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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.

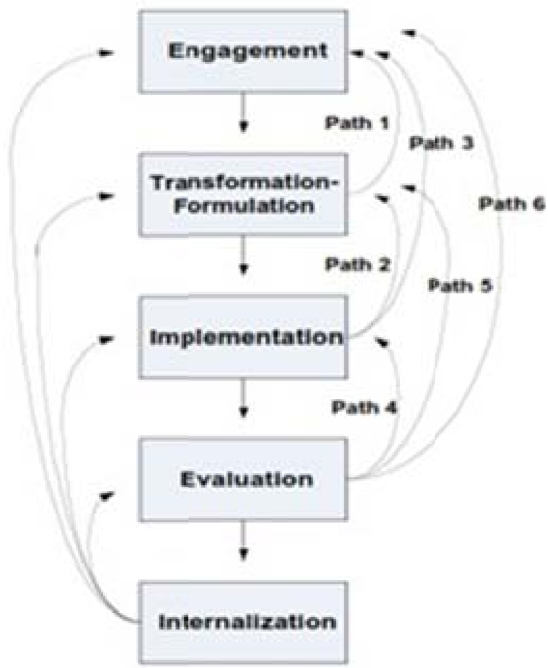

Figure 1. Cognitive Process Flow (Reflection) Problem Solving Model (Yimer & Ellerton, 2009).

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.

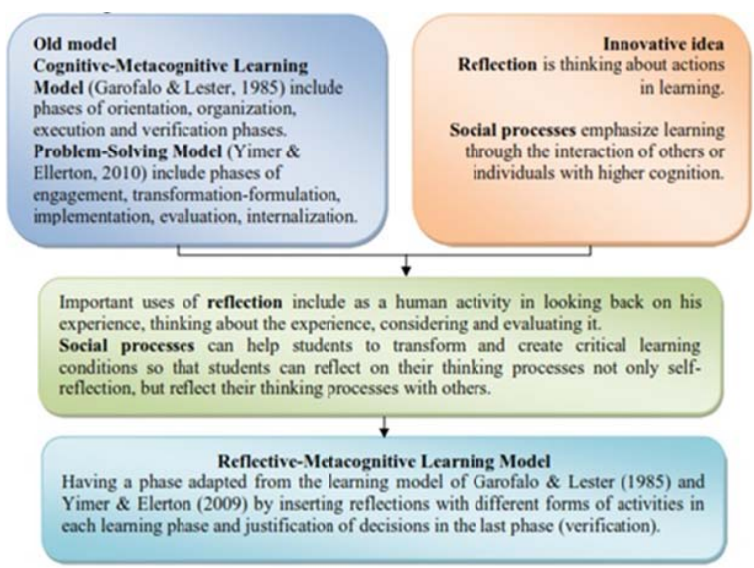

Figure 2. The Idea for Developing a Reflective-Metacognitive Learning Model.

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 situa-tions) B. Conjecturing or hypothesizing (based on specific observations and prior experience) C. Reflection on alleged or exploration feasibility D. Formulation of plans (design strate-gies 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 plan-ning, monitor the progress of general and particular plans, and as-sess 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

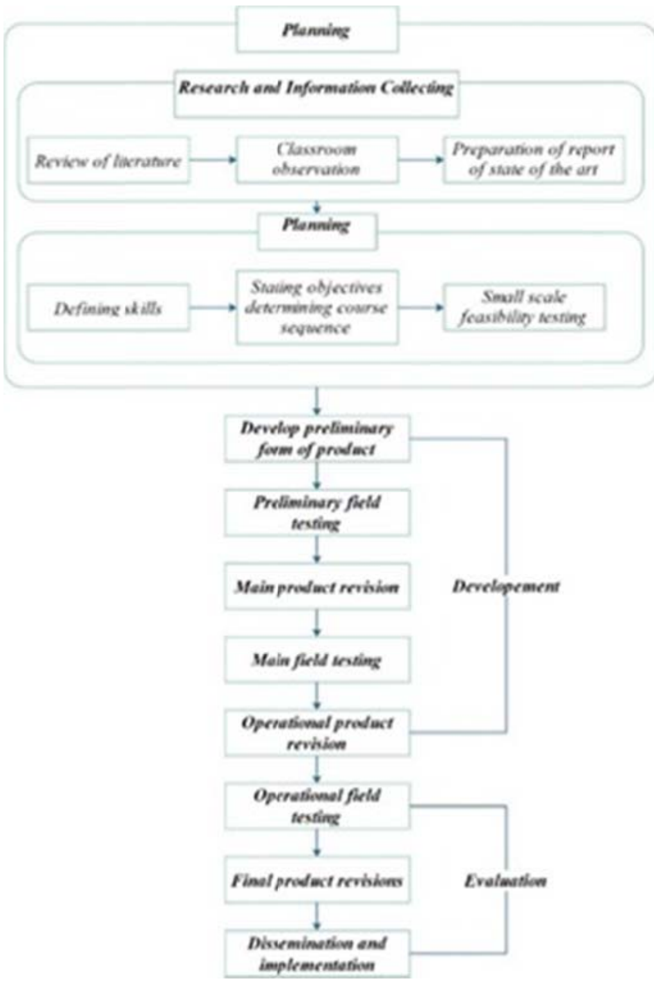

Figure 3. Borg and Gall's (1983) Development Research Flow.

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	$80 \leq P \leq 100$
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' 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.

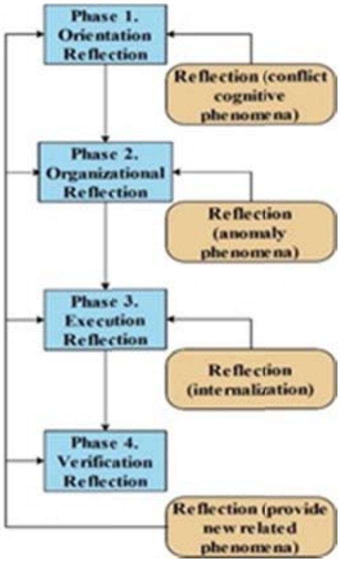

Figure 4. Cognitive Process Flow (Reflection) of the Reflective-Metacognitive Learning Model.

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			
Experiment	20	Pre-test	32.12	45.75	32.44	34.29	4.06	.00
		Post-test	89.66	82.8	86.89	84.42		
		n-gain	0.85	0.67	0.80			
Control	20	Pre-test	30.25	39.50	31.50	33.75	5.49	.00
		Post-test	82.38	68.13	70.00	73.50		
		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.

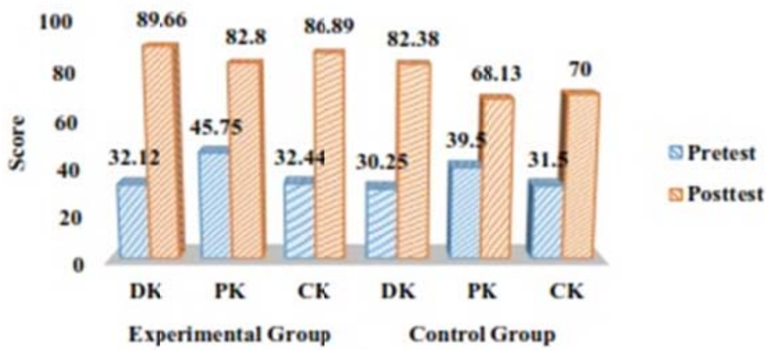

Figure 5. Students' Metacognitive Knowledge (Pre-Test and Post-Test).

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
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		

(continued)

Variable Pair	N	Score	Experimental Group			Control Group		
			Mean	SD	p	Mean	SD	p
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' 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.

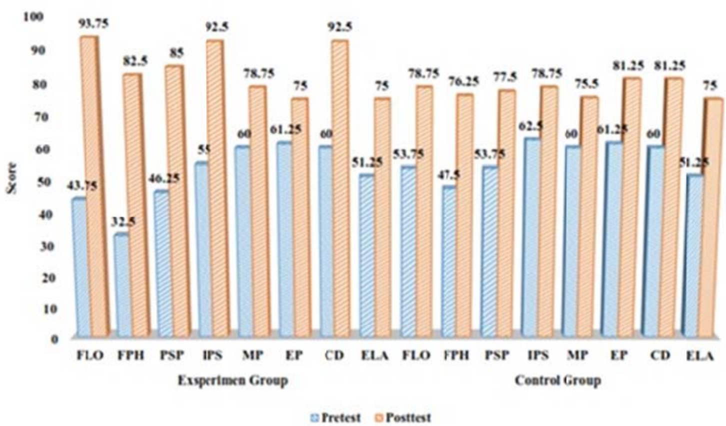

Figure 6. Students' Metacognitive Skills (Pretest and Posttest).

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.

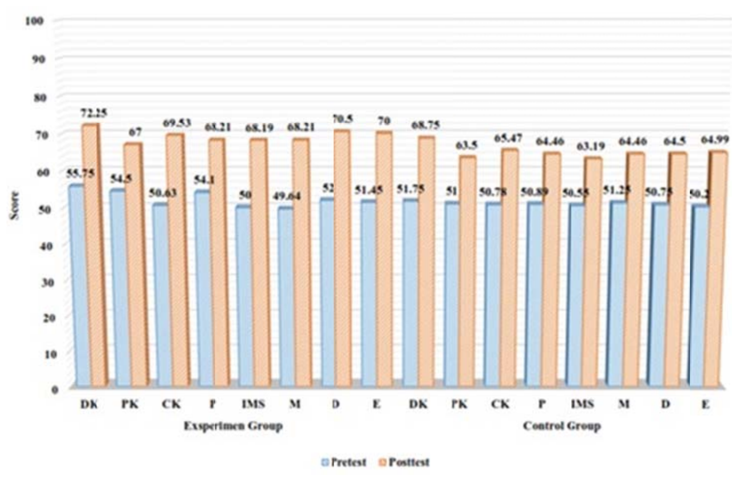

Figure 7. Students' metacognitive awareness (pretest and posttest)

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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