group (20 students) and a control group (20 students) to analyse the effectiveness of RML Model and CML Model in increase students' metacognition ability. The descriptive analysis and inferential statistics conducted in this research are: independent sample t tests and Mann-Whitney U test. This research began with the development of the RML Model adapting Borg and Gall's development design, which comprise: 1) planning, 2) development, and 3) evaluation. The RML Model developed meets three quality product criteria, namely: validity, practicality, and effectiveness (Nieveen, 1999). A Focus Group Discussion (FGD) was conducted with four science education experts to determine the validity of the RML Model and its supporting devices in terms of: 1) need; 2) state of the art; 3) empirical support and theoretical support for the RML model development; 4) rationality of the phases of construction of the RML model; 5) suitability of the RML model's objectives and impacts according to the need for 21st century competence; 6) Learning Environment and Social Systems in RML model; 7) Principle of Reaction in RML model in terms of the purpose of developing the model and equity with its principles of metacognition and reflection; and 8) Support System in RML Model. Eight aspects of expert assessment in the FGD accommodated the content validity and construct validity criteria of the RML Model and its devices.

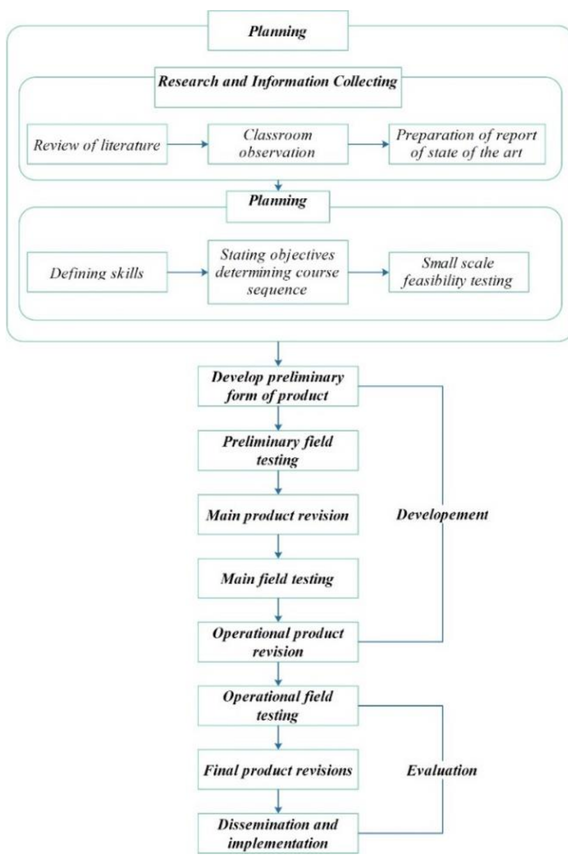

Figure 3. Borg and Gall's (1983) development research flows.

1. ***Validity of Reflective-Metacognitive Learning Model***

The first stage of product development testing was a validation, which included two components namely content validity and construct validity (Nieveen, 1999). The RML Model validation instruments along with supporting devices were validated by experts before being used to assess the quality of the RML Model and the devices according to the following validity formula, r_α = [(Average Square people - Average Square residual) / (Average Square people + (k-1) Average Square residual)] and Cronbach's alpha $\alpha = k\ r_\alpha / [1+ (k-1)r_\alpha]$ (Malhotra, 2011). The criteria of RML model validity and reliability instruments are shown in Table 2.

Table 2. Validity and reliability of RML model criteria

Check	Scale statistics	Category	
Validity	Single measures interrater correlation coefficient-ICC (rα)	$r_\alpha \leq$ r table	Invalid
		$r_\alpha >$ r table	Valid
Reliability	Cronbach's alpha/average measures interrater correlation coefficient-ICC (α)	$\alpha < .6$	Unreliable
		$.6 \leq \alpha \leq 1.0$	Reliable

The learning model was validated by experts and practitioners who have competence in the field of education. Feedback from validators was used as material for the improvement of the model syntax until a valid model syntax was obtained. Assessment of the validity of the RML Model and the learning devices used was conducted using of four-point scales: i.e., much less valid = 1, less valid = 2, valid = 3, and very valid = 4. Obtained scores from expert assessment of the product development were converted to qualitative data on a four-scale (Ratumanan & Lauren, 2011), with criteria as in Table 3 below.

Table 3. Validity Criteria of Model and Learning Devices Based on Average Validator Values

Score Range	Criteria
> 3.6	very valid
2.8 – 3.6	valid
1.9– 2.7	less valid
1.0– 1.8	much less valid

The average value of validity and reliability of models and devices supporting the learning model is determined based on the value given by the validator. The reliability of the learning device is calculated using the percentage agreement equation by Emmer and Millett (in Borich, 1994): the instrument is said to be reliable if it has a percentage agreement of ≥ 75%, or a 75% average score from the validator team with valid category.

2. ***Effectiveness of Reflective-Metacognitive Learning Model in comparison with Cognitive-Metacognitive Learning Model***

This stage was intended to determine the effectiveness of the RML model developed toward students' metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness) in comparison with the CML model after the learning process. The randomized pretest-posttest control group design was used at the implementation stage of the RML Model and CML Model. Two groups were required in this method, namely the experimental and control groups. In the experimental group, the researcher gave a pretest, treatment by applying the RML Model, and then a posttest. Meanwhile in the control group, the researcher gave a pretest, followed by the treatment by applying the CML Model (Garofalo & Lester, 1989), and then a posttest. The following is the research design used.

The Randomized Pretest Posttest Control Group Design

Group	Pretest	Intervention	Posttest
A	*O1*	*X*	*O2*
B	*O3*	*C*	*O4*

Where,

A	: experimental Group	
B	: control Group	
O1	: pretest of experimental group	
O2	: posttest of experimental group	
O3	: pretest of control group	
O4	: posttest of control group	
X	: treatment in experiment group using RML Model	
C	: treatment in control group using CML Model	

(Fraenkel et al, 2011)

Student metacognition ability data is collected using the following instruments:

1) Metacognition Knowledge Test. The students' metacognition knowledge data was collected using ten-item essay test on acid and base materials provided before and after treatment. The metacognition knowledge test contains three indicators of declarative knowledge, procedural knowledge, and conditional knowledge.
2) Performance test. Student performance was measured using the students' worksheets given at the first and the last lesson. The metacognition skills indicators contained in the students' worksheet and measured in this study are: 1) Formulate Learning Objectives both general and specific (FLO); 2) Formulate Problem and problem solving Hypotheses that are relevant to the formulated learning objectives (FPH); 3) Make a Problem-Solving Plan to prove the hypothesis that has been proposed (PSP); 4) Implement Planning Systematically (IPS); 5) Monitor the Process (MP); 6) Evaluate the Process (EP); 7) Collect Data (CD); 8) Evaluate Learning Achievement related to the objectives at the beginning of learning activities (ELA).
3) Metacognition Awareness Inventory (MAI). Students' metacognition awareness was measured using the MAI developed by Schraw and Dennison (1994), which was administered before and after treatment. The indicators contained in the MAI are: planning, information management, monitoring, debugging, evaluation, declarative knowledge, procedural knowledge, and conditional knowledge.

The scores obtained were analysed and categorized into four criteria as in Table 4 below.

Table 4. Student Metacognition Ability Criteria

Criteria	**Score Range**
Very Good	$80 \leq P \leq 100$
Good	$70 \leq P \leq 79$
Good Enough	$60 \leq P \leq 69$
Less Good	$P < 60$

The RML model's effectiveness to improve senior high school students' metacognition ability was decided using the normalized gain score, namely: n-gain = (post-test score – pre-test score)/ (maximum score – pre-test score) (Hake, 1999). According to the following criteria: (1) when n-gain > .70 (high); (2) when .30 < n-gain < .70 (moderate); and (3) when n-gain < .30 (high). IBM SPSS Statistics 23 software was used to test the impact of teaching using the RML model toward the improvement of metacognition ability in comparison with the CML Model. Furthermore, in order to analyse the differences in the RML model's teaching impact toward metacognition ability in comparison with the CML Model of the two groups, an independent sample t test was used. The testing method shall depend on the compatible results of the normality assumption and variant homogeneity tests of n-gain, whereas if the data is not normally distributed, it is analysed using non-parametric tests (Mann-Whitney test).

RESULTS

1. Validity of Reflective-Metacognitive Learning Model

RML Model validation instruments along with supporting devices were validated by three experts with minimum doctoral criteria and expertise in chemistry (one expert) and learning (two experts). The validation results of the RML Model validity instrument and the device are presented in Table 5 below.

Table 5. Results of validation of RML Model validity instruments and devices

Item	r_{α}	**Category**	**Cronbach's alpha (α)**	**Category**
1. RML Model	.761	Valid	0.864	Reliable
2. Syllabus	.724	Valid	0.840	Reliable
3. Lesson Plan	.680	Valid	0.809	Reliable
4. Module	.781	Valid	0.877	Reliable
5. Worksheet	.715	Valid	0.834	Reliable
6. Instruments	.871	Valid	0.931	Reliable

Based on the results of the validity and reliability tests in Table 5 it can be stated that the validation instruments are valid and reliable to assess the quality of the RML Model and its devices. The RML Model is a learning model with reflective attribution in each learning stage to enable a conscious thinking process to increase students' metacognition ability through four phases: 1) Orientation Reflection; 2) Organizational Reflection; 3) Execution Reflection; and 4) Verification Reflection. Its formulation was based on empirical and theoretical support that accommodates cognitive-metacognitive models (Garofalo & Lester, 1985) and problem-solving models (Yimer & Elerton, 2009). Reflections at the end of each learning phase are achieved through various forms of activities, such as providing conflict cognitive phenomena, anomalous phenomena, internalization (through providing problems or concepts), and providing new phenomena that are still related to decision making. Reflection plays an important role in teaching metacognition in students, and can also play a role in monitoring the knowledge processes that students have. The results of metacognition activities can be general, such as classifying information relevant to the problem at hand, or specific, such as finding specific solutions that fit the correct theory or concept to help students solve the problems at hand (Veenman, 2012). The activities and applications of each learning phase are presented in Table 6 below.

Table 6. The Reflective-Metacognitive Learning (RML) Model Phases

Learning Phases	**Learning Activities**	**Applications in Learning Activities**
Orientation Reflection	1. Provide learning objectives	• Deliver learning objectives generally.
	2. Information and condition analysis	• Ask students to read information from relevant learning resources.
	3. Assess familiarity with the task	• Ask students about the material they are studying.
	4. Assess the difficulty level of the problem and the opportunity to successfully solve the problem	• Present students with a common problem in learning activities.
	5. Reflection on orientation activities by providing conflict cognitive phenomena.	• Provide conflict cognitive phenomena to activate students' prior knowledge.
Organizational Reflection	1. Identify sub goals and ultimate goals	• Ask students to identify which sub-goals are the prerequisites that must

(continued)

Learning Phases	Learning Activities	Applications in Learning Activities
		be known first in order to achieve the ultimate/final goal.
	2. Make a general plan	• Establish general troubleshooting steps that have been identified in phase 1 orientation reflection, which is further downgraded to planning for sub-goals.
	3. Data organization	• Divide the students into groups. • Direct students in formulating hypotheses, defining operational variables in learning, determine the problem-solving steps to be used.
	4. Reflection	• Reflection on activities in the organizational reflection phase by presenting anomalous phenomena that enable students to organize activities in this phase.
Execution Reflection	1. Implementing a particular plan	• Ask students to carry out problem-solving planning in accordance with the plan that has been formulated. • Ask students to carefully plan and pay attention to the suitability and relevance of each troubleshooting step. Careful planning demonstrates good knowledge evaluation skills.
	2. Monitoring progress of particular and general plans implementation	• Assess performance of problem-solving implementation based on students' fluency and accuracy of problem-solving.
	3. Make/formulate decisions	• Ask students to formulate decisions by assessing the hypothesis, based on the results of data analysis and information obtained
	4. Reflection	• Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Verification Reflection	1. Final decision making	• Ask students to provide an explanation of the results of the implementation of their problem-solving plan. • Ask students to explain the relevance of the results of their problem-solving to the global goals they previously formulated.
	2. Reflection	• Provide new phenomena that are still related to solving the problem.

The difference in the cognitive process (reflection) flow in the RML Model compared to Yimer & Ellerton's (2009) problem-solving model is evident from Figure 4 below.

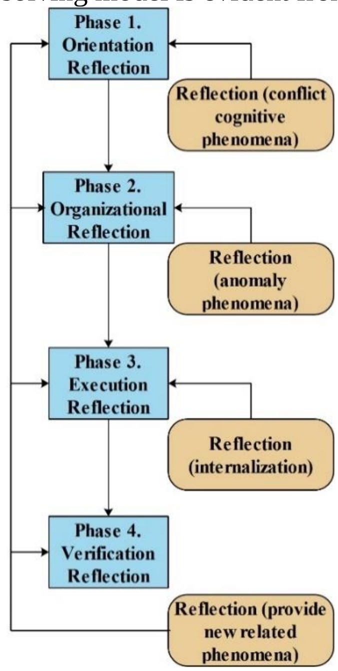

Figure 4. Cognitive Process Flow (Reflection) of the Reflective-Metacognitive Learning Model

Validation of the RML model and supporting tools includes two components: content validity and construct validity. Content validity includes all components of the learning model and the tools should be based on state-of-the-art knowledge. Components assessed for content validity are the development and design needs of RML models and devices based on current knowledge, which are generally categorized as highly valid. The results of this assessment are based on RML Model development objectives to improve students' metacognition skills as needed according to the competencies of 21st century major skill graduates and the applicable school curriculum requirements.

The expert validators involved in this activity were competent experts in chemistry learning, who understand the 2013 curriculum (Curriculum of Education in Indonesia) and are active in classroom learning activities as well as teacher training activities. Validators validated the model and its supporting devices by providing an objective assessment, giving a check mark (√) to the number corresponding to the given statement with the following criteria: Invalid (score 1); Less Valid (score 2); Valid (score 3); Very Valid (score 4). The RML Model validation results, along with the devices, as presented in Table 6, were found to be valid in both content and construct with strong reliability.

Table 6. Expert Validation of RML Model.

Item	Content Validity		Construct Validity		Reliability
	Score	Category	Score	Category	
1. RML Model	3.89	Very Valid	3.84	Very Valid	.94
2. Syllabus	3.75	Very Valid	3.85	Very Valid	.96
3. Lesson Plan	3.87	Very Valid	3.96	Very Valid	.97
4. Module	3.81	Very Valid	3.88	Very Valid	.96
5. Worksheet	3.83	Very Valid	3.84	Very Valid	.96
6. Instruments	3.90	Very Valid	3.975	Very Valid	.98

The RML Model validation result is proven empirically from learning implementation as over the course of six meetings that have been executed (3.9) very well. This criterion was observed from the percentage of the average mode of values in the "very good" category and increased in each learning meeting. The result is in line with students' responses to learning using the RML Model which overall give a very strong response at 86.43%.

2. ***Effectiveness of Reflective-Metacognitive Learning Model in comparison with Cognitive-Metacognitive Learning Model***

a. Metacognition Knowledge

The achievement of metacognition knowledge and n-gain is based on three indicators: declarative knowledge (DK), procedural knowledge (PK), and conditional knowledge (CK) as presented in Table 7. Data on students' metacognition knowledge were analysed using the Kolmogorov-Smirnov test to determine the normality and Levene test to determine the homogeneity of data variance obtained. These test results reveal that the students' metacognition knowledge is normally distributed (Asymp Sig. 2-tailed: 0.2> 0.05), and homogeneous (Sig: 0.421> 0.05), so an independent sample test (t-test) was used to analysis the improvement of students' metacognition knowledge before and after learning.

Table 7. Results of pre-test and post-test of students' metacognition knowledge

Group	**N**	**Scores**	**Metacognition Knowledge Indicators**			**Mean**	**SD**	**p**
			DK	**PK**	**CK**			
		Pre-test	32.12	45.75	32.44	34.2920		
Experiment	20	Post-test	89.66	82.8	86.89	84.4170	4.05841	.000
		n-gain	0.85	0.67	0.80			
		Pre-test	30.25	39.50	31.50	33.7505		
Control	20	Post-test	82.38	68.13	70.00	73.5000	5.48907	.000
		n-gain	0.75	0.47	0.56			

Based on the results of this analysis as presented in Table 7, it can be seen that students' metacognition knowledge has increased after learning. The improvement of students' metacognition knowledge is significant for both groups, but the improvement in the experimental group (tought using RML Model) is better (mean = 84.4170) than that in the control group (tought using CML Model) (mean = 73.5000). In order for a student to have good metacognition knowledge, he or she must be proficient in certain cognitive skills, namely: declarative knowledge, procedural knowledge, and conditional knowledge which are the three kinds of knowledge involved in metacognition. Declarative knowledge is knowledge about oneself as a learner and about factors affecting learning and memory, as well as the skills, strategies, and resources needed to do a task (know what to do); procedural knowledge involved knowing how to use a certain strategy; and conditional knowledge involves knowing when and why to apply certain procedures and strategies (Bruning, Scrhraw, Norby, & Ronning, 2004 in Woolfolk, 2009). Metacognition knowledge is thus the strategic application of declarative, procedural, and conditional knowledge to achieve goals and overcome problems (Schunk in Woolfolk, 2009).

The RML Model is more effective in improving students' metacognition knowledge compared to the CML Model, as demonstrated by the results of the N-Gain analysis (Table 7). We know that the n-gain of students' metacognition knowledge on experimental group for each metacognition knowledge indicator is better (DK: 0.85; PK: 0.67; and CK: 0.8) than the n-gain of students' metacognition knowledge in the control group (DK: 0.75; PK: 0.47; and CK: 0.56). The results of the analysis show that the scores obtained by students before and after learning using the RML Model were significantly different.

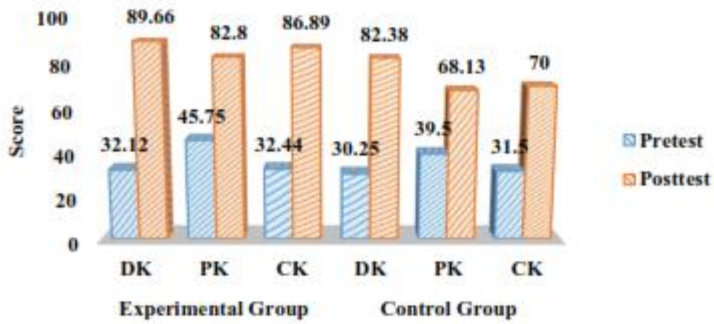

Figure 5. Students' metacognition knowledge (pre-test and post-test)

Figure 5 shows that the most significant impact is seen in the DK (0.85) and CK (0.8) indicators in the experimental group, with a high category, while in the control group, the DK (0.75) indicator had the most significant improvement. The RML model is more effective in increasing students' metacognition knowledge on all three indicators, which is likely to be because of reflection on each phase of learning. The provision of conflict cognitive phenomena, anomalous phenomena, internalization (through providing problems or concepts), and new phenomena that are still related to decision-making as a form of learning reflection enables students to review the purpose and analysis of the material in the readings presented and to understand more deeply the material used as initial knowledge to learn the next set of material. In the line with that opinion, Cowan (1998) states that students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, such as in the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and working out what needs to be done to solve them (Ong, 2010). Providing conflict cognitive phenomena creates a state of imbalance in students' thinking, which teachers can use to encourage students' interest in solving problems (Mischel, 2007). The conflict cognitive phenomenon can promote the monitoring of knowledge in the thinking process and reflecting students' initial knowledge (Thomas, 2012). Students' procedural knowledge as an indicator of metacognition knowledge showed a less significant increase although it was still in the "good" category for both classes. The results of the Independent sample t test also show that students' metacognition knowledge is significantly different (p: .000) between the experimental group and the control group, as presented in Table 8 below.

Tabel 8. Independent sample t test of students' metacognition knowledge

Group	N	sig	t	df	p
Posttest of experimental and control groups	40	.772	6.064	38	.000

The RML model and the learning devices developed, which accommodate the three components of metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness), have been thus shown to be more effective at improving students' metacognition knowledge than the CML model ($p < .005$). McCormick stated that students can be taught a strategy of assessing their own understanding by finding out how much time it takes to learn something and choosing an effective action plan for learning or working on a problem (Slavin, 2011). Oxford (1990) classifies some metacognitive strategies as follows: 1) Centralize student learning; 2) Arrange and plan lessons; 3) Evaluate learning. Another metacognitive strategy is the ability to predict what might happen or mention something rational and irrational.

Teaching metacognitive strategies to students can produce a clear improvement in student achievement (Alexander, Graham & Harris; Hattie et al, in Slavin 2011). Students can learn to think through their own thinking processes and apply certain learning strategies to think themselves through difficult tasks (Butler & Winne; Pressley, Harris & Marks; Schunk in Slavin, 2011). The self-questioning strategy is very effective (Zimmerman in Slavin, 2011). A self-questioning strategy is a learning strategy that asks students to ask themselves about who, what, where, and how students read the material (Slavin, 2011). Students can be taught these strategies by conditioning learning according to the criteria described previously.

Inquiry activities that integrate the process skills are also carried out in the activities of the RML Model and are very effective to raise awareness of the strategies used and positively affect student performance (Pressley, Borkowski, & Schneider, 1987; McCormick, 2003). Crowly, Shrager, & Siegler (1997) described the associative stages and metacognitive mechanisms in strategies that emphasize the discovery process, which has an important role in students' procedural knowledge. Siegler and Jenkins (in Waters and Kunnmann, 2010) further explained that discovery processes in learning can increase students' awareness of their knowledge and accelerate the generalization process of student information.

The RML Model which emphasizes evaluative reflection activity using phenomena that are directly related to students' social aspects can be declared effective to increase students's metacognition knowledge. Moon (2004) argues that reflection is a key component of learning, while Fook (in Hickson, 2011) further argues that evaluative reflection emphasizes thinking about what has been done and elaborating based on the evaluation results to anticipate possible future problems. Further, Hoyrup (2004) suggests that evaluative reflection must be integrated with social aspects and can be measured at a time when one is able to understand and validate the assumptions formulated. The reflection process in the RML Model serves to prevent students from repeating possible mistakes from the previous learning process. In line with that statement, Carrol et al., (2010) states that reflecting on processes that have been done in everyday activities is essential to avoid the lack of ideas and repetition mistakes in routine activities.

b. Metacognition Skills

Students' metacognition skills showed good improvement. The indicators of students' metacognition skills that measured in this study comprised the following: 1) Formulating Learning Objectives both general and specific (FLO); 2) Formulating Problem and problem solving Hypotheses relevant to the formulated learning objectives (FPH); 3) Making a Problem-Solving Plan to prove the hypothesis that has been proposed (PSP); 4) Implementing Planning Systematically (IPS); 5) Monitoring the Processes (MP); 6) Evaluating the Process (EP); 7) Collecting Data (CD); 8) Evaluating Learning Achievement in relation to the objectives at the beginning of the learning activity (ELA). Data on students' metacognition skills were analysed using the Kolmogorov-Smirnov test to determine normality and Levene test to find out the homogeneity of variance obtained. These tests revealed that the students' metacognition skill data were normally distributed ($p > 0.05$) but not homogenous ($p < 0.05$) for both the experimental group and the control group so a paired t test was used to examine the significance of students' metacognition skills improvement before and after learning using the RML Model (experimental group) and CML Model (control group). The results of the paired t test of students' metacognition skills in the experimental and control groups are presented in Table 9 below.

Table 9. Pre-test and post-test result of students' metacognition skills

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	**SD**	**p**	**Mean**	**SD**	**p**
FLO	20	Pretest	43.75	19.86799	.000	53.75	11.47079	.000
		Posttest	93.75			78.75		
		n-gain	0.9			0.5		
FPH	20	Pretest	32.50	11.47079	.000	47.50	9.15869	.000
		Posttest	82.50			76.25		
		n-gain	0.7			0.5		
PSP	20	Pretest	46.25	15.12013	.000	53.75	9.15869	.000

(continued)

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
		Posttest	85.00			77.50		
		n-gain	0.7			0.5		
IPS	20	Pretest	55.00	15.17442	.000	62.50	14.67857	.000
		Posttest	92.50			78.75		
		n-gain	0.8			0.4		
MP	20	Pretest	60.00	17.90876	.000	60.00	16.42367	.000
		Posttest	78.75			75.50		
		n-gain	0.5			0.4		
EP	20	Pretest	61.25	12.76044	.000	61.25	13.07871	.000
		Posttest	75.00			81.25		
		n-gain	0.4			0.5		
CD	20	Pretest	60.00	14.28101	.000	60.00	16.77051	.000
		Posttest	92.50			81.25		
		n-gain	0.8			0.5		
ELA	20	Pre-test	51.25	12.76044	.000	51.25	12.76044	.000
		Post-test	75.00			75.00		
		n-gain	0.5			0.5		

A Mann-Whitney U test was used to compare students' metacognition skills between the two groups, as shown in Table 10. The findings reveal that the metacognition skills of students taught using the RML Model were better (mean rank: 27.32) than those of students taught using the CML Model (mean rank: 13.68). This difference was significant at p: .000.

Table 10. Mann-Whitney U test of students' metacognition skills

Group	N	Mean Rank	p
Experiment	20	27.32	.000
Control	20	13.68	

The improvement of students' metacognition skills in the experimental class cannot be separated from the integration of constructivist views, which in this study can be realized by facilitating students to learn by providing worksheets as a guide for measuring/observing or experimenting and conducting discussions. Students are given the opportunity to interact with the material they learn through observation or practicum, discussions, and opportunities to think about the results of these observations, practicum, and discussion. These activities are expected to develop the science process skills to improve understanding of the material or the concept being learned. This result also shows that the material contained in the students' worksheets is in keeping with the environmental context often encountered by the students and with the material contained in both the syllabus and the lesson plan, so that it can provide genuine support for the achievement of basic competence and facilitate students' metacognition awareness. The differences in the improvement of students' metacognition skills, as obtained through the scores for pretest and posttest activities, are presented in Figure 6.

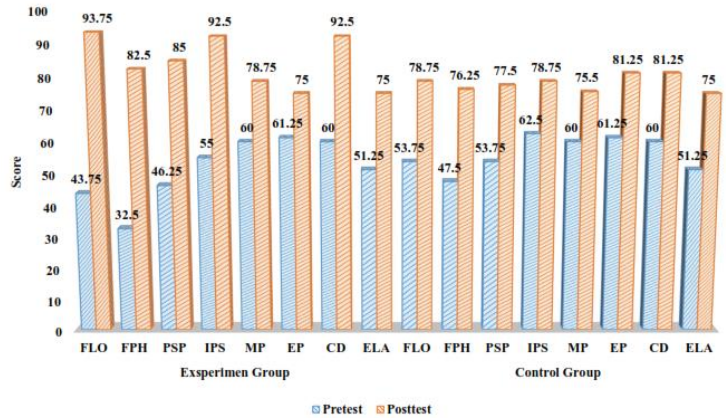

Figure 6. Students' metacognition skills (pretest and posttest)

Students' metacognition knowledge is directly proportional to students' metacognition skills and activities, which are related to students' procedural knowledge. Indicator 6 examining the planning process either individually or in groups (n-gain: 0.4) in the experimental group and indicator 4 systematic planning (n-gain: 0.4) in the control group experienced a significantly less improvement than other skills and activities, but this improvement was still well categorized as good. The integration of contextual phenomena as reflections in the RML Model is an important attribution that plays a role in improving students' metacognition skills. Lee (2006) stated that contextual approach is vital in learning, provided that the contextual problem has two virtues that is to improve students' learning motivation so that they have positive responses to the learning and to provide a good understanding of the material being taught. Brum & McKane (1989) stated that learning science including chemistry cannot be separated from the ability to make observations, formulate testable hypotheses, induce and deduce, and design and execute experiments to test hypotheses. These activities are contained in the students' worksheet so that students' metacognition skills can be improved. In line with that opinion, Nur (2011) stated that student learning activities should place more emphasis on scientific activities such as formulating questions, hypothesising, observation, analysis and conclusion so that the material studied become more meaningful. The RML Model which emphasizes reflection processes in each phase has an important role in improving students' metacognition skills by accommodating scientific activities. This statement is reinforced by Bennet et.al, (2016) who argued that reflection is an essential part of developing students' evaluative-reflective skills in the context of experiential-oriented learning.

c. Metacognition Awareness

Metacognition awareness is related to activities that help a person to control his or her mind and learning. The metacognition awareness in this study includes metacognition knowledge and cognitive regulation, contained in the 52-item metacognition awareness questionnaire developed by Schraw and Dennison (1994), which contains eight aspects: 1) declarative knowledge (DK); 2) procedural knowledge (PK); 3) conditional knowledge (CK); 4) planning (P); 5) information management system (IMS); 6) monitoring (M); 7) debugging (D); and 8) evaluating (E). Students' metacognition awareness indicators are were found to be normally distributed and homogeneous so an independent sample t test was used to investigate the difference in students' metacognition awareness between the control group and the experimental group before and after the learning, as presented in Table 11 below.

Table 11. The pretest and posttest result of students' metacognition awareness

Variable	N	Score	Experimental Group				Control Group			
			Mean	sig	t	p	Mean	sig	t	p
DK	20	Pretest	55.75	.192	-5.885	.000	51.75	.649	-8.535	.000
		Posttest	72.25				68.75			
		n-gain	0.4				0.4			
PK	20	Pretest	54.50	.192	-6.962	.000	51.00	.083	-6.798	.000
		Posttest	67.00				63.50			
		n-gain	0.3				0.3			
CK	20	Pretest	50.63	.631	-7.504	.000	50.78	.893	-9.221	.000
		Posttest	69.53				65.47			
		n-gain	0.4				0.3			
P	20	Pretest	54.10	.131	-5.702	.000	50.89	.145	-7.956	.000
		Posttest	68.21				64.46			
		n-gain	0.3				0.3			
IMS	20	Pretest	50.00	.193	-6.777	.000	50.55	.624	-6.668	.000
		Posttest	68.19				63.19			
		n-gain	0.4				0.3			
M	20	Pretest	49.64	.407	-7.614	.000	51.25	.258	-7.304	.000
		Posttest	68.21				64.46			
		n-gain	0.4				0.3			
D	20	Pretest	52.00	.588	-6.623	.000	50.75	.189	-6.484	.000
		Posttest	70.50				64.50			
		n-gain	0.4				0.3			
E	20	Pre-test	51.45	.480	-6.331	.000	50.20	.364	-8.806	.000
		Post-test	70.00				64.99			
		n-gain	0.4				0.3			

Table 12 also shows that the metacognition awareness of students being taught using the RML Model was better (mean rank = 26.05) than that of students who were taught using the CML Model (mean = 14.05) and that this difference was significant different (p = .027).

Table 11. Mann-Whitney U test of students' metacognition awareness

Group	N	Mean Rank	p
Experiment	20	26.95	.027
Control	20	14.05	

Findings related to metacognition knowledge and metacognition skills were confirmed regarding students' metacognition awareness. Figure 7 shows that students were still unaware of the procedural knowledge they had (PK; n-gain = 0.3), and that the results had an effect on the students' belief in their planning (P; n-gain = 0.3) so that the process of monitoring or examining the processes was performed well but not maximally (M; n-gain = 0.3). These results occurred in the experimental class (tought using RML Model) as well as the control class (tought using CML Model), but generally the students' metacognition awareness is still categorized as good.

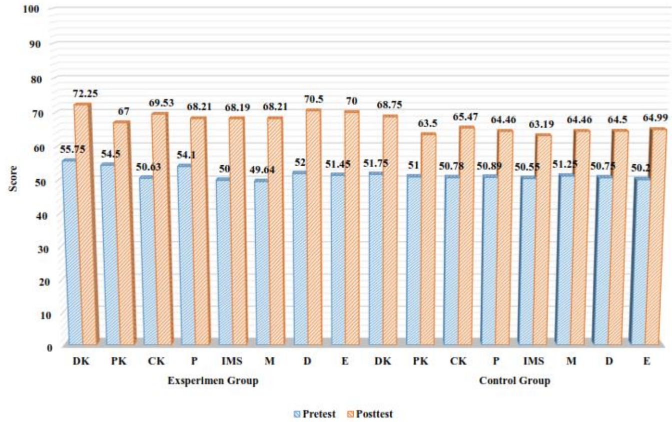

Figure 7. Students' metacognition awareness (pretest and posttest)

The learning activities from beginning to end emphasize training and cultivating students' metacognition knowledge and skills. Yusnaeni et al. (2018) stated that the implementation of metacognitive strategies related to awareness in monitoring cognitive strategies to achieve specific goals can improve students' thinking skills. This is illustrated in the model phases applied to the learning devices. The impact of learning using the RML Model is seen in students' attitude toward the science or information possessed. Such attitudes can be monitored, according to Flavell (1979), through actions and interactions between four components: (a) metacognitive knowledge, (b) metacognitive experiences, (c) objectives (or tasks), and (d) actions (or strategy). Metacognitive knowledge is used to regulate thought and learning (Brown, 1987; Nelson, 1996 in Woolfolk, 2009). Essential skills for metacognition include planning, monitoring, and evaluating (Woolfolk, 2009). Planning includes the students' ability to determine the time needed to perform a task, the strategy to use, how to begin, the resources needed, the sequence followed, what needs attention, and so on. Monitoring is real-time awareness about "how students work". These criteria are encompassed within the entire learning process so that metacognition awareness can be stated to be increased after learning using the RML Model.

The RML model, which emphasizes evaluative reflection activities using the provision of phenomena that are directly related to students' social aspects, can be declared to be effective to improve students' metacognition skills. Fauzi & Hussain (2016) stated that the more closely the learning is related to the social context, the more reflective students are in learning, and that the emphasis on the reflection processes in each phase has an important role in improving students' skills by accommodating scientific activities. This statement was reinforced by Bennet et al. (2016), who argued that reflection is an essential part of developing evaluative reflections in the context of learning oriented to scientific experimental activities. Reflection in learning is not only important in learning chemistry, but in learning science in general, as it can help teachers to identify the level of regulation of cognition possessed by students. In line with this statement, Flavell & Brown (in Herscovitz et al., 2012) defined metacognition as a person's awareness and reflection on the process of self-cognition, which involves self-regulation and coordination of conscious learning tasks. Veenman (2012) further explained that reflection can be used to obtain a student's self-instruction production system. Good science learning, should always pay attention to students' psychological aspects in the learning process, in term of both cognitive development and social psychology. The four phases of the RML model are: (1) orientation reflection, (2) organizational reflection, (3) execution reflection, and (4) verification reflection, which is developed based on the consideration of the above mentioned psychological aspects and is very feasible as an alternative solution in chemistry learning in particular and learning science in general, with reflection activities forming a central element of every phase of learning. This statement is in line with Dewey who argued that important attitudes in reflection, namely open thinking, enthusiasm, and responsibility, not only can bridge the three components of metacognition to be taught to students (Loughran, 2005), but have also become social aspects that are also expected to be developed in all science teaching at every level of education (Education Ministry of Indonesia, 2013).

CONCLUSION

Based on the results and discussion, it can be concluded that: (1) The RML Model is a learning model to facilitate students' metacognition ability, which has four phases, namely orientation reflection, organizational reflection, execution reflection, and verification reflection, with characteristic reflection activities at each phase of learning through providing conflict cognitive phenomena in the first phase, anomalous phenomena in the second phase, the internalization process in the third phase, and new phenomena that are still related to the learning material in the fourth phase; (2) It can be stated that the RML model is highly valid both in terms of both content (3.89) and construct (3.84) validity; (3) metacognition knowledge showed a high increase (mean n-gain = 0.76), while skill, and metacognition awareness showed a medium increase (mean n-gain = 0.66 and 0.4 respectively) for the experimental group (tought using RML Model), while for the control group (tought using CML Model), metacognition knowledge, skills, and awareness showed a medium increase category (mean n-gain = 0.6; 0.475; 0.3125 respectively) and statistical analysis showed that there was improvement in students' metacognition ability in both groups ($p < 0.05$). It can thus be concluded that (1) the RML model is valid and (2) the RML model more effective than the CML model to increase students' metacognition ability.

REFERENCES

Abdullah, M.N.LY. (2016). Interaction effects of gender and motivational beliefs on self-regulated learning: a study at ictintegrated schools. *Malaysian Journal of Learning and Instruction,* 13(1), 25-41.

Alexander, P. A., Schallert, D. I., & Hare, V. C. (1991). Coming to terms. How researchers in learning and literacy talk about knowledge. *Review of Educational Research, 61,* 315-343.

Anderson, J. R. (1996). The architecture of cognition. Mahwah: Erlbaum.

Anderson, J. R., Fincham, J. M., & Douglass, S. (1997). The role of examples and rules in the acquisition of a cognitive skill. Journal of Experimental Psychology: Learning, Memory, and Cognition, 23, 932–945.

Anderson, L.W & Krathwohl, D.R. (2010). *Kerangka Landasan untuk Pembelajaran, Pengajaran dan Asesmen (Revisi Taksonomi Pendidikan Bloom).* Yogyakarta: Pustaka Pelajar.

Asy'ari, M., Prayogi, S., Samsuri, T., & Muhali. (2016). Kajian Literatur tentang Berpikir Kritis, Berpikir Kreatif, dan Metakognisi dalam Pembelajaran. *Prosiding Seminar Nasional PKPSM*. 12 Maret 2016. Mataram, Indonesia. Hal 292-298.

Asy'ari, M. (2016). Identifikasi Kemampuan Metakognisi Mahasiswa Calon Guru Olahraga dan Korelasinya dengan Hasil Belajar Mata Kuliah Ilmu Alamiah Dasar. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, *4*(1), 42-46.

Bennett, D., Power, A., Thomson, C., Mason, B., & Bartleet, B. L. (2016). Reflection for learning, learning for reflection: Developing Indigenous competencies in higher education. *Journal of University Teaching & Learning Practice*, *13*(2).

Borg, W. R. dan Gall, M.D. (1983). *Educational research: An Introduction. Fourth Edition*. Longman Inc.

Borich, G. D. (1994). *Observation Skill for Effective Teaching*. New York: Mac Millan Publishing Company.

Borich, G. D. (2000). *Effective teaching methods*. New Jersey: Pearson Education.

Brum & McKane. (1989). *Study guide biology: Exploring life*. New York: John Wiley & Sons.

Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination, and the fires within: Design thinking in a middle school classroom. *International Journal of Art and Design Education*, 29(1), 37-52.

Conley, L., et al. (2010). *Becoming a teacher*. London, EN: Heinemann.
Crowley, K., Shrager, J., Siegler, R.S. (1997). Strategy discovery as a competitive negotiation between metacognitive and associative mechanisms. Developmental Review, 17, 462–489.
Fauzi, S.S.M., & Hussain, R.M.R. (2016). Designing instruction for active and reflective learners in the flipped classroom. *Malaysian Journal of Learning and Instruction,* 13(2), 147-173.
Fernandez, M. L., Hadaway, N. & Wilson, J. W. (1994). Problem solving: Managing it all. *The Mathematics Teacher*, 87(3), 195 - 199.
Flavell, J.H. (1979). Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmentan Inquiry. *American Psychologist, 34 (10)*, 906-911.
Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2011). *How to design and evaluate research in education.* Boston: McGraw-Hill Higher Education.
Garofalo, J., & Lester, F. K. (1985). Metacognition, cognitivemonitoring, and mathematical performance. *Journal for Research in Mathematics Education*, 16, 163–176.
Hake, R.R. (1999). Analyzing Change/Gain Score. [Online]. Tersedia: http://www.physics.indiana.edu/sdi/AnalizingChange-Gain.pdf. [10 Maret 2012].
Herscovitz, O., Kaberman, Z., Saar, L., & Dori, Y.J. (2012). The Relationship between Metacognition and the Ability to Pose Questions in Chemical Education. In A. Zohar & Y.J. Dori (Eds.), Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education. (pp 165-195). New York: Springer.
Hoyrup, S. (2004). Relective as a core process in organisational learning. *Journal of Workplace Learning*, 16(7/8), 442.
Ibrahim, M. (2010). *Dasar-dasar Proses Belajar Mengajar*. Surabaya: Unesa University Press.
Jacobs, J., & Paris, S. (1987). Children's metacognition about reading. Issues in definition, measurement, and instruction. Educational Psychologist, 22, 255-278. doi:10.1207/s15326985ep2203&4_4
Kaberman, Z.&Y. J. Dori, (2008). Metacognition in chemical education: question posing in the case-based computerized learning environment. *Springer Science+Business Media*. Technion-Israel Institute of Technology.
Kemendikbud. (2012). *Dokumen Kurikulum 2013*. Jakarta: Kementrian Pendidikan dan Kebudayaan.
Kluwe, R. H. (1987). Executive decisions and regulation of problem solving behavior. In F. E. Weinert & R. H. Kluwe (Eds.), Metacognition, motivation, and understanding (pp. 31-64). New Jersey: Lawrence Erlbaum Associates, Inc.
Kroll, D. L. (1988). Cooperative problem solving and metacognition: A case study of three pairs of women. (Doctoral dissertation, Indiana University, 1988).
Lai. E.R. (2011). Metacognition: A Literature Review *Research Report.*
Lee, M. (2006). *What does constructivism suggest for science education*. Northridge: California State University.
Louca, E.P. (2008). *Metacognition and Theory of Mind*. Cambridge Scholars Publishing.
Malhotra, N. K. (2011). *Review of marketing research: Spesial issue-marketing legends*. Emerald Group Publishing Limited.
Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C., & Suthor, C. (1988). Dimensions of thinking: &framework for curriculum and instruction. Alexandria, VA: Association for Supervision and Curriculum Development.
McCormick, C. B. (2003). Metacognition and learning. In W. M. Reynolds & G. E. Miller (Eds.), Handbook of psychology: Educational psychology (pp. 79–102). Hoboken: Wiley.
Meijer, J., Veenman, M.P.J, Wolters. (2006). Metacognitive Activities in Text-Studying and Problem-Solving: Development of a taxonomy. *Educational Research and Evaluation*. 12(3), 209 – 237.
Moon, J.A. (2004). *A Handbook of Reflective and Experimental Learning: Theory and Practice*. London: RoutledgeFalmer.

Muhali, (2013). Analisis Kemampuan Metakognisi Siswa pada Mata Pelajaran Kimia SMA. *Jurnal Kependidikan Kimia Hydrogen*, 1(1), 1-7.
NCES (National Center for Education Statistics). (2013). *Highlights From TIMSS 2011 Mathematics and Science Achievement of U.S. Fourth-and Eighth-Grade Students in an International Context*. Downloaded. https://nces.ed.gov/pubs2013/2013009_1.pdf.
Nelson, T. O. (1996). Consciousness and metacognition. American Psychologist, 51, 102–116.
Nieveen, N. (1999). Prototyping to Reach Product Quality. Kluwer Academic Publishers. University of Twente.
Nur, M. (2011). *Modul Keterampilan-keterampilan Proses dan Hakikat Sains*. Surabaya: PSMS Unesa.
OECD (Organisation for Economic Co-operation and Development). (2013). Country Note – Results from PISA 2012. downloaded: Mei 2018, https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf
OECD (Organisation for Economic Co-operation and Development). (2016). Country Note – Results from PISA 2015. (https://www.oecd.org/pisa/PISA-2015-Indonesia.pdf, downloaded: Mei 2018).
Ong, R. (2010). The role of reflection in student learning: a study of its effectiveness in complementing problem based learning environment.
Oxford, R.L. (1990). *Language Learning Strategies*. USA: Oxford.
Pantiwati, Y., & Husamah (2017). Self and Peer Assessments in Active Learning Model to Increase Metacognitive Awareness and Cognitive Abilities. *International Journal of Instruction*, 10(4), 185-202.
Pintrich, P.R., Wolters,C., & Baxter, G. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. Impara (Eds.), *Issues in the measurement of metacognition* (pp. 43-97). Lincoln, NE: Buros Institute of Mental Measurements.
Polya, G. (1957). *How to solve it. Princeton*, NJ: Lawrence Erlbaum.
Pressley, M., & Harris, K. R. (2006). Cognitive strategy instruction: From basic research to classroom instruction. In P. Alexander & P. Winne (Eds.), Handbook of educational psychology (2nd ed., pp. 265–286). San Diego: Academic.
Pressley, M., Borkowski, J. G., & Schneider, W. (1989). Good information processing: What it is and how education can promote it. International Journal of Educational Research, 13, 866–878.
Pugalee, D. K. (2004). A Comparison of Verbal and Written Descriptions of Students' Problem Solving Processes. *In Educational Studies in Mathematics***.** 55**:** 27 – 47. New York: Kluwer Academic Publishers.
Ratminingsih, N. M., Artini, L. P., & Padmadewi, N. N. (2017). Incorporating Self and Peer Assessment in Reflective Teaching Practices. International Journal of Instruction, 10(4), 165-184.
Ratumanan dan Lauren. (2011). *Evaluasi Hasil Belajar pada Tingkat satuan Pendidikan Edisi 2*. Surabaya. Unesa University Press.
Schoenfeld, A. H. (1985). *Mathematical Problem Solving*. San Diego: Academic Press Inc.
Schraw, G. & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351-371.
Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, 36, 111-139.
Schraw, G., Olafson, L., Weibel, M., & Sewing, D. (2012). Metacognitive Knowledge and Field-based Science Learning in an Outdoor Environmental Education Program. In A. Zohar & Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*. (pp. 57-77). New York: Springer.

Sellars, M. (2012). Teachers and change: The role of reflective practice. Procedia - Social and Behavioral Sciences, 55, 461 – 469.

Slavin, R. E. (2011). Instruction Based on Cooperative Learning. In R. E. Mayer & P. A. Alexander (Eds.), Handbook of Research on Learning and Instruction (pp. 344-360). New York: Taylor & Francis.

Slavin, R.E. (2009). Educational Psychology. Tokyo: Pearson Education, Inc.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.

Thomas, G.P. (2012). Metacognition in science education: past, present and future considerations. *Second international handbook of science educations.* 1(2), 131-144.

Toit, S.D., & Kotze, D. (2009). Metacognitive Strategies in theTeaching and Learning of Mathematics. *Pythagoras*.70.

Veenman, M.P.J, Meijer, J., Wolters. (2006). Metacognition and learning: conceptual and methodological considerations. *Metacognition Learning* (-) 1: 3–14

Veenman. (2012). Metacognition in Science Education: Definitions Consituents, and Their Intricate Relation with Cognition. In A. Zohar & Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*. (pp 21-36). New York: Springer.

Webb, A & Moallem, M. (2016). Feedback and feed-forward for promoting problem-based learning in online learning environments. *Malaysian Journal of Learning and Instruction,* 13(2), 1-42.

Williams, J.P., Atkins, J.G. (2009). *The Role of Metacognition in Teaching Reading Comprehension to Primary Students from:* Handbook of Metacognition in Education Routledge.

Wilson, N. S., & Bai, H. (2010). The relationships and impact of teachers' metacognitive knowledge and pedagogical understandings of metacognition. *Metacognition Learning*. DOI 10.1007/s11409-010-9062-4.

Woolfolk, A. (2009). *Educational Psychology Bagian Kedua Edisi Kesepuluh*. Yogyakarta: Pustaka Pelajar.

Ya-Hui, W. (2012). A Study on Metacognition of College Teachers. *The Journal of Human Resource and Adult Learning,* 8(1), 84-9.

Yimer & Ellerton. (2009). A five-phase model for mathematical problem solving: Identifying synergies in pre-service teachers' metacognitive and cognitive actions. *ZDM Mathematics Education* 42:245–261.

Yusnaeni, Corebima, A. D., Susilo, H. & Zubaidah, S. (2017). Creative Thinking of Low Academic Student Undergoing Search Solve Create and Share Learning Integrated with Metacognitive Strategy. *International Journal of Instruction*, 10(2), 245-262.

Malaysian Journal of Learning and Instruction (MJLI)

Manuscript Evaluation Form (Reviewer B)

Title of Paper:

A. **Details of comments** ***(please fill in where appropriate and use a separate page if necessary)***

No.	Item	Refer to page(s)	Comments (Please make comments specific in order to assist corrections)	Author's Explanation/ Rebuttal	Page and Paragraph No. of Revised version
1	**Does the title accurately reflect the content of the paper?**	**1**	It must be stressed here that the overall idea of the article is on comparing RML to CML. This however was not translated in the title. In addition, as the data obtained for the study was collected (presumably) from Indonesia, it would be good to include 'Indonesia' in the title.	The suggestion of the reviewer related to the addition of the country where the study (Indonesia) has been written in the title. Related to the addition of the idea of comparing RML with CML, it has been described in the abstract.	**Pp 1**
2	**Is the abstract sufficiently concise and informative?**	**1**	The author(s) have followed the format set by the journal. However, the write up of the abstract could still be improved. For example, at the Purpose - the author(s) may straight away write "This study aims to analyze the validity and effectiveness of Reflective-Metacognitive Learning (RML) Model in comparison to the Cognitive-Metacognitive Learning (CML) Model by Garofalo and Lester (1989)". Apart from that, there is a need for the abstract language to be edited for clarity.	The reviewer's suggestion related to the clarity of the research objectives, namely the comparison of the effectiveness of RML with CML has been included in the abstract	**Pp 1**
3	**Is the purpose clearly stated in the introduction?**		No	The research objectives have been presented in detail in the introduction on paragraph 12	**9**
4	**Is the organization of the content acceptable?**		Need some improvement	Paragraph 1: sentence structure improvement which begins with the researchers' opinion on the importance of metacognition, followed by the reasons for the importance of metacognition in learning supported by the results of the PISA study, and the need for Indonesian educators to train metacognition	**2-9**

				in the 2016 and 2017 revised edition of the 2013 curriculum. Paragraphs 2 and 3: merged into 2 Paragraphs 4-7: description of the models that have been developed along with their weaknesses, the addition of the basics of RML development is seen from the steps in the two basic models so that reflection forms appear at each phase as a solution. Paragraph 8: a combination of paragraphs 9 and 10 of the previous manuscript.	
5	**Is the literature review satisfactory?**		No. The information and the previous knowledge included in this section hugely emphasis on the development of metacognition as a body of knowledge. However, there are some confusing information being mixed up with the article's said purpose. For example, it was established earlier on that the study aimed towards providing an analysis of the validity and effectiveness of Reflective-Metacognitive Learning (RML) Model in comparison to the Cognitive-Metacognitive Learning (CML) Model. However, the literature on this was only discussed in two-paragraph at page 5. What was expected to be included in the literature would some details on the development of metacognitive learning approach and CML, how that influence the building block of RML, and advantages (and/or disadvantages) of CML. In addition, the information in this section should include those studies which had utilized CML or some other model similar to CML.	The addition of 4 forms of reflection presented and the basis of his research from theoretical and empirical studies as presented in paragraph 9, figure 2, paragraph 10, and table 1.	**5-9**
6	**Is the methodology appropriate?**		Partially. In this study, the researcher(s) had compared the effectiveness of RML model to CML. It is understandable that the study had divided the subjects into 2 groups - experimental and control group. However, I strongly believe that there is a need for a neutral group to be included to really show and proves that the current education system implemented in Indonesia did not really emphasis on students' metacognitive abilities. Furthermore, there are questions over those selected 'experts' as their task seemed to be solely on the evaluation of RML. This raised a	In this section, the neutral group is not used, because the main purpose of this study is to see the contribution of reflection activities on RML model that highly impact the effectiveness of RML model to increase students' metacognition ability in comparison with CML Model.	

			question of validity of data as were they also an expert of CML. Were they able to differentiate the significant changes in terms of approaches that are different between RML and CML? This brings me to the ‘So what?’ factor of a good research - what is the study’s contribution and what is new being brought about?		
7	**Are there any discrepancies in facts and figures?**		No		
8	**Are the interpretation and conclusion of this paper appropriate?**		No. There is only one sentence and there is no real attempt to discuss the findings obtained in this article.	We have fixed it according to the reviewer's suggestion and presented in conclusion	**23**
9	**Does this article make a contribution to knowledge in the field?**		Novelty and originality The study and the data presented in this article is genuine and timely. As the study focuses on improving students’ metacognitive ability, the study may contribute hugely in improving learning in Indonesia. 2. Importance and impact The study is important as it may create to better the practice of teaching. As teachers learn about the RML, teacher may create better teaching lessons for their students. 3. Relevance to the Body of Knowledge As it is, the new model may prove to be a better version of the well-known CML. This thus contribute to the development of metacognition.	We have fixed it according to the reviewer's suggestion We have explained that in addition to improving students' metacognition skills, this study provides information about learning oriented to conceptual, procedural, and metacognitive knowledge according to the demands of the 2013 curriculum or the current revised 2016 and 2017 editions in Indonesia. This is supported by the results of research that is experimental class knowledge, skills, and metacognition awareness (RML) better than the control class (CML). Presented on paragraph 9, figure 2, paragraph 10, and table 1	**5-9**

D. Other comments

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Malaysian Journal of Learning and Instruction (MJLI)

Manuscript Evaluation Form (Reviewer C)

Title of Paper:

A. Details of comments ***(please fill in where appropriate and use a separate page if necessary)***

No.	Item	Refer to page(s)	Comments (Please make comments specific in order to assist corrections)	Author's Explanation/ Rebuttal	Page and Paragraph No. of Revised version
1	**Does the title accurately reflect the content of the paper?**		Yes		
2	**Is the abstract sufficiently concise and informative?**		Yes		
3	**Is the purpose clearly stated in the introduction?**		Partially, need to clarify whether the RML model is a learning model that can be applied generally for any given lesson implementation or it is a model of learning that must involve problem	We have fixed it according to the reviewer's suggestion presented on the 12th paragraph. Explanation of the application of the RML Model described in the 41st paragraph.	**9; 21**

			solving activity.		
4	**Is the organization of the content acceptable?**		Yes		
5	**Is the literature review satisfactory?**		There is a lot of technical jargon with several terms used that have overlapping meanings. Many terms are not discussed but rather just presented as per the source. The organisation does not provide for a smooth read. Since the author has defined metacognition as in paragraph 3 of page 2, the discussion of the formulation of RML model should map the definition used with the phases of the RML model and at the same time relate the RML model to other CML and other learning models that focus on developing metacognition.	We have fixed it according to the reviewer's suggestion The addition of 4 forms of reflection presented and the basis of his research from theoretical and empirical studies as presented in paragraph 9, figure 2, paragraph 10, and table 1.	**5-8**
6	**Is the methodology appropriate?**		Partially, I would recommend declaring the overall research design as Research and Development according to the Borg and Gall model rather than stating it as an experimental research at the outset. The experimental design is part of the evaluation phase of Borg and Gall R&D design and thus can be stated as such to determine the effectiveness of the RML model in developing metacognition. Need to clarify the theoretical basis for the eight aspects of the content and construct validity of the RML Model and its devices. How was the 'devices' validated? Were the same eight aspects used for the validation of the 'devices'? Need to further clarify what model and its devices 'reliability' mean. How does the reliability of model and devices relate to the reliability of an instrument? (since the article mentioned the reliability of an instrument). Need to justify the use of n-gain in calculating the changes in the metacognition score. In the results section, t-test was used to test the hypothesis but was not described in the methodology section. Also, calculating the effect size would provide for a more insightful interpretation of result as it is more popular among education researchers ? n-	We have fixed it according to the reviewer's suggestion. The addition of tables is analyzed by learning phases in CML (G & L, 1985), PS (Y & E, 2009), RML Models. Assessment of product development criteria categorized by (Niveen 1999, 2002) fulfills 3 criteria, namely validity, practicality and effectiveness. Validation is done through expert judgment, practicality and effectiveness through the RML Model implementation process compared to the CML model Model's Validity & Reliability (table 6) Validity & Reliability Instrument (Table 5)	10-11

			gain is basically popular in physics education research.		
7	**Are there any discrepancies in facts and figures?**		None that I can detect		
8	**Are the interpretation and conclusion of this paper appropriate?**		Need to discuss more on why the RML model leads to better results compared to the CML model since both models explicitly incorporate some aspects of metacognition in the learning process. CML has its strengths but now the author claims that RML is a better model due to incorporating 'reflection' in every phase of learning. Discussion need to highlight more on this point rather than elaborating on the overall strengths of what is common for both models. And how do the 'devices' support reflection. Does the CML model has its own devices? What are the similarities and differences between the set of devices for the RML model and the CML model? Does 'reflection' in every phase being incorporated in the 'devices'? Did the act of 'reflection' actually contributed to a better result or perhaps there are other factors that did it? This part was not convincing enough. Perhaps specific examples of how reflection is embedded in each phase of the learning and in each devices need to be provided.	Addition to students' metacognition skills in the RML Model is better than the CML Model, as a result of awareness of the reflection process of student learning through the presentation of cognitive conflict phenomena, anomalies, internalization, and new phenomena, while in the CML model, students have difficulty seeing what has been done so that the regulation of cognition is not going well. Addition of similarities and differences in both models. The RML model reflection form Phase 1: cognitive conflict phenomenon (increasing student's initial understanding) Phase 2: anomalies (increasing student awareness to look back at the procedures that have been made) Phase 3: internalization (activities that emphasize students to look back at problem solving steps) Phase 4: new phenomena (emphasizing students consciously to look back at all processes or activities during learning). CML: Reflection is required in Phase 4 (Table 1), namely verification through an instructional set to look back at the activities that have been carried out during learning, and this makes it difficult for students to do so. Presented in the discussion section on the effectiveness of RML Model	**15-22**
9	**Does this article make a contribution to knowledge in the field?**		Yes it does. The paper described a structured way of incorporating reflective thinking into the phases of learning to ensure thinking is embedded during learning and thus the development of thinking is		

			not left to chance.		

D. Other comments

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ear Muhali

It appears that you have misunderstood the comments without considering the original study.

In the paper- This study aims to analyse the validity and effectiveness of the RML Model in comparison to the Cognitive-Metacognitive Learning (CML) Model developed by Garofalo and Lester.

In rebuttal- the main purpose of this study is to see the contribution of reflection activities on RML models using previous models that relate and specifically teach metacognition as a control

You must decide what they are aiming to do. All the sections of revision are improved as RML Model in comparison to the Cognitive-Metacognitive Learning (CML) Model but in the method or results we don’t see anything like comparison.

The following message is being delivered on behalf of Malaysian Journal of Learning and Instruction.

THE VALIDITY AND EFFECTIVENESS OF THE REFLECTIVE-METACOGNITIVE LEARNING MODEL TO IMPROVE STUDENTS' METACOGNITION ABILITY IN INDONESIA

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ABSTRACT

Purpose: This study aims to (1) analyze the validity of the Reflective-Metacognitive Learning (RML) Model reviewed from content validity and construct validity; and (2) analyze the effectiveness of the RML Model in comparison with Cognitive-Metacognitive Learning (CML) Model developed by Garofalo and Lester by comparing the improvement of students' metacognition knowledge, metacognition skills, and metacognition awareness after learning process.

Methodology: This research is an experimental study that was begun with developing RML Model adapted from Borg and Gall's development design, which consists of: 1) planning, 2) development, and 3) evaluation. A focus group discussion (FGD) involving four experts in science education was conducted to determine the validity of the RML Model and its supporting devices in terms of content validity and construct validity. The randomized pretest-posttest control group design was used to evaluate the effectiveness of the RML Model and the CML Model, which were implemented towards forty students of a senior high school. Data were analyzed descriptively by using inferential statistics, namely independent sample t-test and Mann-Whitney U test.

Findings: The results obtained indicated that (1) the RML Model was highly valid in both content validity (3.89) and construct validity (3.84), (2) metacognition knowledge increased to the high degree (mean of n-gain: 0.76). Metacognition skill and awareness increased to the medium degree (mean of n-gain: 0.66; and 0.40) for the experimental group (taught using RML Model). Meanwhile, for the control group (taught using CML Model), the result increased to the medium degree (mean of n-gain: 0.60 for metacognition knowledge; 0.48 for metacognition skills; and 0.31 for metacognition awareness). Statistical analysis showed that there was improvement in students' metacognition abilities of both groups ($p < .05$). Therefore, it can be concluded that (1) the RML Model was valid and (2) the RML Model was more effective than the CML Model in terms of improving students' metacognition abilities.

Significance: The RML Models is expected to improve students' metacognition ability, which is marked by the reflection of thinking processes as the core of metacognition ability.

Keywords: Learning Model, RML Model, Validity of RML Model, Metacognition Ability, Effectiveness of RML Model and CML Model.

INTRODUCTION

Metacognition is the important goal and focus of education in Indonesia and all over the world (Asy'ari, et al., 2016). Metacognition can be simply seen as a process of thinking about thinking (Lai, 2011) through the conscious evaluation of thinking processes (Asy'ari, 2016). Permendiknas (2015) urges high school students to be able to solve procedural problems as components of metacognition, in order to train them to have productive thinking of solving routine and non-routine problems. Anderson and Krathwohl (2001) suggest metacognition as the highest dimension of knowledge in learning and therefore, it should be taught and taken as a goal of learning. PISA (Program for International Student Assessment) conducts a study in 2012, which is focused on reading literacy, mathematics and science. Results show that Indonesia was ranked at 55th of 65 countries. In 2015, Indonesia hits rank 69th of 75 countries. Another study by TIMSS (Trends in International Mathematics and Science Study) in 2011 places Indonesian students to have low scores in (1) understanding complex information; (2) theory, analysis, and problem solving; (3) utilizing tools, procedures, and problem-solving; and (4) conducting an investigation (Ministry of Education of Indonesia, 2012). The students' success on completion of given task depends on their awareness on the knowledge and skills applied in learning activities (Lai, 2011; Wilson & Bai, 2010; Pantiwati&Husamah, 2017), which is commonly known as metacognition ability. A study by Muhali (2013) involving students from four schools in Central Lombok reveals percentages of metacognition awareness in students, i.e. 6.15% (very good); 32.31% (good); 51.15% (adequate), and 10.39% (poor).

Basically, metacognition consists of: 1) metacognition knowledge, 2) metacognition control and regulation (Pintich, Wolters, & Baxter, 2000), and 3) metacognition assessment and examination (Meijer, Veenman, & Wolters, 2006). Metacognition knowledge is a declarative, procedural, and conditional knowledge of cognition (Veenman, 2012) and cognitive strategies and variables in tasks or problems encountered that affect someone's cognition (Alexander, Schallert, & Hare, 1991; Flavell, 1979). Metacognition is one of the innovative learning skills of 21st century that involves high-level cognitive processes including thinking about knowledge and how to gain the knowledge through a reflective process. In line with this opinion, Thomas (2012) believes that metacognition is the keyword of developments in science education in the 21st century. The development of science education from this perspective is related to the development of students' science literacy and understanding towards the nature of inquiry, the nature of science and concepts in science itself. Metacognitive teaching can enhance learning activities, understanding, attention, motivation, and memory, as well as to reduce learning disabilities (Ya-Hui, 2012) through effective processes in the planning, monitoring, and evaluation of teaching (Schraw, et al., 2012) within the strategic application of declarative, procedural, and conditional knowledge to achieve goals, and to address problems (Kaberman& Dori, 2008; Schunk in Woolfolk, 2009). Metacognition ability in this study is a high level of thinking ability consisting of: (1) knowledge of cognition (metacognition knowledge), which is knowledge of oneself as a learner that covers declarative, procedural, and conditional knowledge (Lai, 2011; Flavell, 1979; Marzano, et 1988: Woolfolk, 2009; Williams & Atkins, 2009; Anderson & Karthwohl, 2010; Louca, 2008); (2) metacognition skills, which are someone's awareness to control the process of learning (Veenman, 2012); and (3) metacognition awareness, which is someone's ability to reflect, understand, and control his learning including metacognition knowledge and regulation of cognition (planning, information management, monitoring, debugging, and evaluation) (Schraw & Moshman, 1995; Schraw et al., 2006; Schraw, et al., 2012; Jakobs & Paris, 1987; Kluwe, 1987; and Pressley & Harris, 2006).

Curiosity towards cognition and problems encountered in teaching metacognition has prompted many researchers to develop and formulate effective and systematic learning models. Polya (1957) proposes four stages of problem-solving model, i.e. 1) understanding a problem, which includes reading and clarifying problems in an attempt to identify what is known, what is unknown, and objectives; 2) devising a plan, which is selecting strategy and preparing plans to solve the problems; 3) carrying out, time to execute plans and write down solutions; and 4) looking back, once a solution is found, it is necessary to check its legitimacy. The most common problem with this model is that the problem solver does not fully understand the stages. Thus, he or she needs to try many times using different problem solving strategies to succeed. Furthermore, Schoenfield (1983; 1985) postulates a problem-solving scheme consisting of several activities, i.e. reading, analysis, exploration, planning, implementation, and verification. Schoenfield (1985) identifies three levels of knowledge and needs that are supposed to be fulfilled when a problem-solving performance is quantified. These three levels are: (1) sources (knowledge to be used on special problems); (2) control (knowledge possessed by a person to enable him/her to choose and implement his/her knowledge about the problem); and (3) a belief system (self-perception, environment, topics, and/or calculations that may affect one's needs). Kroll (1988) extends Schoenfield's problem-solving scheme to provide an overview of monitoring and procedures used during a group problem-solving process. In particular, Kroll (1988) categorizes monitoring activities into two types, i.e. (1) the type of statements submitted by a person or member of a group to solve a problem, (2) steps in problem solving, i.e. orientation, organization, implementation, and verification. Kroll (1988) specifies four basic types of statement, i.e. self-reflection, group, procedure, and overall assessment.

Schoenfield's problem-solving scheme inspires Garofalo & Lester (1985) in developing Cognitive-Metacognitive Learning (CML) Model by adopting Sternberg's (1985) meta-components, i.e. planning, monitoring, and evaluating problem-solving process, as follows: (1) identifying a problem; (2) describing or knowing the nature or circumstances of the problem; (3) preparing the mental and physical requirements to solve the problem; (4) determining how information be collected; (5) preparing steps of troubleshooting; (6) combining the steps with the right strategy to solve the problem; (7) monitoring the progress of problem solving process; and (8) evaluating solutions when troubleshooting has been resolved.

Pugalee (2004) sets out Garofalo and Lester's CML Model to consist of four categories or stages in solving a problem, i.e. (1) the orientation stage, which includes reading/rereading, introduction and presentation of parts, analysis of conditions and information, and assessment on level of difficulty of questions; (2) the organizational stage, which includes identification of intermediate and major/end targets, creating and implementing global plans, and organization of data; (3) the execution stage, which includes establishing local objectives, making calculations, monitoring objectives, and transferring plans; and (4) the verification stage, which includes evaluation of decisions and decision results. However, the CML Model lacks of reflection, which is the core of metacognition. Reflection or evaluation activities is only conducted by the end of learning, in the verification stage. Another weakness is in how decision-making is not measured or emphasized in the learning process. Student's decision-making skills in learning are only demonstrated through the performance/implementation of a heretofore design of problem-solving strategy.This claim is in compliance to the results of a study by Pugalee (2004), which reveals difficulties in the implementation of the model, where students do not verify all activities in the previous stages. This issue can be resolved by conducting reflection activity in every stage of learning.

Later, Yimer and Ellerton (2009) develop a problem-solving model formulated into five phases, i.e. engagement, transformation-formulation, implementation, evaluation, and internalization, in which reflection activity is conducted in each phase. The details of the five-stages problem solving are, as follows: 1) engagement, which includes initial understanding (finding the main idea, drawing); information analysis (introduction of information, identifying key ideas of relevant information to solve problems, relating them to specific mathematical domains); reflection on the problem (assessing familiarity or recalling similar problems previously solved, assessing the degree of difficulty, assessing the knowledge one needs in relation to the problem); 2) transformation-formulation, which includes exploration (using a particular case or number to visualize a problem situation); conjecturing or hypothesizing (based on specific observations and previous experiences); reflection on alleged or explored feasibility; formulating a plan (designing a good strategy to test allegations or designing a global or local plan); reflections on the feasibility of the plan based on the key features of the problem; 3) implementation, which includes exploration of key features of the plan; assessing the plan with the conditions and requirements set out by the problem; implementing the plan (doing activities both using computer and by way of analysis); reflection on the suitability of activities/actions; 4) evaluation, which includes re-reading the problem to evaluate whether or not the result has answered the question of the problem; assessing plans related to its consistency towards key features and possible errors in a calculation or analysis; assessing the reasonableness of the results; making a decision to accept or reject the solution; and 5) internalization, which includes reflection on the whole process of problem solving; identifying important features within the process; evaluating the problem-solving process for adaptation in other situations, different ways and features of the solution; reflections on the mathematical precision involved, one's confidence in the process, and the level of satisfaction. The reflection path in the Troubleshooting Model (Yimer & Ellerton, 2009) is presented in Figure 1 below.

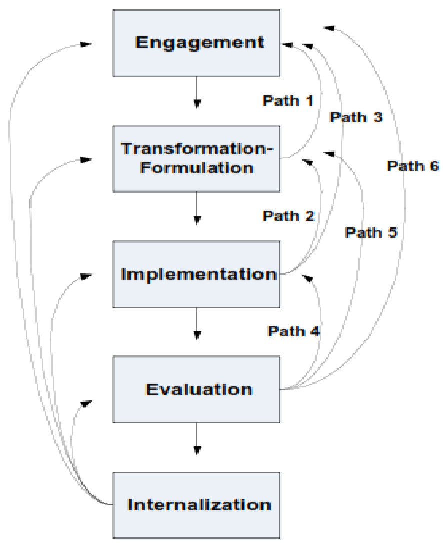

Figure 1. Cognitive Process Flow (Reflection) Problem Solving Model (Yimer & Ellerton, 2009)

The processes in this model replicate the weaknesses of the Polya's problem solving model which was viewed by Fernandez, Hadaway and Wilson (1994) as a back-and-forth process that makes it difficult for students to follow the lesson. Fernandez, Hadaway and Wilson (1994) criticize Polya's problem-solving model by providing examples of models that emphasize the process of cognitive awareness, or what other educators such as Schoenfeld and Flavell call metacognition that emphasize certain behaviors, such as predicting, planning, reviewing, selecting, and checking to help individuals to succeed in problem-solving situations by using their ability to identify and work with good strategies (Pugalee, 2004). Metacognition basically emphasizes on the ability to analyze the characteristics of problems encountered, such as consideration on the content, context, and variable structure of the issues in order to formulate and infer the difficulty of tasks and resources that can be used in problem solving.

Learning activities regarding the production of meaningful information are closely related to reflection that deals with recalling students' initial knowledge and simulating them to come with the interrelation of teaching materials to surrounding phenomena. Arends (2012) states that activities to teach students about interpreting the used teaching materials can be facilitated through orientation activities. Students and teachers are trained to assess themselves using self-checklists and fill in self-reflection journals, and peer-reviewed checklists to assess their instructional planning and teaching performance in reflection-oriented teaching (Ratminingsih, Artini, & Patmadewi, 2017). Teachers' role in reflection-based learning is emphasized in demonstrating both regular capability and authentic reflection in teaching (Sellars, 2012). The reflective approach in learning plays a role in verifying activities and attitudes aimed at increasing these aspects for further learning (Conley et al., 2010). Reflection is built on the day-to-day experiences integrated into learning (Borich, 2000). Reflection in learning can also help teachers to assess the level of students' cognitive regulation. In line with this statement, Flavell and Brown (in Herscovitz, Keberman, Saar, & Dori, 2012) see metacognition as consciousness and one's reflection on the process of self-cognition, which involves self-regulation and the coordination of conscious learning tasks. Furthermore, Veenman (2012) explains that reflection can be used to obtain the student's self-instruction production system. Anderson (1996); Anderson et al (1997) describe the three stages of student skill acquisition. The first stage of cognition comprises a declarative knowledge of the conditions and activities associated with verbal descriptions of procedures performed in the stages of problem solving. In the second stage, the associative stage, the verbal description that has been generated is then poured in a procedure that follows step by step protocol. Incorrect procedures identified in the first stage (cognition) are eliminated at this stage, so that the execution process can be optimized. The last stage is autonomy, which is the most difficult to achieve since the procedures must be prepared and applied independently (Nelson, 1996). Reflection is needed to achieve this stage. The results of metacognition activities should be reflected regarding its conformity towards metacognition knowledge (Vennman, 2012).

Based on the above description, a metacognition learning model was developed and adapted from Garofalo and Lester (1989) and Yimer and Elerton (2009). The CML model basically includes all the problem-solving phases proposed by Yimer & Ellerton (2009), but does not divide the activities in each phase into reflection activities at each of the learning stage, which is at the core of metacognition itself – a reflection of cognitive processes or evaluation of students' thinking processes. Reflection or evaluation activities are only conducted at the end of learning, i.e. at the verification stage. Schoenfeld (in Toit & Kotze, 2009), on the other hand, defines metacognition as the ability and control of cognitive function, meaning one's awareness of cognition and how to regulate cognitive processes during problem solving. The idea for the development of RML Model is presented in Figure 2 below.

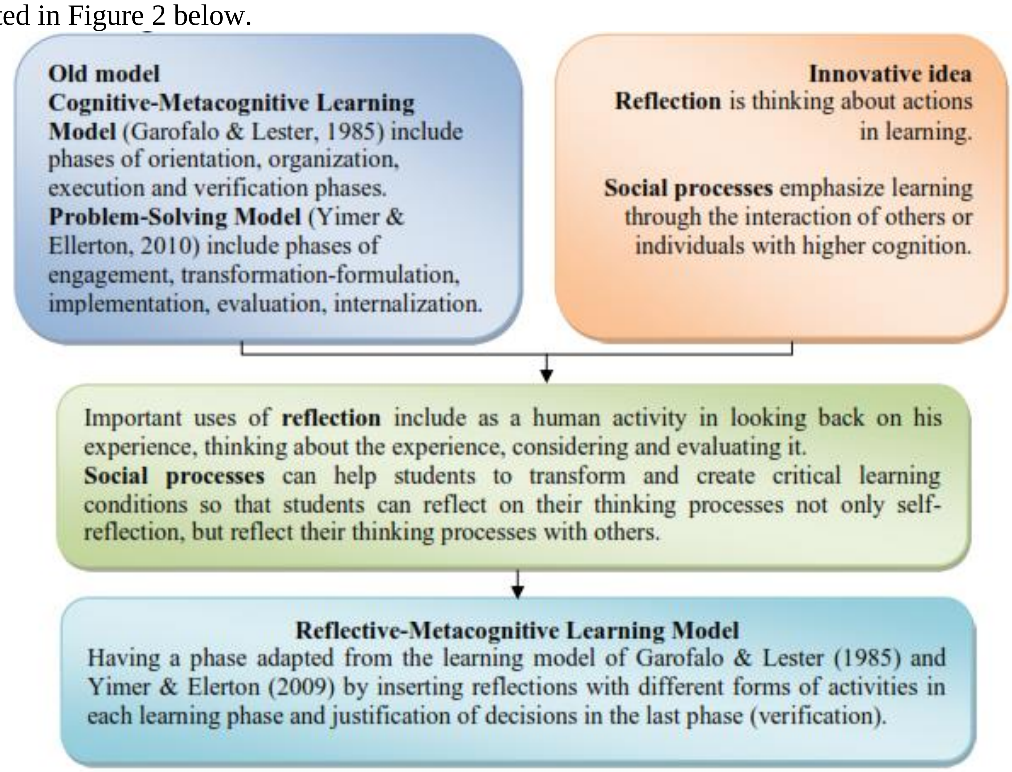

Figure 2. The idea for developing a reflective-metacognitive learning model

The Reflective-Metacognitive Learning (RML) Model is a learning model with reflective attributions in each learning stage to enable a conscious thinking process to increase students' metacognition ability through four phases, i.e.: (1) orientation reflection; (2) organizational reflection; (3) execution reflection; and (4) verification reflection. Formulation of RML Model is based on empirical and theoretical support that accommodate the CML Model (Garofalo & Lester, 1985) and the Problem-solving Model (Yimer & Ellerton, 2009). The differences between the Problem-solving Model by Yimer and Ellerton (2009), the CML model by Garofalo and Lester (1989), and the RML Model are presented in Table 1 below.

Table 1. Differences between the Problem Solving Model Yimer and Ellerton (2009), the CML Model Garofalo and Lester (1985) and the RML Model

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		**Problem-Solving Model (Yimer & Ellerton (2009)**		**Reflective-Metacognitive Learning**	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
Phase 1 Orientation: encompasses strategies for understanding, analysing information and conditions, evaluating familiarity with an initial task and presentation, assessing the difficulties of problems and hopes for success. This phase familiarizes students with problem situations**.**	A. Reading/ rereading, B. Introduction and presentation of parts, C. Analysis of conditions and information, and D. Assessment of the difficulty level of the problem.	**Phase 1 Engagement:** Initial confrontation and problem recognition.	A. Initial understanding (noting main ideas, making pictures), B. Information analysis (information recognition, identifying key information ideas that are relevant to solving problems, relating them to a particular mathematical domain), C. Reflection on the problem (assessing familiarity or remembering whether the same problem has been solved previously, assessing the level of difficulty, assessing the knowledge that needs to be related to the problem).	**Phase 1 Orientation reflection:** Strategies needed to assess and understand problems	A. Provide learning objectives B. Information and condition analysis C. Assessing the intimacy with the task D. Assessing the difficulty level of the problem and the opportunity to successfully solve the problem E. Reflection of orientation activities by providing conflict cognitive phenomena.

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
Phase 2 Organization Identifying key objectives, global planning and local planning needed to complete the global plan.	A. Identification of intermediate and ultimate/final goals, B. Creating and implementing global plans, and C. Organization of data.	**Phase 2 Transformation-Formulation:** Transform the initial involvement for exploration and formal plans.	A. Exploration (using certain cases or numbers to visualise problem situations), B. Conjecturing or hypothesizing (based on specific observations and prior experience), C. Reflection on alleged or exploration feasibility, D. Formulation of plans (design strategies to test guesses or design global or local plans), E. Reflection on the feasibility of the plan based on the key features of the problem.	**Phase 2 Organizational Reflection:** Identify the main goals and objectives, general and specific planning needed to complete the general plan.	A. Identify sub goals and ultimate goals B. Make a general plan C. Data organization D. Reflection through the presentation of an anomalous phenomenon that allows students to organize activities in this phase.
Phase 3 Execution: Includes the achievement of local actions, monitoring the progress of global and local plans, and assessing the decisions of performance (accuracy and fluency in carrying out planning in phase two).	A. Hold local destinations B. Make calculations, C. Monitoring objectives, D. Transfer of plans.	**Phase 3 Implementation:** Monitoring activities on the plan and exploration.	A. Exploration of key features of the plan, B. Assessing plans with conditions and requirements set based on problems, C. Implement the plan (doing activities using a computer or analyzed), D. Reflection on the suitability of activities / actions.	**Phase 3 Execution Reflection:** Implement special planning, monitor the progress of general and particular plans, and assess decisions.	A. Implementing a particular plan B. Monitoring progress of implementation of particular and general plans C. Make/formulate decisions D. Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning	
Learning Phases	**Learning Activities**	**Learning Phases**	**Learning Activities**	**Learning Phases**	**Learning Activities**
Phase 4 Verification: Includes evaluation of decisions and results of plans executed	A. Evaluating the orientation and organizational phases, B. Evaluate execution.	**Phase 4 Evaluation**: Assess the suitability of plans, actions, and solutions.	A. Reread the problem, assess whether or not the results match the question, B. Assess the consistency of the plan with the main features and possible errors in the calculation or analysis, C. Assess the fairness of results, D. Make a decision to accept or reject a solution, E. Reflection on the entire problem solving process.	**Phase 4 Verification Reflection**: Evaluation of decisions and results of plans executed and decision making.	A. Final decision making, B. Reflection of activities through the presentation of new phenomena that are still related to be solved.
		Phase 5 Internalization: reflection of the level of depth and other qualities of the problem solving process.	A. Identify important features in the process, B. Evaluate the problem solving process for adaptation to other situations, C. Reflection on accuracy, confidence in the process, and level of satisfaction.		

The RML Model is characterized by different and non-recurrent reflection activities in each phase of the CML Model, such as: (1) presentation of conflict phenomena in the first phase, (2) presentation of anomalous phenomena in the second phase, (3) internalization activities in the third phase, and (4) presentation of new phenomena that are still related to the fourth phase. Reflection through different forms of presentation in each phase of learning is expected to train students to be reflective and independent learners, who can develop knowledge through consciously trained skills. Cowan (1998) provides an example of how reflection works in the thinking process, in which students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, such as the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and what needs to be done to solve the problem (Ong, 2010). Reflection has a close relationship with students' metacognition abilities, Veenman et al., (2006) states that reflection and metacognition have similarities in emphasizing understanding, improving processes, learning outcomes, and focusing on effective student attention.

This study aims to analyze the validity and effectiveness of Reflective-Metacognitive Learning (RML) Models. The objectives of the study are as follows: (1) analyzing the validity of RML Models and supporting devices; (2) analyzing the effectiveness of the model developed by comparing the RML Model and Garofalo and Lester's (1985) Cognitive-Metacognitive Learning Model in the implementation phase of learning in six meetings to improve metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness) among senior high school students in Indonesia. The results of this study are useful to improve educators' knowledge related to a more interactive and effective learning model to improve students' metacognition ability by reflecting on the thinking process as the core of each phase of the RML Model. In line with this statement, Webb and Moallem (2016) state that metacognitive (reflective) questions that are used as feedbacks in learning can improve students' learning achievement. In addition, teaching metacognition ability can bring out the students' original potential so that they can become individuals who are rich in original ideas in accordance with their potential. Further, Abdullah (2016) explained that the core purpose of education is to enable students to learn independently. Metacognition as a conscious process of knowledge processing is needed to achieve that goal.

METHODOLOGY

This research was an experimental study with the randomized pretest-posttest control group design towards 40 high school students, who were divided into an experimental group (20 students) and a control group (20 students) as an attempt to analyze the effectiveness of RML Model and CML Model in increasing students' metacognition ability. The descriptive analysis and inferential statistics conducted in this research were: independent sample t-test and Mann-Whitney U-test. This research began with the development of the RML Model adapting Borg and Gall's development design, which comprised: 1) planning, 2) development, and 3) evaluation. The RML Model developed meets three quality product criteria, namely validity, practicality, and effectiveness (Nieveen, 1999). A Focus Group Discussion (FGD) was conducted with four science education experts to determine the validity of the RML Model and its supporting devices in terms of: 1) need; 2) state of the art; 3) empirical support and theoretical support for the RML Model development; 4) rationality of the phases of construction of the RML Model; 5) suitability of the RML Model's objectives and impacts according to the need for the 21st century competences; 6) learning environment and social systems in RML Model; 7) principle of reaction in RML Model in terms of the purpose of developing the model and equity with the principles of metacognition and reflection; and 8) support system in RML Model. Eight aspects of expert assessment in the FGD accommodated the content validity and construct validity criteria of the RML Model and its devices.

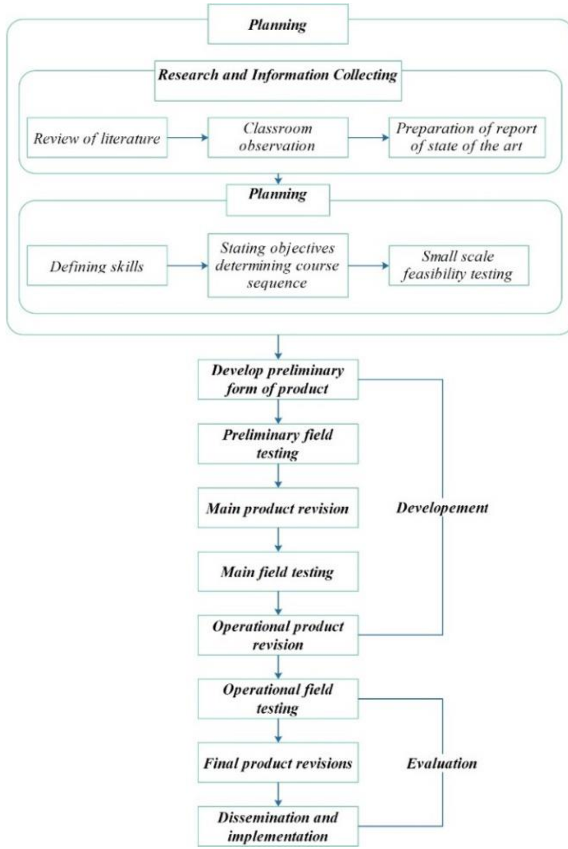

Figure 3. Borg and Gall's (1983) development research flows.

1. *Validity of Reflective-Metacognitive Learning Model*

The first stage of product development testing was a validation, which included two components namely content validity and construct validity (Nieveen, 1999). The RML Model validation instruments along with supporting devices were validated by experts before being used to assess the quality of the RML Model and the devices according to the following validity formula, r_α = [(Average Square people - Average Square residual)/(Average Square people + (k-1) Average Square residual)] and Cronbach's alpha $\alpha = k\, r_\alpha / [1+ (k-1)r_\alpha]$ (Malhotra, 2011). The criteria of RML Model validity and reliability instruments are shown in Table 2.

Table 2. Validity and reliability of RML Model criteria

Check	Scale statistics	Category	
Validity	Single measures interrater correlation coefficient-ICC (rα)	$r_\alpha \leq$ r table	Invalid
		$r_\alpha >$ r table	Valid
Reliability	Cronbach's alpha/average measures interrater correlation coefficient-ICC (α)	$\alpha < .60$	Unreliable
		$.60 \leq \alpha \leq 1.00$	Reliable

The learning model was validated by experts and practitioners who had competence in the field of education. Feedback from validators was used as material for the improvement of the model syntax until a valid model syntax was obtained. Assessment of the validity of the RML Model and the learning devices used was conducted using of four-point scales, i.e. much less valid = 1, less valid = 2, valid = 3, and very valid = 4. Obtained scores from expert assessment of the product development were converted to qualitative data on a four-scale (Ratumanan & Lauren, 2011), with criteria as in Table 3 below.

Table 3.Validity Criteria of Model and Learning Devices Based on Average Validator Values

Score Range	Criteria
> 3.60	very valid
2.80 – 3.60	valid
1.90– 2.70	less valid
1.00– 1.80	much less valid

The average value of validity and reliability of models and devices supporting the learning model is determined based on the value given by the validator. The reliability of the learning device is calculated using the percentage agreement equation by Emmer and Millett (in Borich, 1994):the instrument is said to be reliable if it has a percentage agreement of ≥ 75%, or a 75% average score from the validator team with valid category.

2. *Effectiveness of Reflective-Metacognitive Learning Model in comparison with Cognitive-Metacognitive Learning Model*

This stage was intended to determine the effectiveness of the RML model developed toward students' metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness) in comparison with the CML Model after the learning process. The randomized pretest-posttest control group design was used at the implementation stage of the RML Model and CML Model. Two groups were required in this method, namely the experimental and control groups. In the experimental group, the researcher gave a pretest, treatment by applying the RML Model, and then a posttest. Meanwhile in the control group, the researcher gave a pretest, followed by the treatment by applying the CML Model (Garofalo & Lester, 1989), and then a posttest. The following is the research design used.

The Randomized PretestPosttest Control Group Design			
Group	**Pretest**	**Intervention**	**Posttest**
A	*O1*	*X*	*O2*
B	*O3*	*C*	*O4*

Where,

A : experimental group
B : control group
O1 : pretest of experimental group
O2 : posttest of experimental group
O3 : pretest of control group
O4 : posttest of control group
X : treatment in experiment group using RML Model
C : treatment in control group using CML Model

(Fraenkel et al, 2011)

Students' metacognition ability data were collected using the following instruments:

1) Metacognition Knowledge Test. Data on students' metacognition knowledge were collected using ten-item essay test on acid and base materials provided before and after treatment. The metacognition knowledge test contained three indicators of declarative knowledge, procedural knowledge, and conditional knowledge.
2) Performance test. Student performance was measured using the students' worksheets given at the first and the last lesson. The metacognition skills indicators contained in the students' worksheet and measured in this study are: 1) formulating the learning objectives both general and specific (FLO); 2) formulating problem and problem solving on hypotheses that were relevant to the

formulated learning objectives (FPH); 3) making a problem-solving plan to prove the hypothesis that had been proposed (PSP); 4) implementing planning systematically (IPS); 5) monitoring the process (MP); 6) evaluating the process (EP); 7) collecting data (CD); 8) evaluating learning achievement related to the objectives at the beginning of learning activities (ELA).

3) Metacognition Awareness Inventory (MAI). Students' metacognition awareness was measured using the MAI developed by Schraw and Dennison (1994), which was administered before and after treatment. The indicators contained in the MAI were: planning, information management, monitoring, debugging, evaluation, declarative knowledge, procedural knowledge, and conditional knowledge.

The scores obtained were analyzed and categorized into four criteria, as in Table 4 below.

Table 4. Student Metacognition Ability Criteria

Criteria	**Score Range**
Very Good	$80 \leq P \leq 100$
Good	$70 \leq P \leq 79$
Good Enough	$60 \leq P \leq 69$
Less Good	$P<60$

The RML Model's effectiveness in improving senior high school students' metacognition ability was decided using the normalized gain score, namely: n-gain = (post-test score – pre-test score)/ (maximum score – pre-test score) (Hake, 1999). According to the following criteria: (1) when n-gain > .70 (high); (2) when .30 < n-gain < .70 (moderate); and (3) when n-gain < .30 (high). Computation program software IBM SPSS Statistics 23 was used to test the impact of teaching using the RML Model toward the improvement of metacognition ability in comparison with the CML Model. Furthermore, in order to analyze the differences in the RML Model's teaching impact toward metacognition ability in comparison with the CML Model of the two groups, anindependent sample t-test was used. The testing method should be depended on the compatible results of the normality assumption and variant homogeneity tests of n-gain, whereas if the data was not normally distributed, it was further analyzed using non-parametric tests (Mann-Whitney test).

RESULTS

1. *Validity of Reflective-Metacognitive Learning Model*

RML Model validation instruments along with supporting devices were validated by three experts with minimum qualification of doctoral degree and expertise in chemistry (one expert) and learning (two experts). The validation results of the RML Model validity instrument and the device are presented in Table 5 below.

Table 5. Results of validation of RML Model validity instruments and devices

Item	r_α	**Category**	**Cronbach's alpha (α)**	**Category**
1. RML Model	.76	Valid	0.86	Reliable
2. Syllabus	.72	Valid	0.84	Reliable
3. Lesson Plan	.68	Valid	0.81	Reliable
4. Module	.78	Valid	0.88	Reliable
5. Worksheet	.72	Valid	0.83	Reliable
6. Instruments	.87	Valid	0.93	Reliable

Based on the results of the validity and reliability tests in Table 5, it can be stated that the validation instruments were valid and reliable to assess the quality of the RML Model and its devices. The RML Model is a learning model with reflective attribution in each learning stage to enable a conscious thinking process to increase students' metacognition ability through four phases:

1) orientation reflection; 2) organizational reflection; 3) execution reflection; and 4) verification reflection. Its formulation was based on empirical and theoretical support that accommodated cognitive-metacognitive models (Garofalo & Lester, 1985) and problem-solving models (Yimer & Elerton, 2009). Reflections at the end of each learning phase were achieved through various forms of activities, such as providing conflict cognitive phenomena, anomalous phenomena, internalization (through providing problems or concepts), and providing new phenomena that were still related to decision making. Reflection played an important role in teaching metacognition to students, and could also play a role in monitoring the knowledge processes that students performed. The results of metacognition activities could be general, such as classifying information that was relevant to the problem at hand, or specific, such as finding specific solutions that fit the correct theory or concept to help students solve the problems at hand (Veenman, 2012). The activities and applications of each learning phase are presented in Table 6 below.

Table 6. The Reflective-Metacognitive Learning (RML) Model Phases

Learning Phases	**Learning Activities**	**Applications in Learning Activities**
Orientation Reflection	1. Provide learning objectives	• Deliver learning objectives generally.
	2. Information and condition analysis	• Ask students to read information from relevant learning resources.
	3. Assessfamiliarity with the task	• Ask students about the material they are studying.
	4. Assess the difficulty level of the problem and the opportunity to successfully solve the problem	• Present students with a common problem in learning activities.
	5. Reflection on orientation activities by providingconflict cognitive phenomena.	• Provide conflict cognitive phenomena to activate students' prior knowledge.
Organizational Reflection	1. Identify sub goals and ultimate goals	• Ask students to identify which sub-goals are the prerequisites that must be known first in order to achieve the ultimate/final goal.
	2. Make a general plan	• Establish general troubleshooting steps that have been identified in phase 1 orientation reflection, which is further downgraded to planning for sub-goals.
	3. Data organization	• Divide the students into groups. • Direct students in formulating hypotheses, defining operational variables in learning, determine the problem-solving steps to be used.
	4. Reflection	• Reflection on activities in the organizational reflection phase by presenting anomalous phenomena that enable students to organize activities in this phase.
Execution Reflection	1. Implementing a particular plan	• Ask students to carry out problem-solving planning in accordance with the plan that has been formulated. • Ask students to carefully plan and pay attention to the suitability and relevance of each troubleshooting step. Careful planning demonstrates good knowledge evaluation skills.

(continued)

Learning Phases	Learning Activities	Applications in Learning Activities
	2. Monitoring progress of particular and general plans implementation	• Assess performance of problem-solving implementation based on students' fluency and accuracy of problem-solving.
	3. Make/formulate decisions	• Ask students to formulate decisions by assessing the hypothesis, based on the results of data analysis and information obtained
	4. Reflection	• Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Verification Reflection	1. Final decision making	• Ask students to provide an explanation of the results of the implementation of their problem-solving plan. • Ask students to explain the relevance of the results of their problem-solving to the global goals they previously formulated.
	2. Reflection	• Provide new phenomena that are still related to solving the problem.

The difference in the cognitive process (reflection) flow in the RML Model compared to Yimer & Ellerton's (2009) problem-solving model is evident from Figure 4 below.

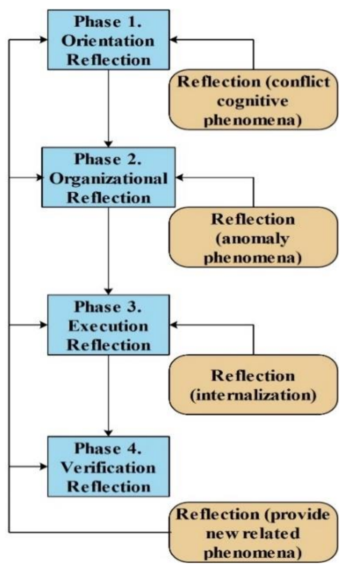

Figure 4. Cognitive Process Flow (Reflection) of the Reflective-Metacognitive Learning Model

Validation of the RML model and supporting tools included two components, i.e. content validity and construct validity. Content validity included all components of the learning model and the tools that should be based on the state-of-the-art knowledge. Components assessed for content validity were the development and design needs of RML Model and devices based on current knowledge, which were generally categorized as highly valid. The results of this assessment were based on RML Model development objectives, i.e. to improve students' metacognition skills as needed according to the competencies of the 21stcentury major skill of graduates and the applicable school curriculum requirements.

The expert validators involved in this activity were competent experts in chemistry learning, who understood the 2013 curriculum (National Curriculum of Education in Indonesia) and were active in classroom learning activities as well as teacher training activities. Validators validated the model and its supporting devices by providing an objective assessment, giving a check mark (√) to each number corresponding the given statement with the following criteria: Invalid (score 1); Less Valid (score 2); Valid (score 3); Very Valid (score 4). The RML Model validation resulted, along with its devices, as presented in Table 6, were found to be valid in both content and construct with strong reliability.

Table 6. Expert Validation of RML Model.

Item	**Content Validity**		**Construct Validity**		**Reliability**
	Score	**Category**	**Score**	**Category**	
1. RML Model	3.89	Very Valid	3.84	Very Valid	.94
2. Syllabus	3.75	Very Valid	3.85	Very Valid	.96
3. Lesson Plan	3.87	Very Valid	3.96	Very Valid	.97
4. Module	3.81	Very Valid	3.88	Very Valid	.96
5. Worksheet	3.83	Very Valid	3.84	Very Valid	.96
6. Instruments	3.90	Very Valid	3.98	Very Valid	.98

The RML Model validation result was proven empirically during learning implementation over six meetings of the course that had been conducted (3.90), which was found at "very well" level. This criterion was observed from the percentage of the average mode of values in the "very good" category and its increase in each meeting. The result was in line with the students' responses towards the learning using the RML Model, which overall gave a very strong response at 86.43%.

2. *Effectiveness of Reflective-Metacognitive Learning Model in comparison with Cognitive-Metacognitive Learning Model*

a. *Metacognition Knowledge*

The achievement of metacognition knowledge and n-gain is based on three indicators, i.e. declarative knowledge (DK), procedural knowledge (PK), and conditional knowledge (CK) as presented in Table 7. Data on students' metacognition knowledge were analyzed using the Kolmogorov-Smirnov test to determine the normality and Levene test to determine the homogeneity of data variance obtained. These test results revealed that the students' metacognition knowledge was normally distributed (Asymp Sig. 2-tailed: 0.20 > 0.05), and homogeneous (Sig: 0.42 > 0.05), so an independent sample test (t-test) was used to analysis the improvement of students' metacognition knowledge before and after learning.

Table 7. Results of pre-test and post-test of students' metacognition knowledge

Group	**N**	**Scores**	**Metacognitive Knowledge Indicators**			**Mean**	**SD**	**p**
			DK	**PK**	**CK**			
		Pre-test	32.12	45.75	32.44	34.29		
Experiment	20	Post-test	89.66	82.8	86.89	84.42	4.06	.00
		n-gain	0.85	0.67	0.80			
		Pre-test	30.25	39.50	31.50	33.75		
Control	20	Post-test	82.38	68.13	70.00	73.50	5.49	.00
		n-gain	0.75	0.47	0.56			

Based on the results of the analysis as presented in Table 7, it can be seen that students' metacognition knowledge had increased after learning. The improvement of students' metacognition knowledge was significant for both groups, but the improvement in the experimental group (tought using RML Model) is better (mean = 84.42) than that in the control group (taught using CML Model) (mean = 73.50). To have good metacognition knowledge, a student must be proficient in certain cognitive skills, namely declarative knowledge, procedural knowledge, and conditional knowledge which are the three kinds of knowledge involved in metacognition. Declarative knowledge is the knowledge about oneself as a learner and about factors affecting learning and memory, as well as the skills, strategies, and resources needed to do a task (know what to do); procedural knowledge involved knowing how to use a certain strategy; and conditional knowledge involves knowing when and why to apply certain procedures and strategies (Bruning, Scrhraw, Norby, & Ronning, 2004 in Woolfolk, 2009). Metacognition knowledge is thus the strategic application of declarative, procedural, and conditional knowledge to achieve goals and overcome problems (Schunk in Woolfolk, 2009).

The RML Model wass more effective in improving students' metacognition knowledge compared to the CML Model, as demonstrated by the results of the n-gain analysis (Table 7). We know that the n-gain of students' metacognition knowledge on experimental group for each metacognition knowledge indicator was better (DK: 0.85; PK: 0.67; and CK: 0.80) than the n-gain of students' metacognition knowledge in the control group (DK: 0.75;PK: 0.47; and CK: 0.56). The results of the analysis showed that the scores obtained by students before and after learning using the RML Model were significantly different.

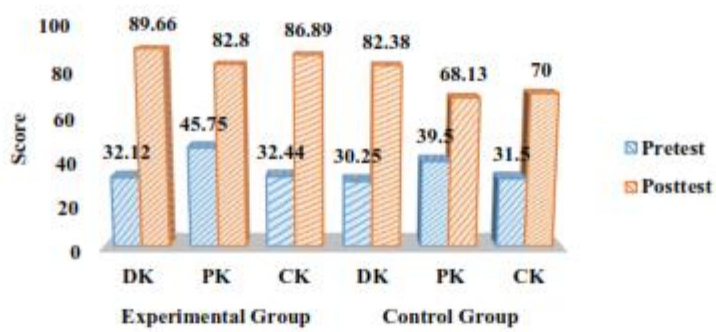

Figure 5. Students' metacognition knowledge (pre-test and post-test)

Figure 5 shows that the most significant impact is seen in the DK (0.85) and CK (0.80) indicators in the experimental group, which is in the high category. Meanwhile, in the control group, the DK (0.75) indicator shows the most significant improvement. The RML Model was more effective in increasing students' metacognition knowledge of all three indicators, which was likely to be caused by the reflection activity on each phase of learning. The provision of conflict cognitive phenomena, anomalous phenomena, internalization (through providing problems or concepts), and new phenomena that are still related to decision-making as a form of learning reflection enables students to review the purpose and analysis of the material in the readings presented and to understand more deeply the material used as an initial knowledge to learn the next set of material. In line with this finding, Cowan (1998) states that students reflect on their knowledge once they realize existing difference between the knowledge they already have and the new knowledge they gain, such as in the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when they identify problems and working out with what needs to be done to solve the problems (Ong, 2010). Providing conflict cognitive phenomena creates a state of imbalance in students' thinking, which can be used by the teachers to encourage students' interest in solving problems (Mischel, 2007). The conflict cognitive phenomenon can promote the monitoring of knowledge in the thinking process and reflecting students' initial knowledge (Thomas, 2012). As an indicator of metacognition knowledge, students' procedural knowledge showed a less significant increase although it was still in the "good" category for both classes. The results on the independent sample t test also showed that the students' metacognition knowledge was significantly different (p: .00) between those in the experimental group and the control group, as presented in Table 8 below.

Tabel 8. Independent sample t test of students' metacognition knowledge

Group	N	sig	t	df	p
Posttest of experimental and control groups	40	.77	6.06	38	.00

The RML Model and the learning devices developed, which accommodated the three components of metacognition ability (metacognition knowledge, metacognition skills, and metacognition awareness), had been thus shown to be more effective at improving students' metacognition knowledge than the CML Model ($p < .05$). McCormick states that students can be taught a strategy of assessing their own understanding by finding out how much time it takes to learn something and choosing an effective action plan for learning or working on a problem (Slavin, 2011). Oxford (1990) classifies some metacognition strategies, as follows: 1) centralizing student learning; 2) arranging and planning lessons; 3) evaluating learning. Another metacognition strategy is the ability to predict what might happen or mention something rational and irrational.

Teaching metacognition strategies to students can produce a clear improvement in students' achievement (Alexander, Graham & Harris; Hattie et al. in Slavin 2011). Students can learn to think through their own thinking processes and apply certain learning strategies to think themselves through difficult tasks (Butler & Winne; Pressley, Harris & Marks; Schunk in Slavin, 2011). The self-questioning strategy is very effective (Zimmerman in Slavin, 2011). A self-questioning strategy is a learning strategy that asks students to ask themselves about who, what, where, and how students read the material (Slavin, 2011). Students can be taught these strategies by conditioning learning according to the criteria described previously.

Inquiry activities that integrate the process skills are also carried out in the activities of the RML Model are very effective to raise awareness of the strategies used and positively affect student's performance (Pressley, Borkowski, & Schneider, 1987; McCormick, 2003). In the line with this opinion, Asy'ari, Ikhsan, and Muhali (2019) found that inquiry learning model was considered effective to increase students' metacognition knowledge and awareness. Crowly, Shrager, & Siegler (1997) describe the associative stages and metacognition mechanisms in strategies that emphasize on the discovery process, which has an important role in students' procedural knowledge. Siegler and Jenkins (in Waters and Kunnmann, 2010) further explain that the discovery processes in learning can increase students' awareness on their knowledge and accelerate the generalization process of students' information.

The RML Model which emphasizes evaluative reflection activity using phenomena that are directly related to the students' social aspects can be declared effective to increase students' metacognition knowledge. Moon (2004) argues that reflection is a key component of learning, while Fook (in Hickson, 2011) further argues that evaluative reflection emphasizes thinking about what has been done and elaborated based on the evaluation results to anticipate possible future problems. Further, Hoyrup (2004) suggests that evaluative reflection must be integrated to the social aspects and can be measured at a time when one is able to understand and validate the assumptions formulated. The reflection process in the RML Model avoids students from repeating possible mistakes from the previous learning process. In line with this finding, Carrol et al. (2010) state that reflecting on processes that have been done in everyday activities is essential to avoid the lack of ideas and repeat mistakes in routine activities.

b. Metacognition Skills

Students' metacognition skills showed good improvement. The indicators of students' metacognition skills measured in this study comprised the following skills, i.e. 1) formulating learning objectives of both general and specific (FLO); 2) formulating problem and problem solving hypotheses relevant to the formulated learning objectives (FPH); 3) making a problem-solving plan to prove the hypothesis that has been proposed (PSP); 4) implementing planning systematically (IPS); 5) monitoring the processes (MP); 6) evaluating the process (EP); 7) collecting data (CD); and 8) evaluating learning achievement in relation to the objectives at the beginning of learning activity (ELA). Data on students' metacognition skills were analyzed using the Kolmogorov-Smirnov test to determine normality and Levene test to find out the homogeneity of variance obtained. These tests revealed that the students' metacognition skill data were normally distributed ($p>.05$) but not homogenous ($p<.05$) for both the experimental group and the control group, therefore, a paired t test was used to examine the significance of students' metacognition skills improvement before and after learning using the RML Model (experimental group) and CML Model (control group). The results of the paired t test on the students' metacognition skills in the experimental and control groups are presented in Table 9 below.

Table 9. Pre-test and post-test result of students' metacognition skills

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
FLO	20	Pretest	43.75	19.87	.00	53.75	11.47	.00
		Posttest	93.75			78.75		
		n-gain	0.90			0.50		
FPH	20	Pretest	32.50	11.47	.00	47.50	9.16	.00
		Posttest	82.50			76.25		
		n-gain	0.70			0.50		
PSP	20	Pretest	46.25	15.12	.00	53.75	9.16	.00
		Posttest	85.00			77.50		
		n-gain	0.70			0.50		
IPS	20	Pretest	55.00	15.17	.00	62.50	14.68	.00
		Posttest	92.50			78.75		
		n-gain	0.80			0.40		
MP	20	Pretest	60.00	17.91	.00	60.00	16.42	.00
		Posttest	78.75			75.50		
		n-gain	0.50			0.40		
EP	20	Pretest	61.25	12.76	.00	61.25	13.08	.00
		Posttest	75.00			81.25		
		n-gain	0.40			0.50		
CD	20	Pretest	60.00	14.28	.00	60.00	16.77	.00
		Posttest	92.50			81.25		
		n-gain	0.80			0.50		
ELA	20	Pre-test	51.25	12.76	.00	51.25	12.76	.00
		Post-test	75.00			75.00		
		n-gain	0.50			0.50		

A Mann-Whitney U test was used to compare students' metacognition skills between the two groups, as shown in Table 10. The findings reveal that the metacognition skills of the students taught using the RML Model were better (mean rank: 27.32) than those taught using the CML Model (mean rank: 13.68). This difference was significant at p: .00.

Table 10. Mann-Whitney U test of students' metacognition skills

Group	N	Mean Rank	p
Experiment	20	27.32	.00
Control	20	13.68	

The improvement of students' metacognition skills in the experimental class cannot be separated from the integration of constructivist views, which in this study can be realized by facilitating students to learn by providing worksheets as a guide for measuring/observing or experimenting and conducting discussions. Students are given the opportunity to interact with the material they learn through observation or practicum, discussions, and opportunities to think about the results of these observations, practicum, and discussion. These activities are expected to develop the science processing skills to improve understanding on the material or the concept being learned. This result also showed that the material contained in the students' worksheets was in keeping with the environmental context often encountered by the students and with the material contained in both the syllabus and the lesson plan, so that it can provide genuine support for the achievement of basic competence and facilitate students' metacognition awareness. The differences in the improvement of students' metacognition skills, as obtained through the scores for pretest and posttest activities, are presented in Figure 6.

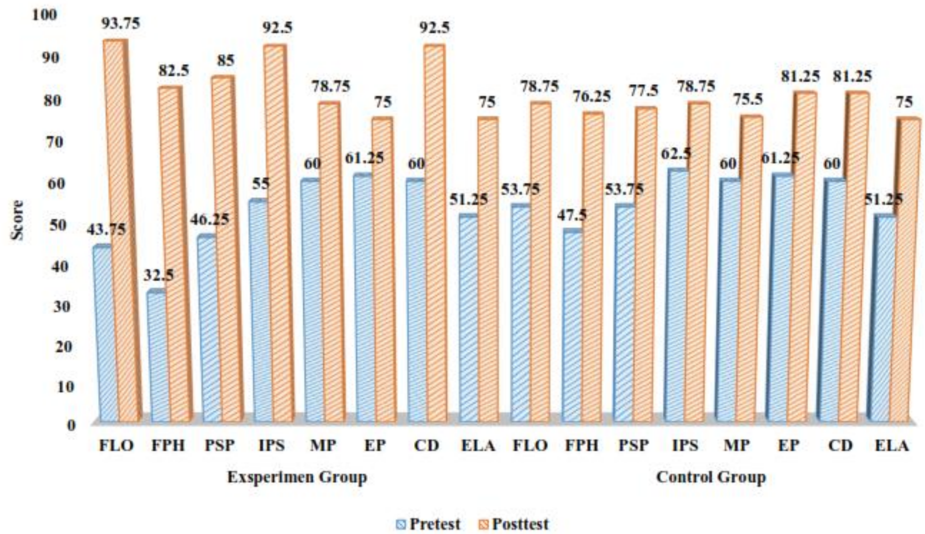

Figure 6. Students' metacognition skills (pretest and posttest)

Students' metacognition knowledge is directly proportional to students' metacognition skills and activities, which are related to students' procedural knowledge. Indicator 6 (EP) to examine the planning process either individually or in groups (n-gain: 0.4) in the experimental group and indicator 4 (IPS) to plan systematically (n-gain: 0.40) in the control group, indicated a less significant improvement than other skills and activities, but this improvement was still well categorized as good. The integration of contextual phenomena as reflections in the RML Model is an important attribution that plays a role in improving students' metacognition skills. Lee (2006) states that contextual approach is vital in learning, provided that the contextual problem has two virtues that is to improve students' learning motivation so that they have positive responses to the learning and to provide a good understanding of the material being taught. Brum and McKane (1989) state that learning science including chemistry cannot be separated from the ability to make observations, formulate testable hypotheses, induce and deduce, and design and execute experiments to test hypotheses. These activities are contained in the students' worksheet so that students' metacognition skills can be improved. In line with that opinion, Nur (2011) states that student's learning activities should place more emphasis on scientific activities, such as formulating questions, hypothesizing, observation, analysis, and conclusion so that the material studied become more meaningful. The RML Model which emphasizes reflection processes in each phase has an important role in improving students' metacognition skills by accommodating scientific activities. This statement is reinforced by Bennet et al. (2016) who argue that reflection is an essential part of developing students' evaluative-reflective skills in the context of experiential-oriented learning.

c. Metacognition Awareness

Metacognition awareness is related to activities that help a person to control his or her mind and learning. The metacognition awareness in this study includes metacognition knowledge and cognitive regulation, contained in the 52-item metacognition awareness questionnaire developed by Schraw and Dennison (1994), which contains eight aspects, i.e. 1) declarative knowledge (DK); 2) procedural knowledge (PK); 3) conditional knowledge (CK); 4) planning (P); 5) information management system (IMS); 6) monitoring (M); 7) debugging (D); and 8) evaluating (E). Students' metacognition awareness indicators were found to be normally distributed and homogeneous so an independent sample t test was used to investigate the difference in students' metacognition awareness between the control group and the experimental group before and after the learning, as presented in Table 11 below.

Table 11. The pretest and posttest result of students' metacognition awareness

Variable	**N**	**Score**	**Experimental Group**				**Control Group**			
			Mean	**sig**	**t**	**p**	**Mean**	**sig**	**t**	**p**
		Pretest	55.75	.19	-5.89	.00	51.75	.65	-8.54	.00
DK	20	Posttest	72.25				68.75			
		n-gain	0.40				0.40			
		Pretest	54.50	.19	-6.96	.00	51.00	.08	-6.80	.00
PK	20	Posttest	67.00				63.50			
		n-gain	0.30				0.30			
		Pretest	50.63	.63	-7.50	.00	50.78	.89	-9.22	.00
CK	20	Posttest	69.53				65.47			
		n-gain	0.40				0.30			
		Pretest	54.10	.13	-5.70	.00	50.89	.15	-7.96	.00
P	20	Posttest	68.21				64.46			
		n-gain	0.30				0.30			
		Pretest	50.00	.19	-6.78	.00	50.55	.62	-6.67	.00
IMS	20	Posttest	68.19				63.19			
		n-gain	0.40				0.30			
		Pretest	49.64	.41	-7.61	.00	51.25	.26	-7.30	.00
M	20	Posttest	68.21				64.46			
		n-gain	0.40				0.30			
		Pretest	52.00	.59	-6.62	.00	50.75	.19	-6.48	.00
D	20	Posttest	70.50				64.50			
		n-gain	0.40				0.30			
		Pre-test	51.45	.48	-6.33	.00	50.20	.36	-8.81	.00
E	20	Post-test	70.00				64.99			
		n-gain	0.40				0.30			

Table 12 also shows that the metacognition awareness of students being taught using the RML Model was better (mean rank = 26.05) than that of students who were taught using the CML Model (mean = 14.05) and that this difference was significant different (p = .03).

Table 11. Mann-Whitney U test of students' metacognition awareness

Group	**N**	**Mean Rank**	**p**
Experiment	20	26.95	.03
Control	20	14.05	

Findings related to metacognition knowledge and metacognition skills were confirmed regarding students' metacognition awareness. Figure 7 shows that students were still unaware of the procedural knowledge they had (PK; n-gain = 0.30), and that the results had an effect on the students' belief in their planning (P; n-gain = 0.30). It implies that the process of monitoring or examining the processes was performed well but not maximally (M; n-gain = 0.30). These results occurred in the experimental class (taught using RML Model) as well as in the control class (taught using CML Model), but generally the students' metacognition awareness categorized as good.

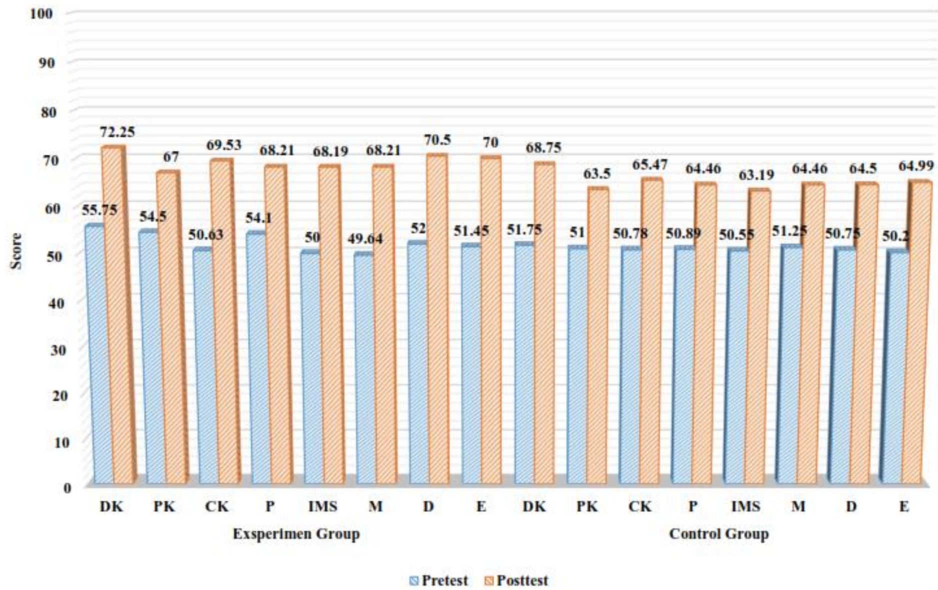

Figure 7. Students' metacognition awareness (pretest and posttest)

The learning activities from the beginning to the end emphasized on training and cultivating students' metacognition knowledge and skills. Yusnaeni et al. (2018) state that the implementation of metacognition strategies related to awareness in monitoring cognitive strategies to achieve specific goals can improve students' thinking skills. This is illustrated in the model phases applied to the learning devices. The impact of learning using the RML Model is seen in students' attitude toward the science or information possessed. Such attitudes can be monitored, according to Flavell (1979), through actions and interactions between four components: (a) metacognition knowledge, (b) metacognition experiences, (c) objectives (or tasks), and (d) actions (or strategy). Metacognition knowledge is used to regulate thought and learning (Brown, 1987; Nelson, 1996 in Woolfolk, 2009). Essential skills for metacognition include planning, monitoring, and evaluating (Woolfolk, 2009). Planning includes the students' ability to determine the time needed to perform a task, the strategy to use, how to begin, the resources needed, the sequence followed, what needs attention, and so on. Monitoring is a real-time awareness about "how students work". These criteria are encompassed within the entire learning process so that metacognition awareness can be stated to be increased after learning using the RML Model.

The RML model, which emphasizes evaluative reflection activities using the provision of phenomena that are directly related to students' social aspects, can be declared to be effective to improve students' metacognition skills. Fauzi & Hussain (2016) state that the more closely the learning is related to the social context, the more reflective students are in learning, and that the emphasis on the reflection processes in each phase has an important role in improving students' skills by accommodating scientific activities. This statement was reinforced by Bennet et al. (2016) who argue that reflection is an essential part of developing evaluative reflections in the context of learning oriented to scientific experimental activities. Reflection in learning is not only important in learning chemistry, but in learning science in general, as it can help teachers to identify the level of regulation of cognition possessed by students. In line with this statement, Flavell & Brown (in Herscovitz et al., 2012) define metacognition as a person's awareness and reflection on the process of self-cognition, which involves self-regulation and coordination of conscious learning tasks. Veenman (2012) further explains that reflection can be used to obtain a student's self-instruction production system. Good science learning should always pay attention to the students' psychological aspects in the learning process, in term of both cognitive development and social psychology. The four phases of the RML model are: (1) orientation reflection, (2) organizational reflection, (3) execution reflection, and (4) verification reflection, which are developed based on the consideration of the above mentioned psychological aspects and is very feasible as an alternative solution in chemistry learning in particular and learning science in general, with reflection activities forming a central element of every phase of learning. This statement is in line with Dewey who argues that important attitudes in reflection, namely open thinking, enthusiasm, and responsibility, not only can bridge the three components of metacognition to be taught to students (Loughran, 2005), but have also become social aspects that are also expected to be developed in all science teaching at every level of education (Education Ministry of Indonesia, 2013).

CONCLUSION

Based on the results and discussion, it can be concluded that: (1) the RML Model is a learning model to facilitate students' metacognition ability, which has four phases, namely orientation reflection, organizational reflection, execution reflection, and verification reflection, within characteristic reflection activities at each phase of learning through providing conflict cognitive phenomena in the first phase, anomalous phenomena in the second phase, internalization process in the third phase, and new phenomena that are still related to the learning material in the fourth phase; (2) it can be stated that the RML Model is highly valid in terms of both content (3.89) and construct (3.84) validity; (3) metacognition knowledge showed a high increase (mean n-gain = 0.76), while skill, and metacognition awareness showed a medium increase (mean n-gain = 0.66 and 0.40 respectively) for the experimental group (taught using RML Model), while for the control group (taught using CML Model), metacognition knowledge, skills, and awareness showed a medium increase category (mean n-gain = 0.60; 0.48; 0.31 respectively) and a statistical analysis showed that there was improvement in students' metacognition ability in both groups ($p <.05$). Thus, it can be concluded that (1) the RML Model is valid and (2) the RML Model is more effective than the CML model to increase students' metacognition ability.

REFERENCES

Abdullah, M.N.LY. (2016). Interaction effects of gender and motivational beliefs on self-regulated learning: a study at ICT integrated schools. *Malaysian Journal of Learning and Instruction*, 13(1), 25-41.

Alexander, P. A., Schallert, D. I., & Hare, V. C. (1991). Coming to terms. How researchers in learning and literacy talk about knowledge. *Review of Educational Research, 61,* 315-343.

Anderson, J. R. (1996). The architecture of cognition. Mahwah: Erlbaum.

Anderson, J. R., Fincham, J. M., & Douglass, S. (1997). The role of examples and rules in the acquisition of a cognitive skill. Journal of Experimental Psychology: Learning, Memory, and Cognition, 23, 932–945.

Anderson, L.W &Krathwohl, D.R. (2010). *Kerangka Landasan untuk Pembelajaran, Pengajaran dan Asesmen (Revisi Taksonomi Pendidikan Bloom).* Yogyakarta: Pustaka Pelajar.

Asy'ari, M., Ikhsan, M., & Muhali. (2019). The Effectiveness of Inquiry Learning Model in Improving Prospective Teachers' Metacognition Knowledge and Metacognition Awareness. *International Journal of Instruction*, 12(2), 455-470. https://doi.org/10.29333/iji.2019.12229a

Asy'ari, M., Prayogi, S., Samsuri, T., & Muhali. (2016). Kajian Literatur tentang Berpikir Kritis, Berpikir Kreatif, dan Metakognisi dalam Pembelajaran. *Prosiding Seminar Nasional PKPSM*. 12 Maret 2016. Mataram, Indonesia. Hal 292-298.

Asy'ari, M. (2016). Identifikasi Kemampuan Metakognisi Mahasiswa Calon Guru Olahraga dan Korelasinya dengan Hasil Belajar Mata Kuliah Ilmu Alamiah Dasar. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, *4*(1), 42-46.

Bennett, D., Power, A., Thomson, C., Mason, B., &Bartleet, B. L. (2016). Reflection for learning, learning for reflection: Developing Indigenous competencies in higher education. *Journal of University Teaching & Learning Practice*, *13*(2).
Borg, W. R. dan Gall, M.D. (1983). *Educational research: An Introduction. Fourth Edition*. Longman Inc.
Borich, G. D. (1994). *Observation Skill for Effective Teaching*. New York: Mac Millan Publishing Company.
Borich, G. D. (2000). *Effective teaching methods*. New Jersey: Pearson Education.
Brum & McKane. (1989). *Study guide biology: Exploring life*. New York: John Wiley & Sons.
Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination, and the fires within: Design thinking in a middle school classroom. *International Journal of Art and Design Education*, 29(1), 37-52.
Conley, L., et al. (2010). *Becoming a teacher*. London, EN: Heinemann.
Crowley, K., Shrager, J., Siegler, R.S. (1997). Strategy discovery as a competitive negotiation between metacognitive and associative mechanisms. Developmental Review, 17, 462–489.
Fauzi, S.S.M., & Hussain, R.M.R. (2016). Designing instruction for active and reflective learners in the flipped classroom. *Malaysian Journal of Learning and Instruction*, 13(2), 147-173.
Fernandez, M. L., Hadaway, N. & Wilson, J. W. (1994). Problem solving: Managing it all. *The Mathematics Teacher*, 87(3), 195 - 199.
Flavell, J.H. (1979). Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmentan Inquiry. *American Psychologist*, *34 (10)*, 906-911.
Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2011). *How to design and evaluate research in education.*Boston: McGraw-Hill Higher Education.
Garofalo, J., & Lester, F. K. (1985). Metacognition, cognitive monitoring, and mathematical performance. *Journal for Research in Mathematics Education*, 16, 163–176.
Hake, R.R. (1999). Analyzing Change/Gain Score. [Online]. Tersedia: http://www.physics.indiana.edu/sdi/AnalizingChange-Gain.pdf. [10Maret 2012].
Herscovitz, O., Kaberman, Z., Saar, L., & Dori, Y.J. (2012). The Relationship between Metacognition and the Ability to Pose Questions in Chemical Education. In A. Zohar & Y.J. Dori (Eds.), Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education. (pp 165-195). New York: Springer.
Hoyrup, S. (2004). Relective as a core process in organisational learning. *Journal of Workplace Learning*, 16(7/8), 442.
Ibrahim, M. (2010). *Dasar-dasar Proses BelajarMengajar*. Surabaya: Unesa University Press.
Jacobs, J., & Paris, S. (1987). Children's metacognition about reading. Issues in definition, measurement, and instruction. Educational Psychologist, 22, 255-278. doi:10.1207/s15326985ep2203&4_4
Kaberman, Z.&Y. J. Dori, (2008). Metacognition in chemical education: question posing in the case-based computerized learning environment. *Springer Science+Business Media*. Technion-Israel Institute of Technology.
Kemendikbud. (2012). *DokumenKurikulum 2013*. Jakarta: Kementrian Pendidikan dan Kebudayaan.
Kluwe, R. H. (1987). Executive decisions and regulation of problem solving behavior. In F. E. Weinert& R. H. Kluwe (Eds.), Metacognition, motivation, and understanding (pp. 31-64). New Jersey: Lawrence Erlbaum Associates, Inc.
Kroll, D. L. (1988). Cooperative problem solving and metacognition: A case study of three pairs of women. (Doctoral dissertation, Indiana University, 1988).
Lai. E.R. (2011). Metacognition: A Literature Review *Research Report*.
Lee, M. (2006). *What does constructivism suggest for science education*. Northridge: California State University.
Louca, E.P. (2008). *Metacognition and Theory of Mind*. Cambridge Scholars Publishing.

Malhotra, N. K. (2011). *Review of marketing research: Spesial issue-marketing legends*. Emerald Group Publishing Limited.
Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C., &Suthor, C. (1988). Dimensions of thinking: &framework for curriculum and instruction. Alexandria, VA: Association for Supervision and Curriculum Development.
McCormick, C. B. (2003). Metacognition and learning. In W. M. Reynolds & G. E. Miller (Eds.), Handbook of psychology: Educational psychology (pp. 79–102). Hoboken: Wiley.
Meijer, J., Veenman, M.P.J, Wolters. (2006). Metacognitive Activities in Text-Studying and Problem-Solving: Development of a taxonomy. *Educational Research and Evaluation*. 12(3), 209 – 237.
Moon, J.A. (2004). *A Handbook of Reflective and Experimental Learning: Theory and Practice*. London: Routledge Falmer.
Muhali, (2013). Analisis Kemampuan Metakognisi Siswa pada Mata Pelajaran Kimia SMA. *Jurnal Kependidikan Kimia Hydrogen*, 1(1), 1-7.
NCES (National Center for Education Statistics). (2013). *Highlights From TIMSS 2011 Mathematics and Science Achievement of U.S. Fourth-and Eighth-Grade Students in an International Context*. Downloaded. https://nces.ed.gov/pubs2013/2013009_1.pdf.
Nelson, T. O. (1996). Consciousness and metacognition. American Psychologist, 51, 102–116.
Nieveen, N. (1999). Prototyping to Reach Product Quality. Kluwer Academic Publishers. University of Twente.
Nur, M. (2011). *ModulKeterampilan-keterampilan Proses danHakikatSains*. Surabaya: PSMS Unesa.
OECD (Organisation for Economic Co-operation and Development). (2013). Country Note – Results from PISA 2012. downloaded: Mei 2018, https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf
OECD (Organisation for Economic Co-operation and Development). (2016). Country Note – Results from PISA 2015. (https://www.oecd.org/pisa/PISA-2015-Indonesia.pdf, downloaded: Mei 2018).
Ong, R. (2010). The role of reflection in student learning: a study of its effectiveness in complementing problem based learning environment.
Oxford, R.L. (1990). *Language Learning Strategies*. USA: Oxford.
Pantiwati, Y., &Husamah (2017). Self and Peer Assessments in Active Learning Model toIncrease Metacognitive Awareness and Cognitive Abilities. *International Journal of Instruction*, 10(4),185-202.
Pintrich, P.R., Wolters,C., & Baxter, G. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. Impara (Eds.), *Issues in theme measurement of metacognition* (pp. 43-97). Lincoln, NE: Buros Institute of Mental Measurements.
Polya, G. (1957). *How to solve it. Princeton*, NJ: Lawrence Erlbaum.
Pressley, M., & Harris, K. R. (2006). Cognitive strategy instruction: From basic research to classroom instruction. In P. Alexander & P. Winne (Eds.), Handbook of educational psychology (2nd ed., pp. 265–286). San Diego: Academic.
Pressley, M., Borkowski, J. G., & Schneider, W. (1989). Good information processing: What it is and how education can promote it. International Journal of Educational Research, 13, 866–878.
Pugalee,D.K.(2004).A Comparison of Verbal and Written Descriptions of Students' Problem Solving Processes. *In Educational Studies in Mathematics***.** 55**:** 27 – 47. New York: Kluwer Academic Publishers.
Ratminingsih, N. M., Artini, L. P., & Padmadewi, N. N. (2017). Incorporating Self and Peer Assessment in Reflective Teaching Practices. International Journal of Instruction, 10(4), 165-184.

Ratumanandan Lauren. (2011). *Evaluasi Hasil Belajar pada Tingkat satuan Pendidikan Edisi 2*. Surabaya. Unesa University Press.

Schoenfeld, A. H. (1985). *Mathematical Problem Solving*. San Diego: Academic Press Inc.

Schraw, G. &Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351-371.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, 36, 111-139.

Schraw, G., Olafson, L., Weibel, M., & Sewing, D. (2012). Metacognitive Knowledge and Field-based Science Learning in an Outdoor Environmental Education Program. In A. Zohar & Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*. (pp. 57-77). New York: Springer.

Sellars, M. (2012). Teachers and change: The role of reflective practice. Procedia - Social and Behavioral Sciences, 55, 461 – 469.

Slavin, R. E. (2011). Instruction Based on Cooperative Learning. In R. E. Mayer & P. A. Alexander (Eds.), Handbook of Research on Learning and Instruction (pp. 344-360). New York: Taylor & Francis.

Slavin, R.E. (2009). Educational Psychology. Tokyo: Pearson Education, Inc.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.

Thomas, G.P. (2012). Metacognition in science education: past, present and future considerations. *Second international handbook of science educations.* 1(2), 131-144.

Toit, S.D., &Kotze, D. (2009). Metacognitive Strategies in the Teaching and Learning of Mathematics. *Pythagoras*.70.

Veenman, M.P.J, Meijer, J., Wolters. (2006). Metacognition and learning: conceptual and methodological considerations. *Metacognition Learning* (-) 1: 3–14

Veenman. (2012). Metacognition in Science Education: Definitions Consituents, and Their Intricate Relation with Cognition. In A. Zohar & Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*. (pp 21-36). New York: Springer.

Webb, A & Moallem, M. (2016). Feedback and feed-forward for promoting problem-based learning in online learning environments. *Malaysian Journal of Learning and Instruction*, 13(2), 1-42.

Williams, J.P., Atkins, J.G. (2009). *The Role of Metacognition in Teaching Reading Comprehension to Primary Students from:* Handbook of Metacognition in Education Routledge.

Wilson, N. S., & Bai, H. (2010). The relationships and impact of teachers' metacognitive knowledge and pedagogical understandings of metacognition. *Metacognition Learning*. DOI 10.1007/s11409-010-9062-4.

Woolfolk, A. (2009). *Educational Psychology Bagian Kedua Edisi Kesepuluh*. Yogyakarta: Pustaka Pelajar.

Ya-Hui, W. (2012). A Study on Metacognition of College Teachers. *The Journal of Human Resource and Adult Learning*, 8(1), 84-9.

Yimer & Ellerton. (2009). A five-phase model for mathematical problem solving: Identifying synergies in pre-service teachers' metacognitive and cognitive actions. *ZDM Mathematics Education* 42:245–261.

Yusnaeni, Corebima, A. D., Susilo, H. & Zubaidah, S. (2017). Creative Thinking of Low Academic Student Undergoing Search Solve Create and Share Learning Integrated with Metacognitive Strategy. *International Journal of Instruction*, 10(2), 245-262.

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Mataram, 22nd April 2019

LETTER OF NOTIFICATION

No: 022/e/pengen/iv/2019

To whom it may concern,

This letter is an official statement from Genius Foundation. Established in 2010, Genius Foundation now has been running Genius Press, our a publishing department that concerns with academic literature. We publish books for university and public readers across disciplines legally and administered by International Serial Book Number (ISBN), which is operated in Indonesia by the Indonesia's National Library in Jakarta. To ensure control on quality of our publication, we have strict policy regarding manuscript screening, which includes legal aspect and language use. For this purpose, we hire qualified proof readers and editors who are professional writters/authors and academician. We therewith have qualification to serve our customer with proof reading and translation services in two languages, i.e. Indonesian and English.

By referring the statements given above, we hereby inform that a manuscript entitled "**The Validity and Effectiveness of the Reflective-Metacognitive Learning Model to Improve Students's Metacognition Ability in Indonesia**" written by Muhali, Leny Yuanita, & Muslimin Ibrahim has been checked and edited as requested by the editorial board of Malaysian Journal of Learning and Instruction. Proof reading was conducted by Dr. Lalu Ari Irawan, S.E., S.Pd., M.Pd., one of senior editors in Genius Press.

Should you need further correspondence regarding the content of this letter, please do not be hesitate to send us an email at genius7ntb@gmail.com (and/or cc to ariirawanlalu@gmail.com).

Regards,

M. Zainul Firdaus
Director of Publication

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THE VALIDITY AND EFFECTIVENESS OF THE REFLECTIVE-METACOGNITIVE LEARNING MODEL IN IMPROVING STUDENTS' METACOGNITIVE ABILITY IN INDONESIA

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ABSTRACT

Purpose – This study investigated the content and construct validity of the Reflective-Metacognitive Learning (RML) Model, and the effectiveness of the RML Model in comparison with Cognitive-Metacognitive Learning (CML) Model in improving students' metacognitive knowledge, skills, and awareness after the learning process.

Methodology – This experimental study began with developing the RML Model, which covered planning, development and evaluation. A focus group discussion involving four experts in science education was conducted to determine the validity of the RML Model and its supporting devices in terms of content validity and construct validity. An experimental study using a randomized pretest-posttest control group design was then implemented on forty senior high school students to evaluate the effectiveness of the RML Model against the CML Model. Data were analyzed descriptively and statistically.

Findings – The results showed that the RML Model was highly valid in terms of content validity and construct validity, Metacognitive knowledge increased to a high degree, while metacognitive skills and awareness increased to a medium degree. Based on the results, it was concluded that the RML Model was valid and more effective than the CML Model in terms of improving students' metacognitive ability.

Significance – The RML Model, which is marked by the reflection of thinking processes as the core,is expected to improve students' metacognitive ability.

Keywords: Learning model, RML model, validity of RML model, metacognitive ability, effectiveness of RML model and CML model.

INTRODUCTION

Metacognition is an important goal and focus in education, both in Indonesia and globally (Asy'ari, Prayogi, Samsuri, & Muhali, 2016). Metacognition can simply be seen as a process of thinking about thinking (Lai, 2011) through the conscious evaluation of thinking processes (Asy'ari, 2016). Anderson and Krathwohl (2001) suggest that metacognition is the highest dimension of knowledge in learning and therefore should be taught and taken as a goal of learning. A 2012 PISA (Program for International Student Assessment) study that focused on reading literacy, mathematics and science showed that Indonesia was ranked 55th out of 65 countries. In 2015, Indonesia was ranked 69th out of 75 countries. Another study by TIMSS (Trends in International Mathematics and Science Study) in 2011 found Indonesian students to have low scores in four elements: understanding complex information; theory, analysis, and problem solving; utilizing tools, procedures, and problem-solving; and conducting an investigation (Education Ministry of Indonesia, 2012). Students' success in the completion of given tasks depends on their awareness of the knowledge and skills applied in learning activities (Lai, 2011; Wilson & Bai, 2010; Pantiwati & Husamah, 2017), which is commonly known as metacognitive ability. A study by Muhali (2013) involving students from four schools in Central

Lombok revealed the following levels of metacognitive awareness in students: very good (6.15%); good (32.31%); adequate (51.15%) and poor (10.39%).

Basically, metacognition consists of metacognitive knowledge, metacognitive control and regulation (Pintrich, Wolters, & Baxter, 2000), and metacognitive assessment and examination (Meijer, Veenman, & van Hout-Wolters, 2006). Metacognitive knowledge is a declarative, procedural, and conditional knowledge of cognition (Veenman, 2012) and cognitive strategies and variables in tasks or problems encountered that affect someone's cognition (Alexander, Schallert, & Hare, 1991; Flavell, 1979). Metacognition is one of the innovative learning skills of the 21st century that involves high-level cognitive processes including thinking about knowledge and how to gain the knowledge through a reflective process.

Thomas (2012) believes that metacognition is the keyword in developments in science education in the 21st century. The development of science education from this perspective is related to the development of students' science literacy and understanding towards the nature of inquiry, the nature of science and concepts in science itself. Metacognitive teaching can enhance learning activities, understanding, attention, motivation, and memory, as well as reduce learning disabilities (Ya-Hui, 2012) through effective processes in the planning, monitoring, and evaluation of teaching (Schraw, Olafson, Weibel, & Sewing, 2012) within the strategic application of declarative, procedural and conditional knowledge to achieve goals and to address problems (Kaberman & Dori, 2008; Schunk, in Woolfolk, 2009). Metacognitive ability in this study is a high level of thinking ability consisting of: (1) knowledge of cognition (metacognitive knowledge), i.e., knowledge of oneself as a learner-- covering declarative, procedural, and conditional knowledge (Anderson & Krathwohl, 2010; Lai, 2011; Louca, 2008; Flavell, 1979; Marzano et al., 1988; Williams & Atkins, 2009; Woolfolk, 2009;); (2) metacognitive skill, which is someone's awareness to control the process of learning (Veenman, 2012); and (3) metacognitive awareness, which is someone's ability to reflect, understand, and control his learning, including metacognitive knowledge and regulation of cognition (planning, information management, monitoring, debugging, and evaluation) (Jacobs & Paris, 1987; Kluwe, 1987; Pressley & Harris, 2006; Schraw &

Moshman, 1995; Schraw, Crippen, & Hartley, 2006; Schraw et al., 2012).

The aim of this study was to analyze the validity and effectiveness of Reflective-Metacognitive Learning (RML) Model. The objectives were as follows: (1) to analyze the validity of RML Model and supporting devices; (2) to analyze the effectiveness of the model developed by comparing the RML Model with Garofalo and Lester's (1985) Cognitive-Metacognitive Learning Model in the implementation phase of learning, in order to identify improvements in metacognitive ability (metacognitive knowledge, metacognitive skills, and metacognitive awareness) among senior high school students in Indonesia. The results of this study would be useful in terms of enhancing educators' knowledge about a more interactive and effective learning model that would improve students' metacognitive ability by reflecting on the thinking process as the core of each phase of the RML Model. Webb and Moallem (2016) suggest that metacognitive (reflective) questions that are used as feedback in learning can improve students' learning achievement. In addition, teaching metacognitive ability can bring out the students' original potential so that they can become individuals who are rich in original ideas in accordance with their potential. Further, Abdullah (2016) explained that the core purpose of education is to enable students to learn independently. Metacognition as a conscious process of knowledge processing is needed to achieve that goal.

LITERATURE REVIEW

Curiosity about cognition and problems encountered in teaching metacognition have prompted many researchers to develop and formulate effective and systematic learning models. Polya (1957) proposed four stages in a problem-solving model, i.e., (1) understanding a problem, which includes reading and clarifying problems in an attempt to identify what is known, what is unknown, and objectives; (2) devising a plan, i.e., selecting a strategy and preparing plans to solve the problem; (3) carrying out, time to execute plans and write down solutions; and (4) looking back— once a solution is found, it is necessary to check its legitimacy. The most common problem with this model is that the problem solver does not fully understand the stages. Thus, he or she needs to try many times using different problem-solving strategies to succeed. Schoenfield (1983;1985) postulated that a problem-solving scheme consists of several activities, i.e., reading, analysis, exploration, planning, implementation and verification. Schoenfield (1985) identified three levels of knowledge and needs that are supposed to be fulfilled when a problem-solving performance is quantified. These three levels are: (1) sources (knowledge to be used on special problems); (2) control (knowledge possessed by a person to enable him/her to choose and implement his/her knowledge about the problem); and (3) a belief system (self-perception, environment, topics, and/or calculations that may affect one's needs). Kroll (1988) extended Schoenfield's problem-solving scheme to provide an overview of monitoring and procedures used during a group problem-solving process. In particular, Kroll (1988) categorized monitoring activities into two types: (1) the type of statements submitted by a person or member of a group to solve a problem; and (2) steps in problem solving, i.e., orientation, organization, implementation and verification. Kroll (1988) specified four basic types of statement, i.e., self-reflection, group, procedure, and overall assessment.

Schoenfield's problem-solving scheme inspired Garofalo & Lester (1985) in developing a Cognitive-Metacognitive Learning (CML) Model by adopting Sternberg's (1985) meta-components of planning, monitoring and evaluating the problem-solving process as follows: (1) identifying a problem; (2) describing or knowing the nature or circumstances of the problem; (3) preparing the mental and physical requirements to solve the problem; (4) determining how information is to be collected; (5) preparing steps of troubleshooting; (6) combining the steps with the right strategy to solve the problem; (7) monitoring the progress of the problem solving process; and (8) evaluating solutions when troubleshooting has been resolved.

Pugalee (2004) set out Garofalo and Lester's CML Model into four categories or stages in solving a problem: (1) the orientation stage, which includes reading/rereading, introduction and presentation of parts, analysis of conditions and information, and assessment on level of difficulty of questions; (2) the organizational stage, which includes identification of intermediate and major/end targets, creating and implementing global plans, and organization of data; (3) the execution stage, which includes establishing local objectives, making calculations, monitoring objectives, and transferring plans;

and (4) the verification stage, which includes evaluation of decisions and decision results. However, the CML Model lacks reflection, which is the core of metacognition. Reflection or evaluation activities are only conducted by the end of learning, in the verification stage. Another weakness is in how decision-making is not measured or emphasized in the learning process. Students' decision-making skills in learning are only demonstrated through the performance/ implementation of a problem-solving strategy. This is consistent with the results of a study by Pugalee (2004), which revealed difficulties in the implementation of the model, where students do not verify all activities in the previous stages. This issue can be resolved by conducting a reflection activity in every stage of learning.

Yimer and Ellerton (2009) later developed a five-phase problem-solving model comprising engagement, transformation-formulation, implementation, evaluation and internalization, in which a reflection activity is conducted in each phase. The details of the five-stages of problem solving are as follows: (1) engagement, which includes initial understanding (finding the main idea, drawing); information analysis (introduction of information, identifying key ideas in relevant information to solve problems, relating them to specific mathematical domains); reflection on the problem (assessing familiarity or recalling similar problems previously solved, assessing the degree of difficulty, assessing the knowledge one needs in relation to the problem); (2) transformation-formulation, which includes exploration (using a particular case or number to visualize a problem situation); conjecturing or hypothesizing (based on specific observations and previous experiences); reflection on alleged or explored feasibility; formulating a plan (designing a good strategy to test allegations or designing a global or local plan); reflections on the feasibility of the plan based on the key features of the problem; (3) implementation, which includes exploration of key features of the plan; assessing the plan with the conditions and requirements set out by the problem; implementing the plan (doing activities both using the computer and by way of analysis); reflection on the suitability of activities/actions; (4) evaluation, which includes re-reading the problem to evaluate whether or not the result has answered the question of the problem; assessing plans related to its consistency towards key features and possible errors in a calculation or analysis; assessing the reasonableness of the results; making a decision to accept or reject the solution; and (5) internalization, which includes reflection on the whole process of problem solving; identifying important features within the process; evaluating the problem-solving process for adaptation in other situations, different ways and features of the solution; reflections on the mathematical precision involved, one's confidence in the process, and the level of satisfaction. The reflection path in the Troubleshooting Model (Yimer & Ellerton, 2009) is presented in Figure 1.

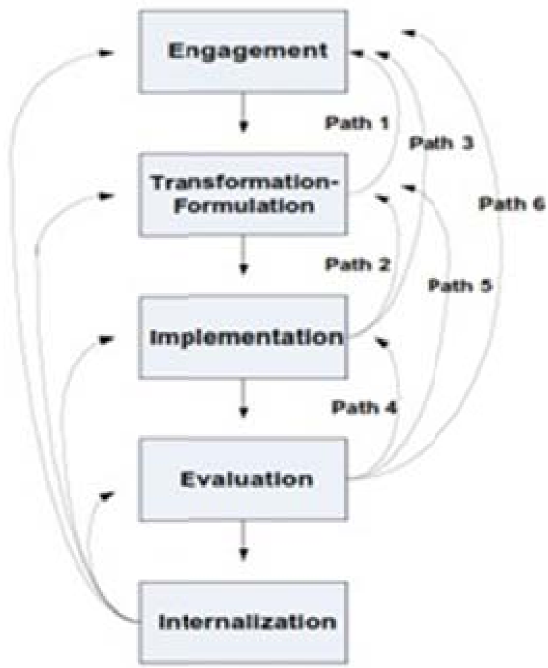

Figure 1. Cognitive Process Flow (Reflection) Problem Solving Model (Yimer & Ellerton, 2009).

The processes in this model replicate the weaknesses of Polya's problem solving model which was viewed by Fernandez, Hadaway and Wilson (1994) as a back-and-forth process that makes it difficult for students to follow the lesson. Fernandez et al.(1994) criticize Polya's problem-solving model by providing examples of models that emphasize the process of cognitive awareness, or what other educators such as Schoenfeld and Flavell call metacognition that emphasizes certain behaviours, such as predicting, planning, reviewing, selecting, and checking to help individuals to succeed in problem-solving situations by using their ability to identify and work with good strategies (Pugalee, 2004). Metacognition basically emphasizes on the ability to analyze the characteristics of problems encountered, such as consideration of the content, context, and variable structure of the issues in order to formulate and infer the difficulty of tasks and resources that can be used in problem solving.

Learning activities regarding the production of meaningful information are closely related to reflection that deals with recalling students' initial knowledge and simulating them to arrive at the interrelation of teaching materials to surrounding phenomena. According to Arends (2012), activities to teach students about interpreting the teaching materials used can be facilitated through orientation activities. In reflection-oriented teaching, students and teachers are trained to assess themselves using self-checklists, self-reflection journals, as well as peer-reviewed checklists (Ratminingsih, Artini, & Patmadewi, 2017). The teachers' role in reflection-based learning is emphasized in demonstrating both regular capability and authentic reflection in teaching (Sellars, 2012). The reflective approach plays a role in verifying activities and attitudes aimed at increasing these aspects for further learning (Conley et al., 2010). Reflection is built on day-to-day experiences integrated into learning (Borich, 2000). Reflection in learning can also help teachers to assess the level of students' cognitive regulation. Flavell and Brown (in Herscovitz, Keberman, Saar, & Dori, 2012) see metacognition as consciousness and one's reflection on the process of self-cognition, which involves self-regulation and the coordination of conscious learning tasks. Furthermore, Veenman (2012) explains that reflection can be used to obtain the student's self-instruction production system. Anderson (1996) and Anderson, Fincham and Douglass (1997) describe three stages of student skill acquisition. The first stage of cognition comprises a declarative knowledge of the conditions and activities associated with verbal descriptions of procedures performed in the stages of problem solving. In the second stage, the associative stage, the verbal description that has been generated is then poured into a procedure that follows a step by step protocol. Incorrect procedures identified in the first stage (cognition) are eliminated at this stage, so that the execution process can be optimized. The last stage is autonomy, which is the most difficult to achieve since the procedures must be prepared and applied independently (Nelson, 1996). Reflection is needed to achieve this stage. The results of metacognitive activities should reflect conformity with metacognitive knowledge (Vennman, 2012).

Based on the above description, a metacognitive learning model was developed and adapted from Garofalo and Lester (1989) and Yimer and Ellerton (2009). The CML model basically includes all the problem-solving phases proposed by Yimer and Ellerton (2009), but does not divide the activities in each phase into reflection activities at each of the learning stage, which is at the core of metacognition itself – a reflection of cognitive processes or evaluation of students' thinking processes. Reflection or evaluation activities are only conducted at the end of learning, i.e., at the verification stage. Schoenfeld (in du Toit & Kotze, 2009), on the other hand, defines metacognition as the ability and control of cognitive function, i.e., one's awareness of cognition and how to regulate cognitive processes during problem solving. The idea for the development of the RML Model is presented in Figure 2.

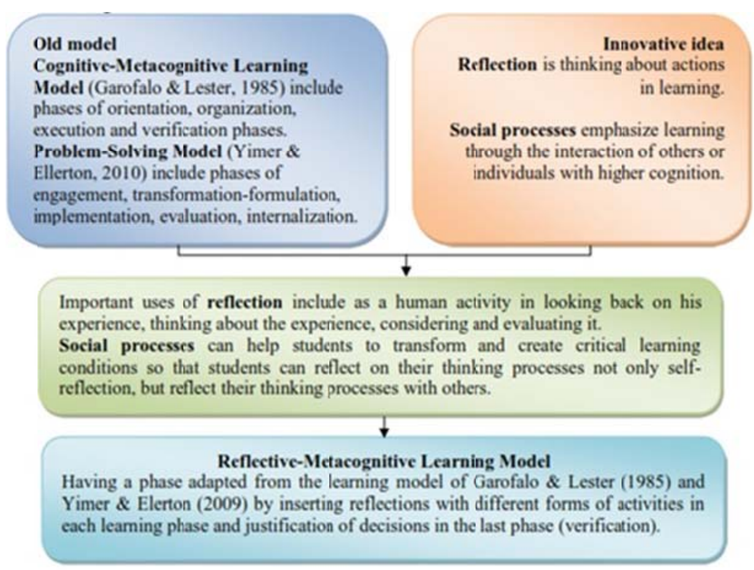

Figure 2. The Idea for Developing a Reflective-Metacognitive Learning Model.

Table 1

Differences between the CML Model (Garofalo & Lester,1985), the Problem Solving Model (Yimer & Ellerton, 2009) and the RML Model

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning Model	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
Phase 1 Orientation: Encompasses strategies for understanding, analysing information and conditions, evaluating familiarity with an initial task and presentation, assessing the difficulties of problems and hopes for success. This phase familiarizes students with problem situations.	A. Reading/ rereading, B. Introduction and presentation of parts C. Analysis of conditions and information D. Assessment of the difficulty level of the problem.	Phase 1 Engagement: Initial confrontation and problem recogition	A. Initial understanding (noting main ideas, making pictures) B. Information analysis (information recognition, identifying key information ideas that are relevant to solving problems, relating them to a particular mathematical domain), C. Reflection on the problem (assessing familiarity or remembering whether the same problem has been solved previously, assessing the level of difficulty, assessing the knowledge that needs to be related to the problem).	Phase 1 Orientation reflection: Strategies needed to assess and understand problems	A. Provide learning objectives B. Information and condition analysis C. Assessing the intimacy with the task D. Assessing the difficulty level of the problem and the opportunity to successfully solve the problem E. Reflection of orientation activities by providing cognitive conflict phenomena

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning Model	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
Phase 2 Organization Identify key objectives, global planning and local planning needed to complete the global plan	A. Identification of intermediate and ultimate/final goals B. Creating and implementing global plans C. Organization of data	Phase 2 Transformation-Formulation: Transform the initial involvement for exploration and formal plans	A. Exploration (using certain cases or numbers to visualise problem situations) B. Conjecturing or hypothesizing (based on specific observations and prior experience) C. Reflection on alleged or exploration feasibility D. Formulation of plans (design strategies to test guesses or design global or local plans), E. Reflection on the feasibility of the plan based on the key features of the problem	Phase 2 Organizational Reflection: Identify the main goals and objectives, general and specific planning needed to complete the general plan	A. Identify sub goals and ultimate goals B. Make a general plan C. Data organization D. Reflection through the presentation of an anomalous phenomenon that allows students to organize activities in this phase
Phase 3 Execution: Includes the achievement of local actions, monitor the progress of global and local plans, and assess the decisions of performance (accuracy and fluency in carrying out planning in phase two)	A. Holding local destinations B. Making calculations C. Monitoring objectives D. Transfer of plans	Phase 3 Implementation: Monitor activities on the plan and exploration	A. Exploring key features of the plan B. Assessing plans with conditions and requirements set based on problems C. Implementing the plan (doing activities using a computer or analyzing) D. Reflecting on the suitability of activities/actions	Phase 3 Execution Reflection: Implement special planning, monitor the progress of general and particular plans, and assess decisions.	A. Implementing a particular plan B. Monitoring progress of implementa-tion of particular and general plans C. Make/form-ulate decisions D. Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshoot-ing steps.

(continued)

Cognitive-Metacognitive Learning Model (Garofalo & Lester, 1985)		Problem-Solving Model (Yimer & Ellerton (2009)		Reflective-Metacognitive Learning Model	
Learning Phases	Learning Activities	Learning Phases	Learning Activities	Learning Phases	Learning Activities
Phase 4 Verification: Includes evaluation of decisions and results of plans executed	A. Evaluating the orientation and organization-al phases B. Evaluate execution	Phase 4 Evaluation: Assess the suitability of plans, actions, and solutions	A. Reread the problem, assess whether or not the results match the question B. Assess the consistency of the plan with the main features and possible errors in the calculation or analysis C. Assess the fairness of results D. Make a decision to accept or reject a solution E. Reflection on the entire problem-solving process	Phase 4 Verification Reflection: Evaluation of decisions and results of plans executed and decision making	A. Final decision making B. Reflection of activities through the presentation of new phenomena that are still related to be solved.
		Phase 5 Internalization: Reflection of the level of depth and other qualities of the problem-solving process	A. Identify important features in the process B. Evaluate the problem-solving process for adaptation to other situations C. Reflection on accuracy, confidence in the process, and level of satisfaction		

The Reflective-Metacognitive Learning (RML) Model is a learning model with reflective attributions in each learning stage to enable a conscious thinking process to increase students' metacognitive ability through four phases: (1) orientation reflection; (2) organizational reflection; (3) execution reflection; and (4) verification reflection. The formulation of the RML Model is based on empirical and theoretical support that accommodate the CML Model (Garofalo & Lester, 1985) and the Problem-solving Model (Yimer and Ellerton, 2009). The differences between the Problem-solving Model by Yimer and Ellerton (2009), the CML model by Garofalo and Lester (1989), and the RML Model are presented in Table 1.

The RML Model is characterized by different and non-recurrent reflection activities in each phase of the CML Model, such as: (1) presentation of conflict phenomena in the first phase, (2) presentation of anomalous phenomena in the second phase, (3) internalization activities in the third phase, and (4) presentation of new phenomena that are still related in the fourth phase. Reflection through different forms of presentation in each phase of learning is expected to train students to be reflective and independent learners, who can develop knowledge through consciously trained skills. Cowan (1998) provides an example of how reflection works in the thinking process, in which students reflect on their knowledge when they realize that there is a difference between the knowledge they have and the new knowledge gained, such as the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when identifying problems and what needs to be done to solve the problem (Ong, 2010). Reflection has a close relationship with students' metacognitive abilities. Veenman, van Hout-Wolters & Afflerbach (2006) point out that reflection and metacognition have similarities in emphasizing understanding, improving processes, learning outcomes, and focusing on effective student attention.

METHODOLOGY

This research was an experimental study with a randomized pretest-posttest control group design. 40 high school students were divided into an experimental group (20 students) and a control group (20 students) to analyze the effectiveness of the RML Model and the

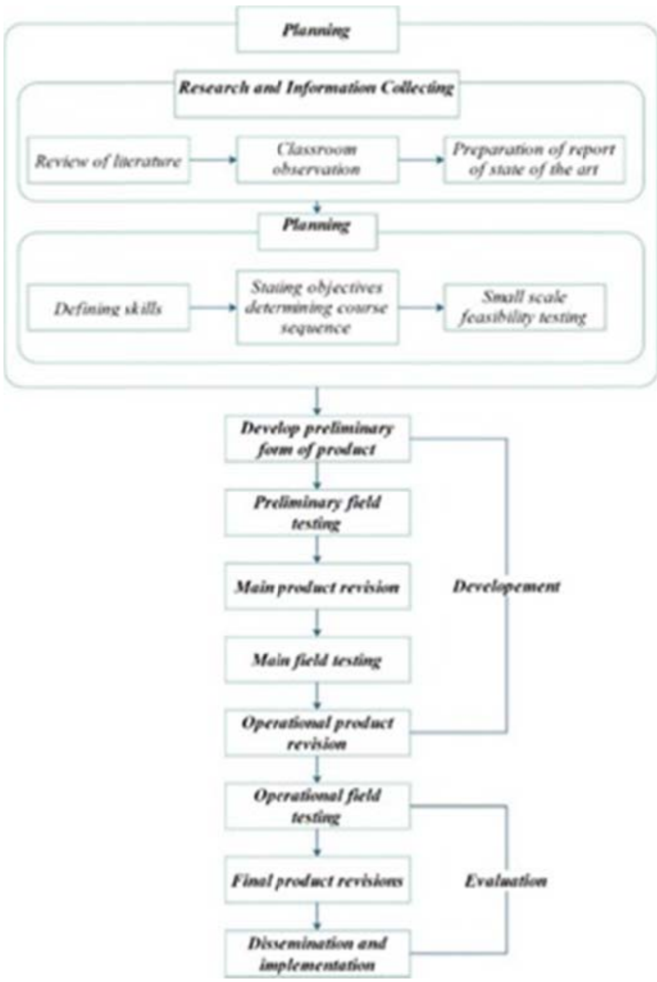

Figure 3. Borg and Gall's (1983) Development Research Flow.

CML Model in increasing students' metacognitive ability. The descriptive analysis and inferential statistics conducted were independent samples t-test and Mann-Whitney U-test. The research began with the development of the RML Model, adapting Borg and Gall's (1983) development design which comprised planning, development and evaluation. The RML Model developed met three quality product criteria, namely validity, practicality, and effectiveness (Nieveen, 1999). A Focus Group Discussion (FGD) was conducted with four science education experts to determine the validity of the RML Model and its supporting devices in terms of: (1) need; (2) state of the art; (3) empirical and theoretical support for the RML Model development; (4) rationality of the phases of the RML Model construction (5) suitability of the RML Model's objectives and impacts according to 21st century competencies; (6) learning environment and social systems in the RML Model; (7) principle of reaction in the RML Model in terms of the purpose of developing the model and equity with the principles of metacognition and reflection; and (8) the support system in the RML Model. Eight aspects of expert assessment in the FGD accommodated the content validity and construct validity criteria of the RML Model and its devices.

Validity of the Reflective-Metacognitive Learning Model

The first stage of the product development testing was a validation, which included two components namely content validity and construct validity (Nieveen, 1999). The RML Model validation instruments along with supporting devices were validated by experts before being used to assess the quality of the RML Model and the devices, according to the following validity formula: r_α = [(Average Square people - Average Square residual)/(Average Square people + (k-1) Average Square residual)] and Cronbach's alpha $\alpha = k\, r_\alpha / [1+(k-1)r_\alpha]$ (Malhotra, 2011). The criteria of RML Model validity and reliability instruments are shown in Table 2.

Table 2

Validity and Reliability of RML Model Criteria

Check	Scale statistics	Category	
Validity	Single measures interrater correlation coefficient-ICC ($r\alpha$)	$r_\alpha \leq$ r table	Invalid
		$r_\alpha >$ r table	Valid
Reliability	Cronbach's alpha/average measures interrater correlation coefficient-ICC (α)	$\alpha < .60$	Unreliable
		$.60 \leq \alpha \leq 1.00$	Reliable

The learning model was validated by experts and practitioners who had competence in the field of education. Feedback from validators was used as material for the improvement of the model syntax until a valid model syntax was obtained. Assessment of the validity of the RML Model and the learning devices used was conducted using four-point scales, i.e., much less valid = 1, less valid = 2, valid = 3, and very valid = 4. Obtained scores from the expert assessment of the product development were converted to qualitative data on a four-scale (Ratumanan & Laurens, 2011), with criteria as in Table 3.

Table 3

Validity Criteria of Model and Learning Devices Based on Average Validator Values

Score Range	Criteria
> 3.60	very valid
2.80 – 3.60	valid
1.90– 2.70	less valid
1.00– 1.80	much less valid

The average value of the validity and reliability of models and devices supporting the learning model was determined based on the value given by the validator. The reliability of the learning device was calculated using the percentage agreement equation by Emmer and Millett (in Borich, 1994), i.e., the instrument is said to be reliable if it has a percentage agreement of ≥ 75%, or a 75% average score from the validator team with valid category.

Effectiveness of the Reflective-Metacognitive Learning Model in Comparison with the Cognitive-Metacognitive Learning Model

This stage was intended to determine the effectiveness of the RML model in improving students' metacognitive ability (metacognitive knowledge, metacognitive skills, and metacognitive awareness) after the learning process, in comparison with the CML Model,. A randomized pretest-posttest control group design was used at the implementation stage of the RML Model and CML Model. Two groups were required in this method, namely the experimental and control groups. In the experimental group, the researcher gave a pretest, treatment by applying the RML Model, and then a posttest. Meanwhile in the control group, the researcher gave a pretest, followed by the treatment by applying the CML Model (Garofalo & Lester, 1989), and then a posttest. The following was the research design used.

The Randomized Pretest-Posttest Control Group Design			
Group	Pretest	Intervention	Posttest
A	*O1*	*X*	*O2*
B	*O3*	*C*	*O4*

Where,
A : experimental group
B : control group
O1 : pretest of experimental group
O2 : posttest of experimental group
O3 : pretest of control group
O4 : posttest of control group
X : treatment in experimental group using RML Model
C : treatment in control group using CML Model
(Fraenkel, Wallen, & Hyun, 2011)

Students' metacognitive ability data were collected using the following instruments:

(1) Metacognitive Knowledge Test. Data on students' metacognitive knowledge were collected using a ten-item essay test on acid and base materials provided before and after treatment. The metacognitive knowledge test contained three indicators of declarative knowledge, procedural knowledge, and conditional knowledge.

(2) Performance test. Student performance was measured using worksheets that were given in the first and the last lesson. The metacognitive skills indicators contained in the students' worksheet and measured in this study were: a. formulating the learning objectives, both general and specific (FLO); b. formulating problems and problem solving on hypotheses that were relevant to the formulated learning objectives (FPH); c. making a problem-solving plan to prove the hypothesis that had been proposed (PSP); d. implementing the plan systematically (IPS); e. monitoring the process (MP); f. evaluating the process (EP); f. collecting data (CD); h.

evaluating learning achievement in relation to the objectives at the beginning of learning activities (ELA).

(3) Metacognitive Awareness Inventory (MAI). Students' metacognitive awareness was measured using the MAI developed by Schraw and Dennison (1994), which was administered before and after treatment. The indicators contained in the MAI were: planning, information management, monitoring, debugging, evaluation, declarative knowledge, procedural knowledge, and conditional knowledge.

The scores obtained were analyzed and categorized into four criteria, as in Table 4.

Table 4

Students' Metacognitive Ability Criteria

Criteria	Score Range
Very Good	$80 \le P \le 100$
Good	$70 \le P \le 79$
Good Enough	$60 \le P \le 69$
Less Good	$P<60$

The RML Model's effectiveness in improving senior high school students' metacognitive ability was decided using the normalized gain score, namely: n-gain = (post-test score – pre-test score)/(maximum score – pre-test score) (Hake, 1999). According to the following criteria: (1) when n-gain > .70 (high); (2) when .30 < n-gain < .70 (moderate); and (3) when n-gain < .30 (low). Computation program software IBM SPSS Statistics 23 was used to test the impact of teaching using the RML Model toward the improvement of metacognitive ability in comparison with the CML Model. Furthermore, in order to analyze the differences in the RML Model's teaching impact toward metacognitive ability in comparison with the CML Model of the two groups, an independent sample t-test was used. The testing method should depend on the compatible results of the normality assumption and variant homogeneity tests of n-gain, where if the data was not normally distributed, it was further analyzed using non-parametric tests (Mann-Whitney test).

RESULTS

Validity of the Reflective-Metacognitive Learning Model

The RML Model validation instrument along with supporting devices were validated by three experts with a minimum qualification of a doctoral degree and expertise in chemistry (one expert) and learning (two experts). The validation results of the RML Model validity instruments and devices are presented in Table 5.

Table 5

Results of Validation of RML Model Validity Instrument and Devices

	Item	r_α	Category	Cronbach's alpha (α)	Category
1.	RML Model	.76	Valid	0.86	Reliable
2.	Syllabus	.72	Valid	0.84	Reliable
3.	Lesson Plan	.68	Valid	0.81	Reliable
4.	Module	.78	Valid	0.88	Reliable
5.	Worksheet	.72	Valid	0.83	Reliable
6.	Instruments	.87	Valid	0.93	Reliable

Based on the results of the validity and reliability tests in Table 5, it can be stated that the validation instruments were valid and reliable for assessing the quality of the RML Model and its devices. The RML Model is a learning model with reflective attribution in each learning stage to enable a conscious thinking process to increase students' metacognitive ability through four phases: (1) orientation reflection; (2) organizational reflection; (3) execution reflection; and (4) verification reflection. Its formulation was based on empirical and theoretical support that accommodated cognitive-metacognitive models (Garofalo & Lester, 1985) and problem-solving models (Yimer & Ellerton, 2009). Reflections at the end of each learning phase were achieved through various forms of activities, such as providing cognitive conflict phenomena, anomalous phenomena, internalization (through providing problems or concepts), and providing new phenomena that were still related to decision making. Reflection played an important role in teaching metacognition to students, and could also play a role in monitoring the knowledge processes that students engaged in. The results of metacognitive activities could be general, such as classifying information that was relevant to the problem at hand, or specific, such as finding specific solutions that fit the correct theory or concept to help students solve the problems at hand (Veenman, 2012). The activities and applications of each learning phase are presented in Table 6.

Table 6

The Reflective-Metacognitive Learning (RML) Model Phases

Learning Phases	Learning Activities	Applications in Learning Activities
Orientation Reflection	1. Provide learning objectives	• Deliver learning objectives generally.
	2. Information and condition analysis	• Ask students to read information from relevant learning resources.
	3. Assess familiarity with the task	• Ask students about the material they are studying.
	4. Assess the difficulty level of the problem and the opportunity to successfully solve the problem	• Present students with a common problem in learning activities.
	5. Reflection on orientation activities by providing cognitive conflict phenomena.	• Provide cognitive conflict phenomena to activate students' prior knowledge.
Organizational Reflection	1. Identify sub goals and ultimate goals	• Ask students to identify which sub-goals are the prerequisites that must be known first in order to achieve the ultimate/final goal.
	2. Make a general plan	• Establish general troubleshooting steps that have been identified in phase 1 orientation reflection, which is further downgraded to planning for sub-goals.
	3. Data organization	• Divide the students into groups. • Direct students in formulating hypotheses, defining operational variables in learning, determine the problem-solving steps to be used.

(continued)

Learning Phases	Learning Activities	Applications in Learning Activities
	4. Reflection	• Reflection on activities in the organizational reflection phase by presenting anomalous phenomena that enable students to organize activities in this phase.
Execution Reflection	1. Implement a particular plan	• Ask students to carry out problem-solving planning in accordance with the plan that has been formulated. • Ask students to carefully plan and pay attention to the suitability and relevance of each troubleshooting step. Careful planning demonstrates good knowledge evaluation skills.
	2. Monitor progress of particular and general plans implementation	• Assess performance of problem-solving implementation based on students' fluency and accuracy of problem-solving.
	3. Make/formulate decisions	• Ask students to formulate decisions by assessing the hypothesis, based on the results of data analysis and information obtained.
	4. Reflection	• Reflection through the internalization process by providing related phenomena to be solved according to the previous troubleshooting steps.
Verification Reflection	1. Final decision making	• Ask students to provide an explanation of the results of implementing their problem-solving plan. • Ask students to explain the relevance of the results of their problem-solving to the global goals they previously formulated.
	2. Reflection	• Provide new phenomena that are still related to solving the problem.

The difference in the cognitive process (reflection) flow in the RML Model compared to Yimer & Ellerton's (2009) problem-solving model is evident from Figure 4 below.

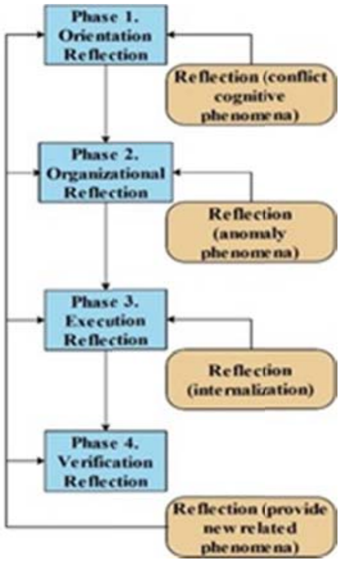

Figure 4. Cognitive Process Flow (Reflection) of the Reflective-Metacognitive Learning Model.

Validation of the RML model and supporting tools included two components, i.e., content validity and construct validity. Content validity included all components of the learning model and the tools that should be based on state-of-the-art knowledge. Components assessed for content validity were the development and design needs of the RML Model and devices based on current knowledge, which were generally categorized as highly valid. The results of this assessment were based on RML Model development objectives, i.e., to improve students' metacognitive skills as needed, according to 21stcentury competencies, major skill of graduates and the applicable school curriculum requirements.

The expert validators involved in this activity were competent experts in chemistry learning, who understood the 2013 curriculum (National Curriculum of Education in Indonesia) and were active in classroom learning activities as well as teacher training activities. Validators validated the model and its supporting devices by providing an objective assessment and giving a check mark (√) to each number corresponding to the given statement, using the following criteria: Invalid (score 1); Less Valid (score 2); Valid (score 3); Very Valid (score 4). The RML Model validation results, along with its devices, were found to be valid in both content and construct with strong reliability (see Table 7).

Table 7

Expert Validation of the RML Model

	Item	Content Validity		Construct Validity		Reliability
		Score	Category	Score	Category	
1.	RML Model	3.89	Very Valid	3.84	Very Valid	.94
2.	Syllabus	3.75	Very Valid	3.85	Very Valid	.96
3.	Lesson Plan	3.87	Very Valid	3.96	Very Valid	.97
4.	Module	3.81	Very Valid	3.88	Very Valid	.96
5.	Worksheet	3.83	Very Valid	3.84	Very Valid	.96
6.	Instruments	3.90	Very Valid	3.98	Very Valid	.98

The RML Model validation result was proven empirically during learning implementation, conducted over six meetings of the course (3.90), which was found at "very well" level. This criterion was observed from the percentage of the average mode of values in the "very good" category and its increase in each meeting. The result was in line with the students' responses towards the learning using the RML Model, which overall gave a very strong response at 86.43%.

Effectiveness of Reflective-Metacognitive Learning Model in Comparison with Cognitive-Metacognitive Learning Model

a. Metacognitive Knowledge

The achievement of metacognitive knowledge and n-gain was based on three indicators, i.e. declarative knowledge (DK), procedural knowledge (PK), and conditional knowledge (CK). Data on students' metacognitive knowledge were analyzed using the Kolmogorov-Smirnov test to determine the normality and Levene's test to determine the homogeneity of data variance obtained. These test results revealed that the students' metacognitive knowledge was normally distributed (Asymp Sig. 2-tailed: $0.20 > 0.05$), and homogeneous (Sig: 0.42 > 0.05), so an independent sample test (t-test) was used to analysis the improvement of students' metacognitive knowledge before and after learning.

Table 8.

Results of Pre-Test and Post-Test of Students' Metacognitive Knowledge

Group	N	Scores	Metacognitive Knowledge Indicators			Mean	SD	p
			DK	PK	CK			
		Pre-test	32.12	45.75	32.44	34.29		
Experiment	20	Post-test	89.66	82.8	86.89	84.42	4.06	.00
		n-gain	0.85	0.67	0.80			
		Pre-test	30.25	39.50	31.50	33.75		
Control	20	Post-test	82.38	68.13	70.00	73.50	5.49	.00
		n-gain	0.75	0.47	0.56			

Based on the results presented in Table 8, it can be seen that students' metacognitive knowledge increased after learning. The improvement was significant for both groups, but the improvement in the experimental group (taught using the RML Model) was better (mean = 84.42) than that in the control group (taught using CML Model) (mean = 73.50). To have good metacognitive knowledge, a student must be proficient in certain cognitive skills, namely declarative knowledge, procedural knowledge, and conditional knowledge which are the three kinds of knowledge involved in metacognition. Declarative knowledge is the knowledge about oneself as a learner and about factors affecting learning and memory, as well as the skills, strategies and resources needed to do a task (know what to do); procedural knowledge involves knowing how to use a certain strategy; and conditional knowledge involves knowing when and why to apply certain procedures and strategies (Bruning, Scrhraw, Norby, & Ronning, 2004, in Woolfolk, 2009). Metacognitive knowledge is thus the strategic application of declarative, procedural, and conditional knowledge to achieve goals and overcome problems (Schunk, in Woolfolk, 2009).

The RML Model wass more effective in improving students'metacognitive knowledge compared to the CML Model, as demonstrated by the results of the n-gain analysis (Table 8). We know that the n-gain of students' metacognition knowledge in the experimental group for each metacognitive knowledge indicator was better (DK: 0.85; PK: 0.67; CK: 0.80) than the n-gain of students' metacognition knowledge in the control group (DK: 0.75; PK: 0.47; CK: 0.56). The data showed that the scores obtained by students before and after learning using the RML Model were significantly different.

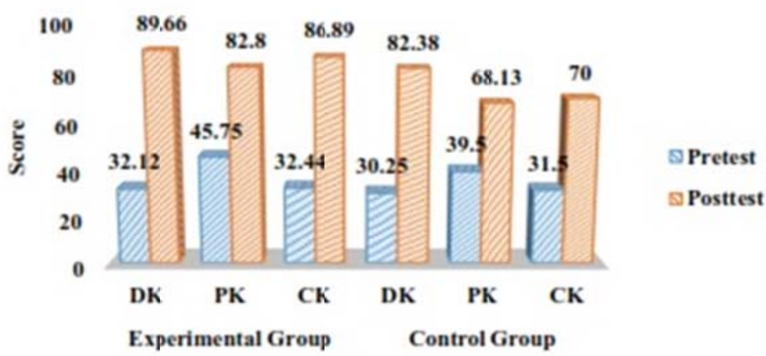

Figure 5. Students' Metacognitive Knowledge (Pre-Test and Post-Test).

Figure 5 shows that the most significant impact was seen in the DK (0.85) and CK (0.80) indicators in the experimental group, which was in the high category. Meanwhile, in the control group, the DK (0.75) indicator showed the most significant improvement. The RML Model was more effective in increasing students' metacognitive knowledge on all three indicators, which was likely to have been caused by the reflection activity in each phase of learning. The provision of cognitive conflict phenomena, anomalous phenomena, internalization (through providing problems or concepts), and new phenomena that are still related to decision-making as a form of learning reflection enabled students to review the purpose and analysis of the material in the readings presented and to understand more deeply the material used as initial knowledge to learn the next set of material. In line with this finding, Cowan (1998) states that students reflect on their knowledge once they realize existing differences between the knowledge they already have and the new knowledge they gain, such as in the presentation of contextual phenomena that are different from the phenomena students have experienced. Students also reflect on their thinking process when they identify problems and working out with what needs to be done to solve the problems (Ong, 2010). Providing cognitive conflict phenomena creates a state of imbalance in students' thinking, which can be used by teachers to encourage students' interest in solving problems (Mischel, 2007). Cognitive conflict phenomenon can promote the monitoring of knowledge in the thinking process and reflect students' initial knowledge (Thomas, 2012). Students' procedural knowledge showed a less significant increase although it was still in the "good" category for both classes. The results of the independent samples test also showed that the students' metacognitive knowledge was significantly different ($p=0.00$) between those in the experimental group and the control group, as presented in Table 9.

Table 9

Independent Samples T-Test of Students' Metacognitive Knowledge

Group	N	sig	t	df	p
Posttest of experimental and control groups	40	.77	6.06	38	.00

The RML Model and the learning devices developed, which accommodated the three components of metacognitive ability (metacognitive knowledge, metacognitive skills, and metacognitive awareness), is thus shown to be more effective at improving students' metacognitive knowledge than the CML Model ($p < .05$). According to McCormick (in Slavin, 2011) students can be taught a strategy of assessing their own understanding by finding out how much time it takes to learn something and choosing an effective action plan for learning or working on a problem. Oxford's (1990) classification of metacognitive strategies include centralizing student learning, arranging and planning lessons, and evaluating learning. Another metacognitive strategy is the ability to predict what might happen or mention something rational and irrational.

Teaching metacognitive strategies to students can produce a clear improvement in students' achievement (Alexander, Graham &

Harris; Hattie et al. in Slavin 2011). Students can learn to think through their own thinking processes and apply certain learning strategies to think themselves through difficult tasks (Butler & Winne; Pressley, Harris & Marks; Schunk in Slavin, 2011). The self-questioning strategy, which is a learning strategy that asks students to ask themselves about who, what, where and how students read the material (Slavin, 2011) is very effective (Zimmerman, in Slavin, 2011). Students can be taught these strategies by conditioning learning according to the criteria described previously.

Inquiry activities that integrate process skills, also carried out in the activities of the RML Model, are very effective in raising awareness of the strategies used and positively affect students' performance (Pressley, Borkowski, & Schneider, 1989; McCormick, 2003). Asy'ari, Ikhsan, and Muhali (2019) similarly found that an inquiry learning model was effective in increasing students' metacognitive knowledge and awareness. Crowley, Shrager, and Siegler (1997) describe the associative stages and metacognitive mechanisms in strategies that emphasize on the discovery process, which has an important role in students' procedural knowledge. Siegler and Jenkins (in Waters & Kunnmann, 2010) further explain that the discovery processes in learning can increase students' awareness of their knowledge and accelerate the information generalization process.

The RML Model, which emphasizes evaluative reflection activities using phenomena that are directly related to the students' social aspects, can be declared effective in increasing students' metacognitive knowledge. Moon (2004) argues that reflection is a key component of learning, while Fook (in Hickson, 2011) further argues that evaluative reflection emphasizes thinking about what has been done, and is elaborated upon based on the evaluation results to anticipate possible future problems. Further, Hoyrup (2004) suggests that evaluative reflection must be integrated with the social aspects, and can be measured at a time when one is able to understand and validate the assumptions formulated. The reflection process in the RML Model prevents students from repeating possible mistakes from the previous learning process. Likewise, Carroll et al. (2010) state that reflecting on processes that have been done in everyday activities is essential to avoid a lack of ideas and a repeat of mistakes in routine activities.

b. Metacognitive Skills

Students' metacognitive skills showed good improvement. The indicators of students' metacognitive skills measured in this study comprised the following: (1) formulating learning objectives, both general and specific (FLO); (2) formulating the problem and problem solving hypotheses relevant to the formulated learning objectives (FPH); (3) making a problem-solving plan to prove the hypothesis that has been proposed (PSP); (4) implementing planning systematically (IPS); (5) monitoring the processes (MP); (6) evaluating the process (EP); (7) collecting data (CD); and (8) evaluating learning achievement in relation to the objectives at the beginning of learning activity (ELA). Data on students' metacognitive skills were analyzed using the Kolmogorov-Smirnov test to determine normality and Levene's test to find out the homogeneity of variance obtained. These tests revealed that the students' metacognitive skill data were normally distributed ($p>.05$) but not homogenous ($p<.05$) for both the experimental group and the control group. Therefore, a paired t-test was used to examine the significance of students' metacognitive skills improvement before and after learning using the RML Model (experimental group) and CML Model (control group). The results of the paired t-test are presented in Table 10.

Table 10

Pre-Test and Post-Test Results on Students' Metacognitive Skills

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
		Pretest	43.75	19.87	.00	53.75	11.47	.00
FLO	20	Posttest	93.75			78.75		
		n-gain	0.90			0.50		
		Pretest	32.50	11.47	.00	47.50	9.16	.00
FPH	20	Posttest	82.50			76.25		
		n-gain	0.70			0.50		
		Pretest	46.25	15.12	.00	53.75	9.16	.00
PSP	20	Posttest	85.00			77.50		
		n-gain	0.70			0.50		

(continued)

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
		Pretest	55.00	15.17	.00	62.50	14.68	.00
IPS	20	Posttest	92.50			78.75		
		n-gain	0.80			0.40		
		Pretest	60.00	17.91	.00	60.00	16.42	.00
MP	20	Posttest	78.75			75.50		
		n-gain	0.50			0.40		
		Pretest	61.25	12.76	.00	61.25	13.08	.00
EP	20	Posttest	75.00			81.25		
		n-gain	0.40			0.50		
		Pretest	60.00	14.28	.00	60.00	16.77	.00
CD	20	Posttest	92.50			81.25		
		n-gain	0.80			0.50		
		Pre-test	51.25	12.76	.00	51.25	12.76	.00
ELA	20	Post-test	75.00			75.00		
		n-gain	0.50			0.50		

A Mann-Whitney U test was used to compare students' metacognitive skills between the two groups, as shown in Table 11. The findings revealed that the metacognitive skills of the students taught using the RML Model were better (mean rank: 27.32) than those taught using the CML Model (mean rank: 13.68). This difference was significant at p=0.00.

Table 11

Mann-Whitney U-Test of Students' Metacognitive Skills

Group	N	Mean Rank	p
Experimental	20	27.32	.00
Control	20	13.68	

The improvement in students' metacognitive skills in the experimental class cannot be separated from the integration of constructivist views, which in this study was realized by facilitating students' by providing worksheets as a guide for measuring/observing or experimenting and conducting discussions. Students were given the opportunity to interact with the material being learned through observations or practicum, discussions, and the chance to think about the results of these observations, practicum, and discussions. These activities were expected to develop the science processing skills to improve their understanding of the material or the concept being learned. The result also showed that the material contained in the students' worksheets was in keeping with the environmental context often encountered by the students, and with the material contained in both the syllabus and the lesson plan, such that these could provide genuine support for the achievement of basic competence and facilitate students' metacognitive awareness. The differences in the improvement of students' metacognitive skills, as shown in the pretest and posttest scores, are presented in Figure 6.

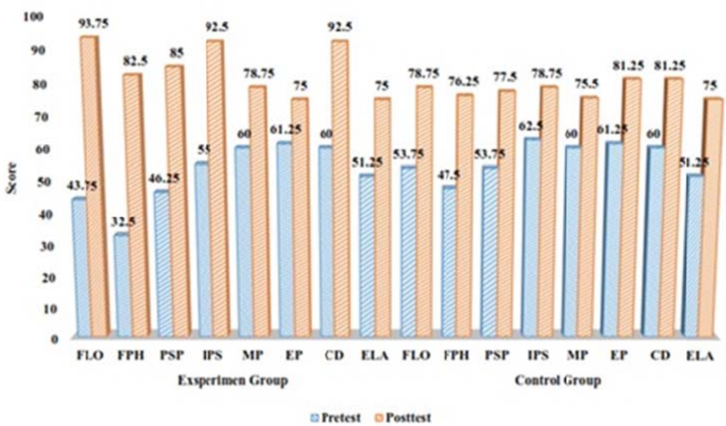

Figure 6. Students' Metacognitive Skills (Pretest and Posttest).

Students' metacognitive knowledge was directly proportional to students' metacognitive skills and activities, which were related to students' procedural knowledge. Indicator 6 (EP) to examine the planning process either individually or in groups (n-gain: 0.4) in the experimental group and indicator 4 (IPS) to plan systematically (n-gain: 0.40) in the control group, indicated a less significant improvement than other skills and activities, but this improvement was still categorized as good. The integration of contextual phenomena as reflections in the RML Model is an important attribute that played a role in improving students' metacognitive skills. Lee (2006) argues that a contextual approach is vital in learning, provided that the contextual problem has two qualities, i.e., to improve students' learning motivation so that they have positive responses to the learning and to provide a good understanding of the material being taught. Brum and McKane (1989) point out that learning science, including chemistry, cannot be separated from the ability to make observations, formulate testable hypotheses, induce and deduce, and design and execute experiments to test hypotheses. These activities were contained in the student worksheet so that students' metacognitive skills could be improved. Similarly, Nur (2011) views that student's learning activities should place more emphasis on scientific activities, such as formulating questions, hypothesizing, observation, analysis, and conclusion so that the material studied becomes more meaningful. The RML Model which emphasizes reflection processes in each phase has an important role in improving students' metacognition skills by accommodating scientific activities. This assertion is reinforced by Bennett, Power, Thomson, Mason and Bartleet (2016), who argue that reflection is an essential part of developing students' evaluative-reflective skills in the context of experiential-oriented learning.

c. Metacognitive Awareness

Metacognitive awareness is related to activities that help a person to control his or her mind and learning. The metacognitive awareness in this study included metacognitive knowledge and cognitive regulation, contained in the 52-item metacognitive awareness questionnaire developed by Schraw and Dennison (1994), which comprised eight aspects: (1) declarative knowledge (DK); (2) procedural knowledge (PK); (3) conditional knowledge (CK); (4) planning (P); (5) information management system (IMS); (6) monitoring (M); (7) debugging (D); and (8) evaluating (E). Students' metacognitive awareness indicators were found to be normally distributed and homogeneous. Hence, an independent samples t-test was used to investigate the difference in students' metacognitive awareness between the control group and the experimental group before and after the learning, as presented in Table 12 below.

Table 12

Pretest and Posttest Result on Students' Metacognitive Awareness

Variable	N	Score	Experimental Group				Control Group			
			Mean	sig	t	p	Mean	sig	t	p
		Pretest	55.75	.19	-5.89	.00	51.75	.65	-8.54	.00
DK	20	Posttest	72.25				68.75			
		n-gain	0.40				0.40			
		Pretest	54.50	.19	-6.96	.00	51.00	.08	-6.80	.00
PK	20	Posttest	67.00				63.50			
		n-gain	0.30				0.30			
		Pretest	50.63	.63	-7.50	.00	50.78	.89	-9.22	.00
CK	20	Posttest	69.53				65.47			
		n-gain	0.40				0.30			
		Pretest	54.10	.13	-5.70	.00	50.89	.15	-7.96	.00
P	20	Posttest	68.21				64.46			
		n-gain	0.30				0.30			
		Pretest	50.00	.19	-6.78	.00	50.55	.62	-6.67	.00
IMS	20	Posttest	68.19				63.19			
		n-gain	0.40				0.30			
		Pretest	49.64	.41	-7.61	.00	51.25	.26	-7.30	.00
M	20	Posttest	68.21				64.46			
		n-gain	0.40				0.30			
		Pretest	52.00	.59	-6.62	.00	50.75	.19	-6.48	.00
D	20	Posttest	70.50				64.50			
		n-gain	0.40				0.30			
		Pre-test	51.45	.48	-6.33	.00	50.20	.36	-8.81	.00
E	20	Posttest	70.00				64.99			
		n-gain	0.40				0.30			

Table 13 shows that the metacognitive awareness of students who were taught using the RML Model was better (mean rank = 26.05) than that of students who were taught using the CML Model (mean = 14.05), and that this difference was significant (p = .03).

Findings related to metacognitive knowledge and metacognitive skills confirmed those regarding students' metacognitive awareness. Figure 7 shows that students were still unaware of the procedural knowledge they had (PK; n-gain = 0.30), and that the results had an

Table 13

Mann-Whitney U-Test of Students' Metacognitive Awareness

Group	N	Mean Rank	p
Experiment	20	26.95	.03
Control	20	14.05	

effect on the students' belief in their planning (P; n-gain = 0.30). It implies that the process of monitoring or examining the processes was performed well but not maximally (M; n-gain = 0.30). These results occurred in the experimental class (taught using the RML Model) as well as in the control class (taught using CML Model), but generally the students' metacognitive awareness was categorized as good.

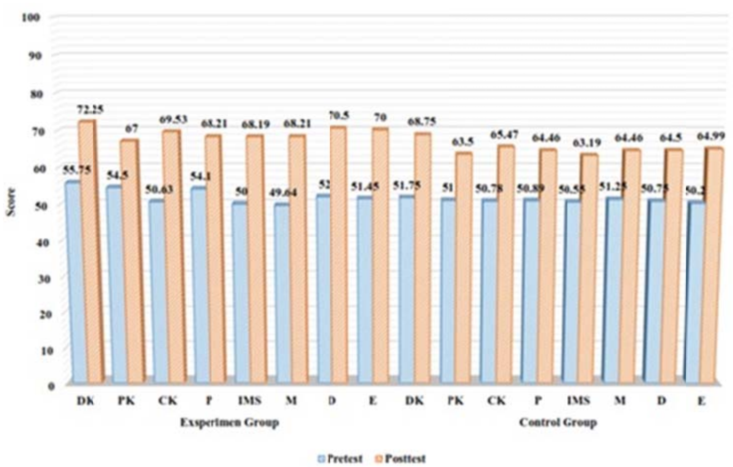

Figure 7. Students' metacognitive awareness (pretest and posttest)

The learning activities from the beginning to the end emphasized on training and cultivating students' metacognitive knowledge and skills. Yusnaeni, Corebima, Susilo and Zubaidah (2018) point out that the implementation of metacognitive strategies related to awareness can improve students' thinking skills. This was illustrated in the model phases, applied to the learning devices. The impact of learning using the RML Model was seen in students' attitude toward the science information possessed. Such attitudes can be monitored, according to Flavell (1979), through actions and interactions between four components, namely metacognitive knowledge, metacognitive experiences, objectives (or tasks), and actions (or strategy). Metacognitive knowledge is used to regulate thought and learning (Brown, 1987; Nelson, 1996 in Woolfolk, 2009). Essential skills for metacognition include planning, monitoring, and evaluating (Woolfolk, 2009). Planning includes the students' ability to determine the time needed to perform a task, the strategy to use, how to begin, the resources needed, the sequence followed, what needs attention, and so on. Monitoring is a real-time awareness about "how students work". These criteria were encompassed within the entire learning process so that metacognitive awareness would be increased after learning using the RML Model.

The RML model, which emphasized evaluative reflection activities using phenomena that are directly related to students' social aspects, can be declared as effective for improving students' metacognitive skills. Fauzi and Hussain (2016) state that the more closely the learning is related to the social context, the more reflective students are in learning, and that the emphasis on the reflection processes in each phase has an important role in improving students' skills by accommodating scientific activities. Bennett et al. (2016) stress that it is essential to develop evaluative reflections in the context of learning oriented to scientific experimental activities. Reflection in learning is not only important in learning chemistry, but also in learning science in general, as it can help teachers to identify the level of regulation of cognition possessed by students. Flavell and Brown (in Herscovitz, et al., 2012) define metacognition as a person's awareness and reflection on the process of self-cognition, which involves self-regulation and coordination of conscious learning tasks. Veenman (2012) further explains that reflection can be used to obtain a student's self-instruction production system. Good science learning should always pay attention to the students' psychological aspects in the learning process, in terms of both cognitive development and social psychology. The four phases of the RML model, i.e., (1) orientation reflection, (2) organizational reflection, (3) execution reflection, and (4) verification reflection, which were developed based on consideration of the above mentioned psychological aspects, offer a very feasible alternative solution in chemistry learning in particular, and learning science in general, with reflection activities forming a central element in every phase of learning. They are consistent with Dewey's argument that important attitudes in reflection, namely open thinking, enthusiasm and responsibility, can bridge the three components of metacognition to be taught to students (Loughran, 2005). At the same time, they also address social aspects that are expected to be developed in all science teaching at every level of education (Education Ministry of Indonesia, 2012).

CONCLUSION

The results and discussion can be summed up as follows: (1) The Reflective-Metacognitive Learning (RML) Model is a learning model to facilitate students' metacognitive ability development. It comprises four phases, namely orientation reflection, organizational reflection, execution reflection, and verification reflection. Each phase of learning is characterized by reflection activities, providing cognitive conflict phenomena in the first phase, anomalous phenomena in the second phase, internalization process in the third phase, and new phenomena that are still related to the learning material in the fourth phase. (2) The RML Model was found to be highly valid in terms of both content and construct validity. (3) For the experimental group (taught using the RML model), metacognitive knowledge showed a high increase, while metacognitive skills and awareness showed a medium increase. For the control group (taught using CML Model), metacognition knowledge, skills, awareness showed a medium increase. Statistical analysis indicated that there was improvement in students' metacognitive ability in both groups, but the metacognitive knowledge, skills and awareness of the group taught using the RML model were significantly better. Thus, it can be concluded that the RML Model is valid and more effective than the CML model in increasing students' metacognitive ability.

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REFERENCES

Abdullah, M. N. L. Y. (2016). Interaction effects of gender and motivational beliefs on self-regulated learning: A study at ICT integrated schools. *Malaysian Journal of Learning and Instruction, 13*(1), 25-41.

Alexander, P. A., Schallert, D. I., & Hare, V. C. (1991). Coming to terms. How researchers in learning and literacy talk about knowledge. *Review of Educational Research, 61,* 315-343.

Anderson, J. R. (1996). *The architecture of cognition.* Mahwah, NJ: Erlbaum.

Anderson, J. R., Fincham, J. M., & Douglass, S. (1997). The role of examples and rules in the acquisition of a cognitive skill. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 932–945.

Anderson, L.W., & Krathwohl, D. R. (2010). *Kerangka landasan untuk pembelajaran, pengajaran dan asesmen (Revisi Taksonomi Pendidikan Bloom)* (A. Prihanto,Trans.). Yogyakarta: Pustaka Pelajar.

Asy'ari, M. (2016). Identifikasi kemampuan metakognisi mahasiswa calon guru olahraga dan korelasinya dengan hasil belajar mata kuliah ilmu alamiah dasar. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, *4*(1), 42-46.

Asy'ari, M., Ikhsan, M., & Muhali. (2019). The effectiveness of inquiry learning model in improving prospective teachers' metacognition knowledge and metacognition awareness. *International Journal of Instruction*, *12*(2), 455-470. hdoi:10.29333/iji.2019.12229a

Asy'ari, M., Prayogi, S., Samsuri, T., & Muhali. (2016). Kajian literatur tentang berpikir kritis, berpikir kreatif, dan metakognisi dalam pembelajaran. *Prosiding Seminar Nasional PKPSM*. 12 Maret 2016. Mataram, Indonesia, 292-298.

Bennett, D., Power, A., Thomson, C., Mason, B., & Bartleet, B.-L. (2016). Reflection for learning, learning for reflection: Developing Indigenous competencies in higher education. *Journal of University Teaching & Learning Practice*, *13*(2), 1-19.

Borg, W. R., & Gall, M. D. (1983). *Educational research: An Introduction* (4th ed). White Plains, NY: Longman.

Borich, G. D. (1994). *Observation skill for effective teaching*. New York: Macmillan.

Borich, G. D. (2000). *Effective teaching methods*. New Jersey: Pearson Education.

Brum, G. D., & McKane, L. (1989). *Study guide biology: Exploring life*. New York: John Wiley & Sons.

Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination, and the fires within: Design thinking in a middle school classroom. *International Journal of Art and Design Education*, *29*(1), 37-52.

Conley, L., van der Merwe, M. , Robinson , M., Petersen, N., Osman, R., November, I., Dunbar-Krige, H. (2010). *Becoming a teacher*. London: Heinemann.

Crowley, K., Shrager, J., & Siegler, R. S. (1997). Strategy discovery as a competitive negotiation between metacognitive and associative mechanisms. *Developmental Review*, *17*, 462–489.

du Toit, S., & Kotze, D. (2009). Metacognitive strategies in the teaching and learning of mathematics. *Pythagoras*, *70,* 57-67.

Fauzi, S. S. M., & Hussain, R. M. R. (2016). Designing instruction for active and reflective learners in the flipped classroom. *Malaysian Journal of Learning and Instruction, 13*(2), 147-173.

Fernandez, M. L., Hadaway, N. & Wilson, J. W. (1994). Problem solving: Managing it all. *The Mathematics Teacher*, *87*(3), 195 - 199.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906-911.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to design and evaluate research in education.* Boston: McGraw-Hill Higher Education.

Garofalo, J., & Lester, F. K. (1985). Metacognition, cognitive monitoring, and mathematical performance. *Journal for Research in Mathematics Education*, *16*, 163–176.

Hake, R. R. (1999). *Analyzing change/gain score*. Retreived from: http://www.physics.indiana.edu/sdi/analizingchange-gain.pdf._

Herscovitz, O., Kaberman, Z., Saar, L., & Dori, Y. J. (2012). The Relationship between metacognition and the ability to pose questions in chemical education. In A. Zohar & Y. J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*, 165-195. New York: Springer.

Hoyrup, S. (2004). Reflective as a core process in organisational learning. *Journal of Workplace Learning*, *16*(7/8), 442-454.

Ibrahim, M. (2010). *Dasar-dasar proses belajar mengajar*. Surabaya: Unesa University Press.

Jacobs, J., & Paris, S. (1987). Children's metacognition about reading. Issues in definition, measurement, and instruction. *Educational Psychologist*, *22*, 255-278. doi:10.1207/s15326985ep2203&4_4

Kaberman, Z., & Dori, Y. J. (2008). Metacognition in chemical education: Question posing in the case-based computerized learning environment. *Instructional Science, 37*(5), 403-436. doi: 10.1007/s11251-008-9054-9

Education Ministry of Indonesia (2012). *Dokumen Kurikulum 2013*. Jakarta: Kementrian Pendidikan dan Kebudayaan.

Kluwe, R. H. (1987). Executive decisions and regulation of problem solving behavior. In F. E. Weinert, & R. H. Kluwe (Eds.), *Metacognition, motivation, and understanding*, 31-64. New Jersey: Lawrence Erlbaum.

Kroll, D. L. (1988). *Cooperative problem solving and metacognition: A case study of three pairs of women* (Unpublished doctoral dissertation). Indiana University, USA.

Lai. E. R. (2011). Metacognition: A literature review. Pearson Research Reports. Retrieved from https://images.pearsonassessments.com/images/tmrs/Metacognition_Literature_Review_Final.pdf

Lee, M. (2006). *What does constructivism suggest for science education* (Issue paper). California State University, Northridge, USA. Retrieved from http://www.csun.edu/~ml727939/documents/other%20materials/Issue%20paper.doc

Louca, E. P. (2008). *Metacognition and theory of mind*. Cambridge Scholars Publishing.

Loughran, J. (2005). Researching teaching about teaching: Self-study of teacher education practices. *Studying Teacher Education*, *1*(1), 5-16.

Malhotra, N. K. (2011). *Review of marketing research: Special issue-marketing legends. Review of Marketing Research, 8*, 269-315. doi:10.1108/S1548-6435(2011)0000008012

Marzano, R. J., Brandt, R. S., Hughes, C. S., Jones, B. F., Presseisen, B. Z., Rankin, S. C., & Suthor, C. (1988). *Dimensions of thinking & framework for curriculum and instruction*. Alexandria, VA: Association for Supervision and Curriculum Development.

McCormick, C. B. (2003). Metacognition and learning. In W. M. Reynolds & G. E. Miller (Eds.), *Handbook of psychology*: *Educational Psychology*, 79–102. Hoboken: Wiley.

Meijer, J., Veenman, M. P. J., & van Hout-Wolters, B. H. A. M. (2006). Metacognitive activities in text-studying and problem-solving: Development of a taxonomy. *Educational Research and Evaluation, 12*(3), 209 – 237.

Moon, J. A. (2004). *A handbook of reflective and experimental learning: Theory and practice*. London: Routledge Falmer.

Muhali. (2013). Analisis kemampuan metakognisi siswa pada mata pelajaran kimia SMA. *Jurnal Kependidikan Kimia Hydrogen*, *1*(1), 1-7.

NCES (National Center for Education Statistics). (2013). *Highlights from TIMSS 2011 Mathematics and Science Achievement of U.S. Fourth-and Eighth-Grade Students in an International Context*. Retrieved from https://nces.ed.gov/pubs2013/2013009_1.pdf.

Nelson, T. O. (1996). Consciousness and metacognition. *American Psychologist*, *51*, 102–116.

Nieveen, N. (1999). Prototyping to reach product quality. In J. van den Akker, R. M. Branch, K. Gustafson, N. Nieveen & T. Plomp (Eds.), *Design approaches and tools in education and training*, 125-135. Dordrecht: Springer.

Nur, M. (2011). *Modul Keterampilan-keterampilan proses dan hakikat Sains*. Surabaya: PSMS Unesa.

OECD (Organisation for Economic Co-operation and Development). (2013). Country note – Results from PISA 2012. Retrieved from: https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf

OECD (Organisation for Economic Co-operation and Development). (2016). Country note – Results from PISA 2015. Retrieved from https://www.oecd.org/pisa/PISA-2015-Indonesia.pdf

Oxford, R. L. (1990). *Language Learning Strategies*. USA: Oxford.

Pantiwati, Y., & Husamah (2017). Self and peer assessments in active learning model to increase metacognitive awareness and cognitive abilities. *International Journal of Instruction*, *10*(4),185-202.

Pintrich, P. R., Wolters, C., & Baxter, G. (2000). Assessing metacognition and self-regulated learning. In G. Schraw & J. Impara (Eds.), *Issues in theme measurement of metacognition* (pp. 43-97). Lincoln, NE: Buros Institute of Mental Measurements.

Polya, G. (1957). *How to solve it*. Princeton, NJ: Lawrence Erlbaum.

Pressley, M., & Harris, K. R. (2006). Cognitive strategy instruction: From basic research to classroom instruction. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology* (2nd ed.), 265–286. San Diego: Academic.

Pressley, M., Borkowski, J. G., & Schneider, W. (1989). Good information processing: What it is and how education can promote it. *International Journal of Educational Research*, *13*, 866–878.

Pugalee, D. K. (2004). A comparison of verbal and written descriptions of students' problem solving processes. *In Educational Studies in Mathematics, 55,* 27-47. New York: Kluwer Academic Publishers.

Ratminingsih, N. M., Artini, L. P., & Padmadewi, N. N. (2017). Incorporating self and peer assessment in reflective teaching practices. *International Journal of Instruction*, *10*(4), 165-184.

Ratumanan, T. G., & Laurens, T. (2011). *Evaluasi hasil belajar pada tingkat satuan pendidikan (Edisi 2)*. Surabaya: Unesa University Press.

Schoenfeld, A. H. (1985). *Mathematical problem solving*. San Diego: Academic Press Inc.

Schraw, G. & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review*, 7(4), 351-371.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, *36*, 111-139.

Schraw, G., Olafson, L., Weibel, M., & Sewing, D. (2012). Metacognitive knowledge and field-based science learning in an outdoor environmental education program. In A. Zohar & Y.J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*, 57-77. New York: Springer.

Sellars, M. (2012). Teachers and change: The role of reflective practice. *Procedia - Social and Behavioral Sciences*, *55*, 461 – 469.

Slavin, R. E. (2011). Instruction based on cooperative learning. In R. E. Mayer & P. A. Alexander (Eds.), *Handbook of research on learning and instruction*, 344-360. New York: Taylor & Francis.

Slavin, R. E. (2009). *Educational psychology*. Tokyo: Pearson Education, Inc.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.

Thomas, G. P. (2012). Metacognition in science education: Past, present and future considerations. *Second International Handbook of Science Education,1*(2), 131-144.

Veenman, M. V. J., van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning, 1,* 3-14.

Veenman, M. V. J. (2012). Metacognition in science education: Definitions constituents, and their intricate relation with cognition. In A. Zohar & Y. J. Dori (Eds.), *Metacognition in Science Education, Trends in Current Research, Contemporary Trends and Issues in Science Education*, 21-36. New York: Springer.

Webb, A., & Moallem, M. (2016). Feedback and feed-forward for promoting problem-based learning in online learning environments. *Malaysian Journal of Learning and Instruction, 13*(2), 1-42.

Williams, J. P., & Atkins, J. G. (2009). The role of metacognition in teaching reading comprehension to primary students. In D. J. Hacker, J. Dunlosky & A. C. Graesser (Eds.), *Handbook of Metacognition in Education,* 26-41. New York: Routledge.

Wilson, N. S., & Bai, H. (2010). The relationships and impact of teachers' metacognitive knowledge and pedagogical understandings of metacognition. *Metacognition and Learning*, *5*(3), 269-288. doi:10.1007/s11409-010-9062-4

Woolfolk, A. (2009). *Educational Psychology. Part 2.* (10th ed.) Yogyakarta: Pustaka Pelajar.

Ya-Hui, W. (2012). A study on metacognition of college teachers. *The Journal of Human Resource and Adult Learning, 8*(1), 84-9.

Yimer, A., & Ellerton, N. F. (2009). A five-phase model for mathematical problem solving: Identifying synergies in pre-service teachers' metacognitive and cognitive actions. *ZDM Mathematics Education, 42*, 245–261.

Yusnaeni., Corebima, A. D., Susilo, H., & Zubaidah, S. (2017). Creative thinking of low academic student undergoing search solve create and share learning integrated with metacognitive strategy. *International Journal of Instruction*, *10*(2), 245-262.