IEJME
OPEN ACCESS

INTERNATIONAL ELECTRONIC JOURNAL OF MATHEMATICS EDUCATION
e-ISSN: 1306-3030. 2020, Vol. 15, No. 1, em0555
https://doi.org/10.29333/iejme/5937

Metacognitive Learning Strategies in Mathematics Classroom Intervention: A Review of Implementation and Operational Design Aspect

Mohamad Ariffin Abu Bakar [1*], Norulhuda Ismail [1]

[1] *School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, MALAYSIA*

* CORRESPONDENCE: ✉ mohamadariffin6299@gmail.com

ABSTRACT

Mathematical learning is to produce a high competence individual with multiple skills in line with the needs of the 21st century. However, mathematical education is still plagued with problem of mastery of mathematical concepts. In addressing this problem, various initiatives and interventions need to be implemented to ensure that mathematical mastery is at the normal and best level. Metacognitive Learning Strategies (MLS) can be used as interventions to tackle weak issues of mastery. The strength of MLS is based on the efficiency of teachers and students managing their teaching and learning. MLS can also produce students who have good thinking skills, good self-esteem, and positive tendencies. However, to ensure that the implementation of this strategy is consistent, it should be designed and constructed to be based on the appropriate Instructional Designed (ID) model. The model is a rubric description that has more specific steps designed to coincide with the operation of MLS. This review aims to study the impact of MLS and discuss the aspects in the operation of MLS approach as an intervention. Papers that were published between 2013 and 2019, focused on an intervention aimed at improving mastery of students were identified and assessed, thirteen such interventions met inclusion criteria and analyzed. These studies addressed that MLS had a great impact on the students' mastery and the ID's steps was applied even though it was not clearly stated. Therefore, in forming innovative approaches and interventions requires an appropriate model of instructional design and selecting a learning approach that enhances student competence.

Keywords: metacognition, metacognitive learning strategies, instructional design, mathematics intervention, operational design

INTRODUCTION

In the 21st century, educators used various methods and also created new approaches to transforming learning capabilities in developing students' competencies in line with the aspirations for development and job requirements. The approach seen to develop individual potential and competence is the Metacognitive Learning Strategy (MLS) (Cera, Mancini & Antionetti, 2013; Hasbullah, 2015; Schraw & Moshman, 1995). Previous studies have proven and reported that MLS was significant and influenced the effectiveness of mathematical learning (Acar & Ader, 2017; Adnan & Arsad Bahri, 2018; Amin & Sukestiyarno, 2015; Daher, Anabousy & Jabarin, 2018; Du Toit & Du Toit, 2013; Suriah, Inprasitha & Sangaroon, 2013). Mastery of student mathematics through MLS is greater than conventional methods (Amin & Sukestiyarno, 2015; Habullah, 2015; Suriyon, Inprasitha & Sangaroon, 2013). Therefore, in order to address the issues and

Article History: Received 15 June 2019 ◆ Revised 1 July 2019 ◆ Accepted 10 July 2019

problems of low level of student's mastery in mathematics, as the suggestion is through applying MLS as a contingency. The importance of learning through MLS has become the latest trend and has become an innovation in instructional design to create active learning. Metacognitive according to Schraw and Moshman (1995) is an individual's ability to manage, monitor and take action on organized thinking and in the correct order. MLS is a strategy that employs students naturally, actively and constantly observing metacognitive skills and behaviors, knows how to learn effectively, be sensitive to strengths and weaknesses, and is efficient in planning, monitoring and evaluating current learning.

The learning situation is clearly different from conventional learning where students actively engage in construct their knowledge through planning, monitoring, and evaluation of self-learning during learning activities (Smith, 2013; Smith & Mancy, 2018). The activities are referred to as MLS will encourage students to discover, discuss, think, compare, predict and even guide other students. Cooperation, relationship between students and interaction with learning materials is the success key of MLS and this is also a learning approach that refers to the Vygotsky Social Development Theory (Vygotsky, 1978). Many researchers have highlighted MLS's advantages by showing them improving academic performance, promoting various skills such as communication skills, collaborative skills, mathematical problem-solving skills, and also improving critical thinking skills (Daher, Anabousy, & Jabarin, 2018; Smith & Mancy, 2018). In addition, MLS can provide satisfaction and learning experiences as well as to encourage self-motivation during learning (Cera, Mancini & Antionetti, 2013). According to Smith and Mancy (2018) and Karnain et al (2014), their effectiveness can be seen during learning activities when students are very excited and cooperate in planning ideas, discussing and challenging their ideas with peers, in the sense of monitoring understanding and working together towards finding solutions to specific problems and tasks. MLS has provided space for students to improve their academic performance with collaborative activity as a catalyst for enhancing metacognitive skills.

In mathematical learning using metacognitive learning strategies, according to Panaoura, Gagatsis, and Demetriou (2009) there are six things to emphasize:

1. Understand phenomena in research (learning), relationship activity, a situation with the learning environment
2. Construct the aspects of activities, relationships and circumstances with learning situations
3. Doing activity based on rules or method to get learning result (objective)
4. Interpret the work systematically to achieve problem-solving in the actual situation exposed in the activity
5. Evaluate the activity by examining whether the mathematical results obtained, are appropriate and reasonable in the real problem
6. Connect with real problem solving

However, in order to produce Instructional Design (ID) which is a truly effective teaching intervention and more systematic operation, it requires a specific model that is appropriate. ID is a unique and systematic set of frameworks (Sebastian, Herman, & Reinke, 2019). To get the final result that achieves the teaching objectives, the implementation of a teaching and learning strategy should meet the recognized IDs (Nadiyah & Faaizah, 2015). If the development of a method is correct and with the existing ID, it can also be adopted as an innovation in teaching and learning approaches. Model of ASSURE, ADDIE, ARCS, Dick and Carey, Hannafin-Peck and many more is the best design and development models to produce teaching and learning interventions as a result of the complete, more specific and structured steps. Because of the metacognitive learning strategy is an operational strategy, so it is appropriate for its design and development based on those models. In designing and implementing MLS, practitioners should not ignore ID operating steps.

The ID model is an analytic rubric for a wider range of use, as mediation of various types of teaching and learning designs. According to Lohr (1998) as cited in (Ozdilek & Robeck, 2009), in general, the aspects of models is analysis of needs, design and development, implementation and evaluation each have specialization. In short, based on Branch (2009) the steps or phases of the model are as follows. The Analysis phase involves a survey and also forms an investigation into the students, to the content, and the purpose of the assignment. The Design phase discusses how to build teaching goals and learning objectives so as to present some strategies. At the Development phase will be emphasized the question of the materials, tools and processes to be used. The purpose of the Implementation phase is to operate material, learning and teaching activities and to see how it is programmed. The Evaluation phase will certainly assess formative and summative the usefulness, suitability and effectiveness of development. Therefore, by using these ID steps, educators should be more committed and dynamic to produce innovative learning approaches that will be based on the application of learning strategies that can enhance the student's competence level likes MLS.

Table 1. Analysis of operational aspect of MLS and the impact on learning

Author(s)	Objective(s)	Operational Aspect	Impact on Learning
Cera,Mancini & Antonietti (2013) **Relationship Between Metacognition, Self-Efficacy And Self-Regulation In Learning.** ***ECPS-Journal 7/2013***	To Study the relationship between metacognition, self-efficacy and self-regulation in learning	1. Analyse student needs 2. Develop with aims and goals 3. Implement while suitable	1. The ability of students to monitor their own learning process 2. Can improve sensitivity to feedback content 3. Higher skill to choose strategies 4. May identify relevant information as necessary 5. Students can manage time more effectively 6. Self-assessment by linking the previous knowledge to the learning process 7. Can connect existing knowledge with new ones
Petra Menz and Cindy Xin (2016) **Making Students' Metacognitive Knowledge Visible through Reflective Writing in a Mathematics-for-Teachers Course.** ***Collected Essays on Learning and Teaching*****, Vol. IX**	To describes the rationale, implementation and assessment of a weekly online reflection activity based on instructor prompts designed for post-secondary students who aspire to be elementary school teachers.	Using Learning Management System (LMS) 1. Apply analysis-get student's respond about previous knowledge and learning goal 2. Design and development based on metacognitive strategies 3. Implement in 12 week 4. Self-evaluation in the end of prompts using the students note	1. Help students to form a new habit of thinking 2. Can successfully implement metacognitive knowledge for the learning of mathematics, such as planning learning tasks, monitoring comprehension, evaluating progress, accessing self-possessed knowledge, and dealing with the feelings of the self specifically during mathematical learning.
Tony Karnain, Md Nor Bakar, Seyed Yaser Mousavi Siamakani, Hossein Mohammadikia & Muhammad Candra (2014) **Exploring the Metacognitive Skills of Secondary School Students' Use During Problem Posing.** ***Jurnal Teknologi (Social Sciences)*** **67:1 (2014), 27–32**	To explore students' use of metacognitive skills during problem posing activities.	1. Analysis of students problems while mathematics learning 2. Apply Problems Solving Activities according to Problem Based-Learning procedure 3. Evaluate learning situation and students note	1. Planning revealed the following metacognitive skills: making sense of the task, extracting the given information, being aware of the goal, seeking any examples used in the past, and mapping a solution. 2. Three types of metacognitive monitoring emerged the thinking aloud protocol transcripts: screening, and justification and a little revision. 3. Two levels of evaluation: intuition and reason
Julie M. Smith & Rebecca Mancy (2018) **Exploring The Relationship Between Metacognitive And Collaborative Talk During Group Mathematical Problem-Solving – What Do We Mean By Collaborative Metacognition?.** ***Journal of Research in Mathematics Education*****, 20:1, 14-36**	To enhance our understanding of the relationship between collaborative talk and metacognitive talk during group mathematical problem solving	1. Analysis of learning problems 2. Apply problem solving activities 3. Implement in 15 week 4. Observe on students behaviour	1. To identify the metacognitive content of student interactions 2. Metacognitive talk-discussion include of planning, monitoring and evaluating about the problem or about the problem-solving process
Mary Jarratt Smith (2013) **An Exploration Of Metacognition And Its Effect On Mathematical Performance In Differential Equations.** ***Journal of the Scholarship of Teaching and Learning*****, Vol. 13, No. 1, February 2013, pp. 100 – 111.**	To study of the metacognitive levels for two classes of differential equations students	1. Analysis students need for well performance	1. Planning is being more effective during learning process such us understanding how to use past strategies and knowing which strategy is most effective

METHODOLOGY

The present study purpose to determine the classroom interventions applied to Metacognitive Learning Strategies (MLS). The aim of the study also to evaluate the operational design aspects of teaching and learning activities whether in line with the ID step in general. Therefore, the research question was formed to achieve the objectives:

1. What is the impact of learning activities as the intervention that implied Metacognitive Learning Strategies (MLS)?
2. Which aspect(s) is most closely related to the operational design of learning activities?

Next, the related articles and journals search is in two steps; i) looking for articles related to metacognitive strategies to identify what the principles and operational of metacognitive learning strategies in mathematics, ii) searching articles based on implementation of ID model to determine how ID is doing and see the organizing on learning activities. Research articles are based on search using keywords, metacognitive learning strategies, mathematics intervention and instructional design from Google Scholar, ERIC, ScienceDirect, Researchgate, and other open database. **Table 1** is an analysis of metacognitive learning strategies.

Based on **Table 1**, shows how aspects of implementation in terms of operations and impacts on students are derived from research reports. Some of the activities contained in the MLS have been found and the impact on learning is also visible. A total of 13 articles are selected and meet the requirements of the study to be discussed. However, this article does not clearly explain how learning activities are operated but almost all only report the effectiveness and impact of these learning activities.

Table 1 (continued). Analysis of operational aspect of MLS and the impact to learning

Author(s)	Objective(s)	Operational Aspect	Impact To Learning
Ihdi Amin & Sukestiyarno (2015) **Analysis Metacognitive Skills On Learning Mathematics In High School. *International Journal of Education and Research* Vol. 3 No. 3 March 2015**	To study the influence of metacognitive awareness of the cognitive skills; the influence of metacognitive awareness of the metacognitive skills; and how the relationship `between cognitive skills and metacognitive skills?	1. Analyse of problems in mathematics learning	1. The student has a good ability in planning, goal setting, and allocate resources before learning 2. The awareness of students reading instruction carefully before starting the task, while the weakest part is the student's ability to regulate the current study in order to have a longer learning time 3. The student has sufficient ability to perform self-assessment of learning or in assessing the strategies it uses. 4. Ability of students to consider some alternative settlement before answering 5. The awareness of students to stop regularly to check for understanding 6. Students is to ask themselves about how well they have achieved the goal (after the task has been completed)
Adnan & Arsad Bahri (2018) **Beyond Effective Teaching: Enhancing Students' Metacognitive Skill Through Guided Inquiry. *IOP Conf. Series: Journal of Physics: Conf. Series* 954 (2018) 012022**	To compare metacognitive skill of students between thought by guided inquiry and traditional teaching.	1. Analysis of students 2. Design and develop guided inquiry activities 3. Apply the intervention performance test	1. Will train skill of student on how plan, manage, and evaluate their learning 2. The students explore their thoughts to find out what previous knowledge they have, that will help them to complete the task 3. The students know what needs to be done first in order to help in completing the task 4. The students plans the time management in planning the task 5. Students take action to solve the problems, remember important information, and check whether it is on the right track 6. The student will ask himself or herself what related information is important to remember and what to do to solve the problem 7. Students can ask themselves how well they have solved the problem
Sd Du Toit & Gf Du Toit (2013) **Learner Metacognition And Mathematics Achievement During Problem-Solving In A Mathematics Classroom. *TD The Journal for Transdisciplinary Research in Southern Africa*, 9(3), Special edition, December 2013, pp. 505-518.**	To investigate the level of learner metacognition as well as the level of mathematics achievement during problem-solving in a mathematics classroom	1. Analyse of needs in mathematical problems solving 2. Design and develop problem solving activities 3. Measuring the metacognitive level based on the solving problem ability	1. Relate mathematical achievement in solving mathematical problems by comparing planning, monitoring and evaluation elements in accordance with the sequence of Polya's Problem Solving Model
Ackerman, R., & Leiser, D. (2014) **The Effect Of Concrete Supplements On Metacognitive Regulation During Learning And Open-Book Test Taking. *British Journal of Educational Psychology*, 84(2), 329–348.**	To examine how being led astray by uninformative concrete supplements in expository texts affects achievement	1. Analysis of low performance in text comprehension 2. Design the learning supplement	1. The elements of time planning and action when completing tasks are very important in influencing achievement. 2. Evaluation needs to be made to ensure that new knowledge is built up in line with the original source of knowledge
Ariya Suriyon, Maitree Inprasitha & Kiat Sangaroon (2013) **Students' Metacognitive Strategies in the Mathematics Classroom Using Open Approach. *Psychology* 2013. Vol.4, No.7, 585-591**	To investigate students' metacognitive behavior and abilities in the mathematic class using the Open Approach	1. Analysis 2. Design and develop activities based on open approach-based problems solving 3. Observe on students during learning 4. Check students work	1. Metacognitive strategies could be defined as thinking ability causing behaviour that a problem solver can control, monitor, and reflect his own thinking process, based on an idea or a way which he values from existent resources
Hasbullah (2015) **The Effect Of Ideal Metacognitive Strategy on Achievement In Mathematic. *International Journal of Educational Research and Technology* 6[4] 2015; 42-45**	To determine the effect metacognitive ideal strategy on achievement in math class	1. Analysis of needs to intervention 2. Implement in 3 week 3. Apply the Ideal Metacognitive Strategies	1. Emphasizes the provision of project or task, which is expected to be focused on the learning materials that are considered important and can stimulate students' sense of responsibility in carrying out the project that has been given by the teacher in accordance with the group. 2. Stimulate the students to understand the situational problem by using a specific form of representation, discuss and evaluate the problem solving.
Wajeeh Daher, Ahlam Anabousy, Roqaya Jabarin (2018) **Metacognition, Positioning And Emotions In Mathematical Activities. *International Journal of Research in Education and Science (IJRES),* 4(1), 292-303.**	To study the interaction between students' metacognitive processes from one side, and their positioning and related emotions from the other side.	1. Analysis of students level in mathematics 2. Design and develop activities with GeoGebra 3. Observe on students behaviour and students work	1. Develop self-awareness, self-complexity, and metacognitive ability 2. Positive affect to self-confidence and being proud of oneself
Fatma Acar & Engin Ader (2017) **Metacognition Used by Tutors during Peer Tutoring Sessions in Mathematics. *Elementary Education Online*, 2017; 16(3): 1185-1200**	To examine metacognitive skills of students who volunteered for teaching mathematical problems to their peers during peer tutoring sessions	1. Analysis of problems 2. Design based on peer tutoring activity 3. Develop the intervention with conducted the peer tutoring sessions 4. Implement in six peer tutoring sessions 5. Evaluate student performance and works	1. Students used metacognition during peer tutoring sessions starting from the preparation to the end of the task 2. Increase students metacognitive skills

Table 2. Meta-analysis of the relation of ID model phases and metacognitive learning strategies

Phases in ID model	Relevance To MLS Aspects	Impact To The Learning Activities
Analysis	Prepare a checklist	Help students to consciously aim, monitor and reflect upon what they are learning
	Makes rubrics	
	Reviews of problem and needs	
Design	Self-instruction	The organizational tools support students in the decision-making process
	Organizers	
	Explicit teacher modelling	Serve as an aid for planning and self-evaluation
	Problem based activity and applied others activities	
Development	Clarify and model when particular strategies are appropriate	Gives students the foundation they need for creating their own strategies
	Makes alternative or contingency plan	Be useful for understanding what they are trying to comprehend
Implementation	Implement the strategies	Develop critical thinking, reasoning and quickly choose a solutions strategy
	Explain the learning activities	Increase communication skill and problem solving skill
	Provide hand-outs and tools regarding particular strategies	Apply various solutions strategies
Evaluation	Clarify why particular strategies are helpful and useful	Students know and need to know to arrive at an answer
	Self-monitoring processes	Emphasize the need to reread the problem and self-check responses

Furthermore, based on **Table 1** analysis, meta-analysis of the relationship between the phase in the ID model and the MLS aspect was built to clarify that the application of the ID model is relevant to the intervention process or to produce learning activities that coincide with MLS, shown in **Table 2**. This guide will be the basis for the discussion of findings in the next.

DISCUSSION

Based on the two stages of objective of the review, the first step is to determine the classroom interventions applied of Metacognitive Learning Strategies (MLS) and secondly to evaluate the operational design aspects of teaching and learning activities whether in line with the ID step in general, so on this part of the discussion will be implemented according to the stage and based on the following two research questions.

What is the Impact of Learning Activities as the Intervention that Implied Metacognitive Learning Strategies (MLS)?

The impacts of implementation of Metacognitive Learning Strategies (MLS) can be seen from the two points of view. First, in mastery of mathematics concept and second is about student's thinking skills. Reviewed articles showed that implementation of metacognitive learning strategies by organizing certain activities likes Problem Based Learning, Project Work, Discussion, Game, etc, is mostly effective to students performance and understanding (e.g; Daher, Anabousy, & Jabarin, 2018; Smith & Mancy, 2018; Suriyon, Inprasitha, & Sangaroon, 2013). It means, student learning is greatly enhanced when the student's level of prior knowledge is made visible. At that point the students have opportunity to correcting any misconceptions; using the prior knowledge, and create schemas of understanding around a topic. Learning is optimized when students can see where new concepts build from prior knowledge. Students learn more when the concepts are personally meaningful to them. In order to deeply understand a topic, learners not only need to know relevant facts, theories, and applications, they must also make sense of the topic through organizing those ideas into a framework (schema) of understanding. The development of schema, require students learned topics in ways that are relevant and meaningful to them. The situations are in line with reported by Schraw and Moshman (1995).

In fact of applying the metacognitive learning strategies, critical thinking skill and other thinking types such as reasoning skill, are popular reported by Suriyon, Inprasitha and Sangaroon (2013), Hasbullah (2015), Tony Karnain et al (2014) and Amin and Sukestiyarno (2015). Critical thinking allows students to process information in a logical manner and to prepare themselves for learning. They can identify logical errors, and it can help students to solve the problems. If student can think critically, creatively, and solve mathematic problems independently, then they will be able to succeed in making decisions (Du Toit & Du Toit, 2013;

Table 3. Learning activities and the impacts on the students

Learning Activities	Reference(s)	Impacts to The Students
Problem Based Learning e.g problems solving activity, problems situation, experiment/investigation activity	Smith & Mancy (2018), Du Toit & Du Toit (2013), Tony Karnain et al (2014)	Being active, interacting with others, higher transfer knowledge / concept to the new experiences
Cooperative Learning e.g class discussion, group work, group project	Smith & Mancy (2018), Smith (2013)	Influence on classroom climate and students behaviour
Competition / Challenge Based Learning e.g individual/group competitions, school competitions or higher level competitions, problems challenge, project challenge	Suriyon, Inprasitha & Sangaroon (2013), Smith & Mancy (2018), Ackerman & Leiser (2014)	Increase in creativity, excitement, stimulation, learning skills
Game Based Learning e.g played game, technology game	Daher, Anabousy & Jabarin (2018)	Excitement, interactivity, emotion, gain in self-care behaviour and self-efficacy
Transformed Learning e.g Web application, online based, representations, reciprocal teaching, folios, innovation competition	Acar & Ader (2017), Smith & Mancy (2018)	Excitement, being active, greater reduction of misconception

Schraw & Moshman,1995), understand options and expand knowledge to daily life (Ackerman & Leiser, 2014; Smith & Mancy, 2018).

In this context, metacognitive learning strategies refer to methods or technics of learning that promote the development of metacognitive aspects (Menz & Cindy Xin, 2016). In fact, using previous knowledge, student's awareness, and student's thinking skills to shape new experiences and knowledge. According to Adnan & Arsad Bahri (2018) a metacognitive learning strategy of mathematics is a way to set up the awareness about the thinking process during learning. This awareness is exists, when students are able to manage their thoughts by planning, monitoring and evaluating while completing tasks. In addition, for more specific teaching strategies (Veenman et al., 2006), as cited in Menz and Cindy Xin (2016) has listed the basic principles to ensure the success of metacognitive strategy teaching: i) metacognitive strategies are applied in learning materials to ensure interrelationships, ii) informing students about the use of metacognitive activities to encourage them to always work, and iii) prolonged training that is practiced to ensure smooth and continuous metacognitive use.

Which Aspect(s) is Most Closely related to the Operational Design of Learning Activities?

Analysis. The analysis phase is the most critical phase that will lead to the proper intervention to the cause of the problem being discussed. Almost all researchers discuss specific phases of analysis and lead to why it is necessary to intervene and why certain learning activities need reform. The phase of analysis is the phase that is most closely related to the operational design of intervention. Researchers such as Menz and Cindy Xin (2016), Du Toit & Du Toit (2013), Tony Karnain et al. (2014), Daher, Anabousy, and Jabarin (2018), Smith and Mancy (2018), Hasbullah (2015) Cera, Mancini and Antionetti (2013) have reported that implementing this phase to produce the activities based on MLS.

Design and Development. The design phase is the phase of the selection of the type of activity will be undertaken primarily to produce renewal in the sense of intervention after obtaining the analysis of needs. Usually researchers will ensure the theory and the adaptability of the activities to be designed. Current levels and levels to be targeted at interventions are the top priority. The selected activity will also illustrate strength and usability as a learning treatment. Subsequent to this phase of the development, researchers will provide interventions based on the selected activities. Activities will be structured to match the objectives. Most researchers develop activities that are closely related to mathematics such as problem solving, inquiry and guidance sessions (Royanto, 2012). In this study, MLS is the right choice to produce interventions based on their impact on student domination. Any theory or strategy involved with MLS can be used. Researchers likes Acar and Ader (2017) used Peer Tutoring, Suriyon, Inprasitha and Sangaroon (2013) applied Open Approach, Adnan and Arsad Bahri (2018) have chosen Guided Inquiry and Menz and Cindy Xin (2016) has been implemented Reflective Writing. Besides that, problem solving activities are prioritized and implemented by researchers such as Smith and Mancy (2018), Du Toit and Du Toit (2013) and Tony Karnain et al. (2014). In fact, only one researcher, Hasbullah (2015) have modified and developed a problem solving activity called IDEAL for mathematics classroom intervention.

Implementation. In this phase, the researchers will test the feasibility of activities to be interventions. Usually researchers will simulate a certain period of time so that the effectiveness of the activity can be seen. In addition, the activities are carried out according to the suitability of time and condition. Some researchers

require a certain time to be given treatment for example choosing a particular student and describing the course of treatment for students (Daher, Anabousy, & Jabarin, 2018; Hasbullah, 2015; Menz & Cindy Xin, 2016; Smith & Mancy, 2018). While there is also the researcher practicing during a normal learning class for keep the naturally status in order to maintain and do not disturb the actual learning setting.

Evaluation. To see the effectiveness of activities and treatments, the researchers are still following the usual procedure of assessment by observing either the researcher himself or another party. Observation is done on behavior and actions during learning. In addition, document analysis is also conducted to assess and compare the implementation of interventions with conventional methods. So, evaluation is also an important stage and is a clear discussed by most researchers. The design of the experimental study is the main choice of measurement and evaluation. Comparison of student achievement was also carried out to see the effectiveness of interventions compared to conventional methods (References: Acar & Ader, 2017; Hasbullah, 2015; Menz & Cindy Xin, 2016; Suriyon, Inprasitha & Sangaroon, 2013).

In short, ID model steps are implemented to design and develop learning activities, especially in addressing learning issues. The aspect (step) is guided to form interventions. In this review, it is clear that the phase of analysis and evaluation is a most relevant phase in forming a mathematics classroom intervention. However, in order to obtain a best practices or intervention, the step of this ID model should be implemented as best as possible and should be followed thoroughly in line with the recommendations by Branch (2009) and Nadiyah and Faaizah (2015).

CONCLUSIONS

This finding demonstrates that it is very coherent and beneficial to form teaching approach by considering and giving priority to systematic operation. It may also be taken into account in producing a more innovative and interactive approach. The less-attention phases should be revisited and updated, however this is a proper process when the approach is implemented, weaknesses may arise and by restructuring with the teaching models such as the ADDIE Model, ASIE Model, ASSURE and so on, the shortcomings can be overcome as soon as improvements. This study also suggests that in generating IDs professionally or as a result of innovation, it is not the ADDIE, ASIE and ASSURE step to be a bulb, but it is only a suggestion to a more organized step by prioritizing the process chronology. In controlling the intervention approach, the model step is considered to be very appropriate and more practical when applied with Metacognitive Learning Strategies (MLS). At the time of design and development promising a strong foundation, during implementing the best of compliance with the terms of the intervention and when organizing, the impact will be more pronounced. Indeed, the impact on student performance and achievement has been answered through this review but the operational aspect is still not clear. So it is suitable for MLS to be content for design and development phase of instructional design for the purpose of mathematical learning intervention.

In this study, it can't be clearly described as a special form of intervention as an innovation as illustrated by the fact that this study only contributes to literature. Therefore, further studies are needed to ensure that this contribution is visible and there is continuity. The suggestions for further research are, creating a teaching by applying MLS based on the specific model likes ADDIE, ASSURE, Dick and Carey model or others. Try to combine with specific technology or web application elements. Make correlate the results of this study by focusing on other subjects or other fields of knowledge. Studying the inclination of the phase in the ID model which is more impactful to produce teaching innovation.

Author Contributions

M.A.A.B and N.I designed the study, prepared the original draft, provided editing, and contributed to writing the paper.

Funding

This research received no external funding

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Mohamad Ariffin Abu Bakar – School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Malaysia.

Ismail Norulhuda – School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Malaysia.

REFERENCES

Acar, F., & Ader, E. (2017). Metacognition Used by Tutors during Peer Tutoring Sessions in Mathematics. *Elementary Education Online*, *16*(3), 1185-1200. https://doi.org/10.17051/ilkonline.2017.330250

Ackerman, R., & Leiser, D. (2014). The Effect of Concrete Supplements on Metacognitive Regulation during Learning and Open-Book Test Taking. *British Journal of Educational Psychology*, *84*(2), 329–348 https://doi.org/10.1111/bjep.12021

Adnan & Bahri, A. (2018). Beyond effective teaching: Enhancing Students' Metacognitive Skill through Guided Inquiry. *IOP Publishing. Journal of Physics: Conf. Series, 954*(2018), 012022. https://doi.org/10.1088/1742-6596/954/1/012022

Amin, I., & Sukestiyarno, Y. L. (2015). Analysis Metacognitive Skills on Learning Mathematics in High School. *International Journal of Education and Research, 3*(3).

Branch, R. M. (2009). *Instructional Design: The ADDIE Approach*. Springer Science Business Media, LLC. Dordrecht Heidelberg, London. https://doi.org/10.1007/978-0-387-09506-6

Cera, R., Mancini, M., & Antonietti, A. (2013). Relationship between Metacognition, Self-Efficacy and Self-Regulation in Learning. *ECPS-Journal*-7/2013. https://doi.org/10.7358/ecps-2013-007-cera

Daher, W., Anabousy, A., & Jabarin, R. (2018). Metacognition, Positioning and Emotions in Mathematical Activities. *International Journal of Research in Education and Science (IJRES)*, *4*(1), 292-303. https://doi.org/10.21890/ijres.383184

Du Toit, S. D. & Du Toit, G. F. (2013). Learner Metacognition and Mathematics Achievement during Problem-Solving In a Mathematics Classroom. *TD the Journal for Transdisciplinary Research in Southern Africa*, *9*(3), Special edition, December 2013, 505-518. https://doi.org/10.4102/td.v9i3.194

Gartmann, S., & Freiberg, M. (1998). Metacognition and Mathematical Problem Solving: Helping Students to Ask the Right Questions. *The Mathematics Educator*, *6*(1).

Hasbullah (2015). The Effect of Ideal Metacognitif Strategy on Achievement In Mathematic. International *Journal of Educational Research and Technology*, *6*(4), 42-45. https://doi.org/10.15515/ijert.0976-4089.6.4.4245

Karnain, T., Bakar, N., Mousavi Siamakani, S. Y., Mohammadikia, H., & Candra, M. (2014). Exploring the Metacognitive Skills of Secondary School Students' Use during Problem Posing. *Jurnal Teknologi (Social Sciences), 67*(1), 27–32.

Menz, P., & Cindy Xin (2016). Making Students' Metacognitive Knowledge Visible through Reflective Writing in a Mathematics-for-Teachers Course. *Collected Essays on Learning and Teaching*, *IX*. Simon Fraser University. https://doi.org/10.22329/celt.v9i0.4426

Nadiyah, R. S., & Faaizah, S. (2015). The Development of Online Project Based Collaborative Learning using ADDIE Model. *Procedia - Social and Behavioral Sciences*, *195*(2015), 1803–1812. https://doi.org/10.1016/j.sbspro.2015.06.392

Nikpour, R., Zakeria, H., & Chalmeh, R. (2011). The Role of Metacognitive Orientation of Classroom Environment in Depression. *Procedia - Social and Behavioral Sciences,* 29(2011), 528 – 532. https://doi.org/10.1016/j.sbspro.2011.11.271

Ozdilek, Z, & Robeck, E. (2009). Operational Priorities Of Instructional Designers Analysed Within The Steps Of The Addie Instructional Design Model. *Procedia Social and Behavioral Sciences*, *1*(2009), 2046–2050 https://doi.org/10.1016/j.sbspro.2009.01.359

Panaoura, A., Gagatsis, A., & Demetriou, A. (2009). An Intervention to the Metacognitive Performance: Self-Regulation in Mathematics And Mathematical Modeling. *Acta Didactica Universitatis Comenianae Mathematics*, (9), 63–79.

Royanto, L. R. M. (2012). The Effect of An Intervention Program Based on Scaffolding to Improve Metacognitive Strategies in Reading: A Study of Year 3 Elementary School Students in Jakarta. *Procedia - Social and Behavioral Sciences*, *69* (2012), 1601–1609. https://doi.org/10.1016/j.sbspro.2012.12.105

Schraw, G., & Moshman, D. (1995). Metacognitive Theories. *Educational Psychology Papers and Publications*. 40. Retrieved from http://digitalcommons.unl.edu/edpsychpapers/40

Sebastian, J., Herman, K. C., & Reinke, W. M. (2019). Do Organizational Conditions Influence Teacher Implementation Of Effective Classroom Management Practices: Findings From A Randomized Trial. *Journal of School Psychology*, *72*(2019), 134-149. https://doi.org/10.1016/j.jsp.2018.12.008

Smith, J. M., & Mancy, R. (2018). Exploring The Relationship Between Metacognitive And Collaborative Talk During Group Mathematical Problem-Solving – What Do We Mean By Collaborative Metacognition? *Research in Mathematics Education*, *20*(1), 14-36. https://doi.org/10.1080/14794802.2017.1410215

Smith, M. J. (2013). An Exploration of Metacognition and Its Effect on Mathematical Performance in Differential Equations. *Journal of the Scholarship of Teaching and Learning*, *13*(1), 100-111.

Suriyon, A., Inprasitha, M., & Sangaroon, K. (2013). Students' Metacognitive Strategies in the Mathematics Classroom Using Open Approach. *Psychology*, *4*(7), 585-591. Published Online July 2013 in SciRes: http://www.scirp.org/journal/psych

Vygotsky, L. S. (1978). *Mind in society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press. Retrieved from http://ouleft.org/wp-content/uploads/Vygotsky-Mind-in-Society.pdf