IJASSE | International Journal of Academic Studies in Science and Education

Year 2025, Vol. 3, No. 1, Pages 43-71 www.ijasse.com

OPEN ACCESS

Investigation of the Effect of Writing Activities for Learning Purposes on Metacognitive Awareness in the Context of Mathematics Course

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Article Info

Article History

Received:
23 August 2024

Accepted:
20 May 2025

Keywords

Mathematics,
Primary school,
Writing for learning purposes,
Metacognition.

Abstract

In this study, the effect of writing for learning activities on metacognitive awareness was investigated in the context of mathematics course. The study group of this research, which was conducted with a pretest-posttest control group quasi-experimental design method, consisted of 39 students (4th grade) selected by convenience sampling method. Data were collected using the "Metacognitive Awareness Scale for Children (MCAS-C) A form and writing for learning activities. The data were analyzed using SPSS. 26 program. As a result of the study, it was determined that writing for learning activities positively affected the knowledge of cognition sub-dimension and total metacognitive awareness in mathematics lesson, although not significantly, but did not cause any effect on the organization of cognition sub-dimension. This result makes the study different in terms of the fact that no significant difference was obtained in metacognitive awareness and all its sub-dimensions. As a result of the comparison of the ÜBFÖ-A form scores between the groups, no significant difference was found in all sub-dimensions of metacognitive awareness and total metacognitive awareness between the pre-test and post-test scores of the groups.

To cite this article

Durmuş, M. E., & Ergen, Y. (2025). Investigation of the effect of writing activities for learning purposes on metacognitive awareness in the context of mathematics course. *International Journal of Academic Studies in Science and Education (IJASSE), 3*(1), 43-71. https://doi.org/10.55549/ijasse.41

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Introduction

Although learning manifests itself through behavioral change, it is actually a cognitive process. Indeed, cognitive theorists (Jean Piaget et al.) have tried to explain the relationship between learning and cognitive processes since the early 1900s. While cognitive theories define learning as the process of receiving, understanding and applying information, they also emphasized the role of concepts such as cognitive flexibility, learning styles and metacognitive awareness in these processes.

There are many ways of learning. Reading, listening, observing and writing are some of them. In order to understand what is read, listened to and observed, it is necessary to think. However, in order to write, that is, to express the thought in writing, it may be necessary to re-run cognitive processes such as revising and organizing, or to use them more intensively. According to Langer and Applebee (1987), writing enables knowledge or thought to be restructured and applied in different contexts. As a matter of fact, Klein and Boscolo (2016), in their study in which they identified the trends in research on writing for learning activities, stated that cognitive theory and social-cultural theory are the theoretical basis of writing for learning activities. This theoretical basis and the idea that writing requires more intensive cognitive processes led us to investigate the question “Can writing activities for learning purposes contribute to increasing metacognitive awareness?”.

Metacognitive Awareness

Metacognitive awareness, one of the important concepts emphasized by cognitive theories, is the ability of students to monitor, manage and organize their own learning processes (Flavell, 1976). In the definition made by Wengrowicz, et al. (2018), metacognitive awareness is defined as the ability to understand and monitor one's own cognitive processes. In the literature, metacognitive awareness is considered as individuals' knowing how to learn by developing a conscious understanding of what, how and when to do in learning processes (Alkan & Açıkyıldız, 2020; Kalemkuş, 2021). In other words, metacognitive awareness can be defined as the individual's awareness of himself/herself about how he/she performs effective and meaningful learning, shaping and evaluating the learning process. In this framework, metacognitive awareness is generally explained with cognitive knowledge and cognitive regulation components (Schraw & Moshman, 1995; Sümen & Çalışıcı, 2016; Wengrowicz et al., 2018). While cognitive knowledge includes individuals' knowledge of their own cognitive structure, learning strategies and when to use these strategies, cognitive regulation includes strategies on how to use this knowledge (Alkan & Açıkyıldız, 2020; Kurtuluş, 2017; Lai, 2011).

The learner's awareness of what he/she needs to learn starts with the identification of missing knowledge, gaps in what is already learned, or what is necessary among the masses of knowledge. How to learn the missing or necessary knowledge may require a number of trials for the learner. As a result of these experiments, the learner can decide what, how and when to learn more effectively, meaningfully and permanently. Thus, the learner can get the highest efficiency by subjectivizing the learning process.As a matter of fact, an efficient learning process is something that students and their teachers also aim for.Therefore, developing students' metacognitive awareness can help them get high efficiency from the learning process. As a matter of fact, there are many studies supporting this in the literature (Sağırlı et al., 2020; Tok et al., 2010; Alkan & Açıkyıldız, 2020). The results of these studies reveal the importance of metacognitive awareness for learners. For this reason, how students' metacognitive awareness can be developed or which educational practices can contribute to the development of metacognitive awareness during the primary school period when basic knowledge is learned is considered a problem worthy of research and was examined in this study.

Writing for Learning

With Janet Emig's (1977) “Writing as a Mode of Learning”, the idea that writing can be used as a learning tool beyond its use as a communication tool has become widespread in the educational literature. Dahlstrand (2006) stated that writing is an important process to enhance student learning in discipline-specific contexts beyond communication skills. Writing for learning (WLL) is a teaching method in which internalization is ensured by rethinking the information (Kennedy, 1980), which includes thinking and interpretation skills (Yıldız, 2012), and which aims to increase the comprehension and retention of information (Hand & Prain, 1996). This method emphasizes that writing genres can be used for more permanent (Lefter, 2006) and in-depth (Martin, 2015) learning of the content.

The integration of writing into learning processes has been supported by many studies (Carter et al., 2007; Graham et al., 2020; Kayaalp et al., 2020; Kayaalp et al., 2021; Öztürk & Günel, 2015; Gubte et al. 2021) by emphasizing its effectiveness in promoting critical thinking and conceptual understanding. For example, Kayaalp, et al. (2020) stated that SCM activities encourage students to conduct research, recognize different ideas, use evidence, and make comprehensive evaluations, and that these activities have positive contributions to critical thinking skills and critical thinking skills. Öztürk and Günel (2015) argued that writing is an integral part of the construction of scientific knowledge and improves learning outcomes in educational settings. Similarly, Kayaalp et al. (2021) stated that CLT activities create conducive environments for meaningful interaction with content and allow learners to acquire and operationalize knowledge through their interactions with writing materials. This is in line with the findings of Bangert-Drowns et al.'s (2004) meta-analysis, which found that SLL activities significantly increased academic achievement in various courses.

For the effective implementation of SLM activities in classrooms, teachers need to follow certain design processes and clarify which writing activity should be used for what and how. In this context, Hand and Prain (2002) put forward one of the frequently used design frameworks for SLW activities in the literature. According to Hand and Prain (2002), this framework, which aims to help teachers plan SCM activities, provides guidance to practitioners by emphasizing that the purpose, genre, topic, reader/audience and text production method should be determined when planning activities.

Mathematics and Metacognitive Awareness

The relationship between metacognitive awareness and mathematics is one of the most important research topics in educational psychology. There is an increasing number of studies emphasizing the important role of metacognitive awareness in mathematical problem solving and mathematics achievement. In the study of Abdullah et al. (2017), it was determined that there was a significant difference between the metacognitive awareness of students with different performance levels in solving non-routine problems in favor of the groups with high problem solving skills and it was emphasized that metacognitive skills should be emphasized in the problem solving process. The study by Hidayat et al. (2018), which showed that metacognitive strategies positively affect students' mathematical modeling competence, also supports this finding. In a study conducted by Demirtaş (2023), it was found that metacognitive awareness of primary school students significantly predicted their mathematics achievement, and it was emphasized that improving this awareness can increase learning outcomes related to mathematics. In the study conducted by Cahayasti & Indrasari (2018), it was stated that the increase in primary school students' mathematics problem solving achievement scores was positively correlated with their metacognitive strategy scores. Hassan & Rahman (2017) also reported a positive relationship between mathematics achievement and metacognitive awareness. Similarly, Özsoy (2010) and Bulut (2021) showed that metacognitive awareness is an important predictor of mathematics achievement. These findings point to the necessity of practices aimed at increasing metacognitive awareness in mathematics teaching.

As a matter of fact, studies integrating metacognitive awareness training into mathematics teaching in terms of teaching practices have shown positive results. Deniz (2017) showed that modeling activities that promote metacognitive awareness improved the results of mathematics problem solving. Similarly, Young & Worrell (2018) showed that students who used metacognitive strategies during mathematics tasks achieved higher scores in mathematics problem solving. These findings emphasize the inclusion of metacognitive awareness instruction in mathematics curricula and classrooms to improve students' mathematics problem solving performance.

Metacognitive awareness also has an indirect effect on students' mathematics problem solving achievement through other variables. For example, Hassan and Rahman (2017) suggested that effective metacognitive strategies can reduce the negative effects of anxiety on mathematics performance and increase motivation. Lai et al. (2015) showed that students with high levels of mathematical metacognition are better equipped to tackle mathematical problems, especially in the context of mathematics anxiety. These findings suggest that developing metacognitive skills can act as a buffer against anxiety and enable students to approach mathematical problems with more confidence and competence. Setyawati and Indrasari (2018), in a study with primary school students, showed that there was a positive relationship between students' use of metacognitive strategies while solving mathematical problems and their beliefs about mathematics. Özcan and Gümüş (2019) stated that students with high metacognitive awareness have more positive attitudes towards mathematics, which increases their motivation and participation in mathematical tasks. This relationship suggests that developing metacognitive skills can improve attitudes towards mathematics and ultimately contribute to higher academic achievement. However, Sümen and Çalışıcı (2016) reported a moderate negative relationship between pre-service teachers' metacognitive awareness and mathematical literacy self-efficacy beliefs. This indicates that high metacognitive awareness, while beneficial, can also lead to increased self-doubt in some cases. This nuanced approach suggests that teachers should implement metacognitive awareness training in a way that does not undermine self-efficacy.

The research results, some of which are mentioned above, consistently support the idea that metacognitive awareness is an important predictor of mathematics achievement and emphasize its importance in mathematics teaching. Accordingly, teachers may consider incorporating practices that increase metacognitive awareness into their classrooms and creating a culture of metacognitive awareness while trying to improve students' mathematics achievement.

Writing for Mathematics and Learning

The implementation of writing for learning in mathematics classrooms can make significant contributions as in other fields. Campbell et al. (2022) argued that SLW activities are underutilized in mathematics and mathematics teacher education and stated that they support students and teachers in the use of these activities. Powell et al. (2021) also stated in their study that the majority of educators believed in the importance of mathematics writing, but less than half of the participants used mathematics-related writing activities in their classrooms.

In mathematics classrooms, SLM can include a variety of activities such as summarizing, explaining, defending ideas or creating a story (Graham et al., 2020). Kostos et al. (2010) stated that mathematics journals positively affect students' mathematical thinking skills and mathematical vocabulary use and can be used as a communication tool between students and teachers and also as an assessment tool for teachers. In support of these results, Van Dayke et al. (2014) also reported that CLT activities enable pre-service teachers to understand how students think.In addition, in meta-analysis studies (Arsenault et al., 2024; Graham et al., 2020; Bangert-Drowns et al., 2004), which examined studies on the use of SLM activities in mathematics courses, it was stated that these activities had a significant effect size on students' mathematics learning outcomes.

The use of SLM activities in mathematics learning-teaching processes requires the blending of content-specific knowledge, domain-specific vocabulary, and written expression skills (Hughes et al., 2019). Britton et al. (1975) categorized mathematical writing into three groups: expressive writing, formal writing for communication purposes, and poetic writing. Expressive writing involves students making sense of a problem, situation, or their own ideas using words, numbers, or visuals. Formal writing for communicative purposes involves students describing, defining, informing, or explaining about a mathematics topic. Poetic writing, on the other hand, involves showing original problems, different solutions, ideas in writing, ensuring fluency and flexibility in thinking, and elaborating ideas. Although there are many activities related to these writing types in the literature, it has been observed that these activities are expressed under different titles. In this context, some writing for learning activities that can be used in mathematics lessons are given below (Durmuş, 2024).

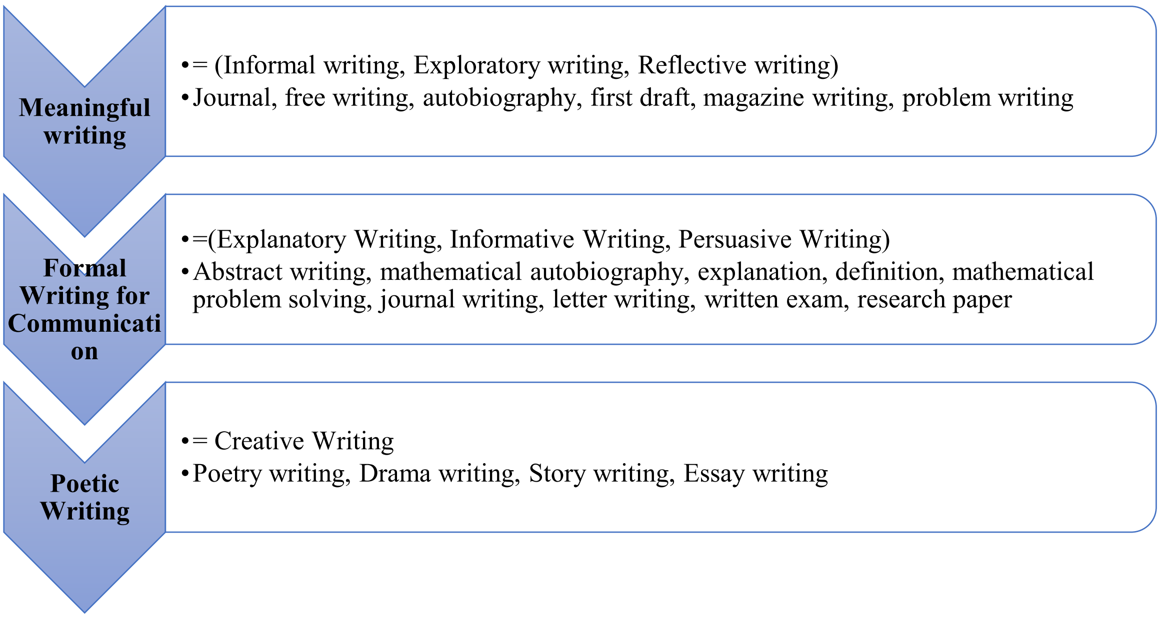

Figure 1. Writing Activities for Learning Purposes Used in Mathematics Lesson

In the study, the SCM activities of diary writing, letter writing, story writing and creating a class book were utilized. These activities were carried out with the students selected as the experimental group, and the effects of these LWP activities on students' metacognitive strategies in the context of mathematics course were examined.

Writing Activities for Learning Purposes Used in the Study

Journal writing: Journal writing is one of the most effective learning tools used in mathematics teaching (Alro & Skovsmose, 2004). It is very effective in making sense of mathematics (Burchfield et al., 1993), in the realization of rethinking (Stan, 2012) and in explaining mathematical concepts (Kostos & Shin, 2010).

Letter Writing: Letter writing is an important learning tool that enables concepts to be structured in the mind (Yıldız & Büyükkasap, 2011). Knox (2017) stated that letter writing is an effective method that can be used in solving math problems. It is important that the letter writer is older than the addressee, that the subject matter is mastered before writing the letter, and that the letter is written by constantly reviewing the letter (Yıldız, 2014).

Story Writing: Story writing involves writing the events that take place in the form of experiences in the context of person, place and time (Takımcıgil-Özcan, 2014). The use of story writing in education has many benefits such as developing different perspectives (McEwan & Egan, 1995), providing problem solving opportunities (Jonassen & Hernandez-Serrano, 2002) and enabling the perception of new information.

Creating a Class Book: Creating a class book is one of the activities used by Wilcox & Monroe (2011) for SLM purposes. This activity consists of students writing on a determined topic, including symbols and figures in their writing, and after the writing is checked, the pages are merged.

Purpose of the Study

It is seen that most of the studies on metacognitive awareness (UA) in the literature (Aydın, 2022; Benli Özdemir & Arık, 2018) are aimed at measuring the level of metacognitive awareness of learners. However, these studies are far from answering the question of how metacognitive awareness can be developed. However, there are also studies (Altunkaya & Sülükçü, 2018; Bulut, 2021; Setyawati & Indrasar, 2018) that aim to determine the relationship between different variables and UA. In these studies, it was tried to explain the variables that metacognitive awareness is related to or predict metacognitive awareness. These studies are based on the perspective of determining the variables with which UA changes and expecting UA to change positively with these variables. The studies that seek to answer the question of how to increase the students' UFC are mostly experimental or quasi-experimental studies in which the variables affecting UFC are tested.In this context, there are studies in the literature investigating the effect of metacognition-supported problem solving education (Arsuk, 2019), material development process (Sevim, 2014), flipped classroom model (Ertaş Karaaslan & Kaptan, 2023), case study method (Fırat Durdukoca, 2017) and many other variables on UIC. However, the abundance of variables that may affect UF makes it necessary to continue such studies with different variables. One of these variables is writing for learning activities. In this study, it was aimed to examine the effect of SLW activities on students' metacognitive awareness and its sub-dimensions. The research questions sought to be answered in this direction are as follows:

- Do the metacognitive awareness and sub-dimensions of the experimental group students differ significantly according to the pre-test - post-test data?
- Do the metacognitive awareness and sub-dimensions of the control group students differ significantly according to the pre-test - post-test data?
- Do metacognitive awareness and its sub-dimensions differ significantly according to the experimental group pre-test and control group pre-test data?
- Do the metacognitive awareness and its sub-dimensions differ significantly according to the post-test data of the experimental group and the post-test data of the control group?

Method

This study was conducted in a quasi-experimental design with a pre-test post-test matched control group, which is one of the quantitative research types. In this design, two of the groups ready to be matched are matched in the context of certain variables and as a result, they are randomly assigned to the treatment groups (Büyüköztürk et al., 2016). In this study, care was taken to determine the groups as equal to each other and it was examined whether there was a difference between the two groups determined in an unbiased manner in terms of dependent variables.

Working Group

The study group of research consists of 39 students, 20 of whom are in the experimental group and 19 of whom are in the control group, who are studying in the 4th grade of primary school in a village school in Pasinler district of Erzurum province. Convenience sampling method was used to determine the study group. Convenience sampling method is used for situations that are close and easy to access (Yıldırım & Şimşek, 2016). The reason for using convenience sampling method in the research is to determine the classes that will provide easy communication and to ensure that communication between the teachers and the researcher in the classes can be carried out effectively. In determining the experimental and control groups in the study, the opinions of the school principals working in the district where the research will be conducted were taken and care was taken to ensure that the groups were equivalent in terms of achievement and attitude.

Data Collection Tools

The "Metacognitive Awareness Scale for Children Form A (MCAS-A)", which was used in the study to determine the effect of SCM activities on students' metacognitive awareness, was obtained from the literature (Karakelle & Saraç, 2007).

Metacognitive Awareness Scale for Children Form A (ÜBFÖ-Ç)

In the study, the "Metacognitive Awareness Scale for Children (MCAS-C) A form" developed by Sperling, Howard, Miller, and Murphy (2002) and translated and adapted into Turkish by Karakelle and Saraç (2007) was used to measure students' metacognitive awareness. The UBFC-Ç consists of two forms, form A and form B.Form A of the UBFC-Scale was developed for 3rd, 4th and 5th grade students, while Form B was developed for 6th, 7th, 8th and 9th grade students. Since the study was conducted with 4th grade students, Form A was used. Form A is a 5-point Likert-type scale consisting of two sub-dimensions, knowledge of cognition and organization of cognition, and a total of 12 items, all of which are positive. The highest score that can be obtained from Form A is 36 and the lowest score is 12. The validity and reliability of Form A was conducted with the data obtained from 565 students, 49.7% of whom were female and 50.3% of whom were male, studying in 3rd (n = 194), 4th (n = 183) and 5th (n = 188) grades. As a result of the factor analysis conducted to determine the construct validity of the scale, it was found that the factor loadings of the scale items ranged between 0.58 and 0.75, the KMO Kaiser-Meyer-Olkin (Sampling Adequacy Measure) value was 0.72, the internal consistency coefficient (Cronbach alpha) value calculated for the reliability study was α=0.76, and the test-retest correlation value was 0.64.The findings of the validity and reliability studies show that the scale has a valid and reliable structure.

Data Collection Process

The data collection process of the study was carried out in 22 weeks. In the first week of the study, the PPFC-A form was administered to the experimental and control groups as a pre-test; in the second and third weeks, the experimental group students and the experimental group teacher were informed about the SCM activities; in the fourth week, the implementation process was started and the activity implementations were finalized in the twenty-first week. Finally, the data collection process was completed in the twenty-second week of the study by applying the ÜBFÖ-A form to the experimental and control groups as a post-test.In the study, the pre-test and post-tests were administered to the experimental and control groups at the same time.The tests were administered by the classroom teachers and the researcher managed the process by continuously controlling the classrooms during this process.

Application

The implementation of the SCM activities was carried out in two stages: "Preparation" and "Implementation Process". Information on these phases is presented below.

Preparation Phase

The preparation phase of the study was carried out before the 2022-2023 academic year started. At this stage, IWL activities were determined, instructions to be considered during the implementation phase were determined, and IWL activity templates and sample IWL activities were prepared.

The studies in literature were taken into consideration in determining the IWL activities and attention was paid to determine the activities with previous examples of use. In this context, diary writing (Kostos & Shin, 2010), letter writing (Aktepe, 2020), story writing (Temizkan, 2011) and class book activity (Wilcox & Monroe, 2011) activities, which have examples of use in this context and were found to have an effect on achievement, were used in the study.

The guidelines suggested by Klishis (2003) were used to determine the guidelines to be considered in the implementation of the activities. In this context, the guidelines were formed by taking into account the suggestions that thoughts should be expressed, a specific interlocutor should be identified, the possibility that thoughts and spelling rules may be wrong should not be doubted, figures should be used, thoughts that are decided to be wrong should not be deleted but marked, and the activity should be finalized by repeated reading. The instructions were explained to the students before each activity.

IWL activity templates and sample IWL activities were prepared by taking into account the learning outcomes related to the implementation weeks. The content of the SCM activity templates was created by explaining the problem-solving process and expressing it with pictures and figures.

Implementation Phase

In the implementation process of the study, the SCM activities were introduced and implemented. In this context, students were informed about the SLM activities for 2 weeks before the implementation of the activities and the implementation of the activities was completed in 21 weeks. The implementations were carried out in 2-hour free activity lessons, one activity per week, after learning the mathematics outcomes related to the activities. The learning outcomes included in the activities were "addition, subtraction, multiplication and division with natural numbers". The importance of the use of SLM activities in the reinforcement phase in the literature (Bogad et al., 2007; Joyner & Muri, 2011; Martin, 2015) was effective in the implementation of the practices after the acquisitions were learned. While the IWL activities were applied to the experimental group students, no additional application was made to the control group students and the lessons in both groups were taught in accordance with the Ministry of National Education [MoNE] (2018) curriculum. During the implementation, care was taken to provide feedback to the students by the researcher. The implementation process was carried out by the class teacher of the experimental group and the researcher, and the researcher assumed the role of guiding the students throughout the implementation process. Information on the implementation process is given in Table 1.

Table 1. Information on the Implementation Process of the Research

	Journal writing				**Writing a letter**				**Writing a story**				**Creating a class book**			
Activity No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Planned Week	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Implementation Status	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	-
Implementation Week	4	5	6	7	8	9	10	11	13	14	15	16	17	18	20	21

As seen in Table 1, diary writing activities were used in the first 4 weeks of the implementation process of the research, letter writing activities were used in the second 4 weeks, and the activities were carried out in accordance with the determined plan. Story writing activities were used in the third 4-week period and class book creation activities were used in the fourth 4-week period.

Data Analysis

SPSS 26 package program was used for data analysis. In the study, the data were analyzed based on the findings obtained from the PPFAS-A form, and in this context, the effects of IWL activities on students' metacognitive awareness and its sub-dimensions were determined by t Test in Dependent Groups and t Test in Independent Groups. The significance level criterion was taken as 0.05 in all analysis procedures. The evaluation of the

ÜBFÖ-A form was carried out by defining the titles “Always”, “Sometimes”, and “Never” as 3, 2, and 1 points, respectively.

Firstly, in order to determine the type of analysis, it was checked whether the data were normally distributed and the homogeneity of variances. The normal distribution of the data related to the ÜBFÖ-A form was tested using the skewness and kurtosis coefficients (Field, 2009) and it was taken into consideration that these values were between -1.5 and +1.5 (Tabachnick & Fidell, 2013). The homogeneity of variances was checked by Levene's Test.

Validity and Reliability

In order to ensure internal validity within the scope of the research, it was ensured that the experimental and control groups were equivalent and that the validity and reliability of the data collection tools obtained from the literature were proven. The research plan was confirmed by the experimental group teacher and all of the data collected within the scope of the research were checked by the researcher and an academician.

In order to ensure external validity in the research, care was taken to select classes with sufficient number of students in the experimental and control groups, and the data collection, data analysis and implementation process of the research were explained in detail in the method section.

In order to ensure internal reliability in the study, the same curriculum was followed for both groups by paying attention to the similarity of the educational environments of the experimental and control groups.
The researcher was actively involved in the implementation process and guided the students in the creation of the activities.

In order to ensure external validity in the study, the synthesis of the data obtained was organized by the researcher and an academician.

Findings

In this section, the findings related to the metacognitive awareness of the students in the research sample are presented. In this context, the findings related to the question “Do SCM activities significantly affect students' metacognitive awareness and its sub-dimensions?” were expressed in 4 stages based on the research questions. The stages of expressing the findings are given in Figure 1.

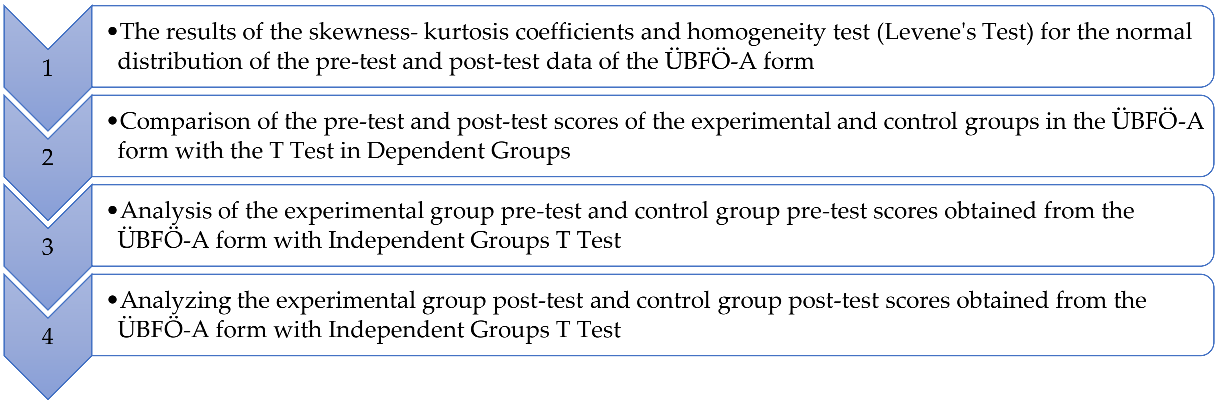

Figure 1. Stages of Expression of Research Findings

1-Specification of the skewness- kurtosis coefficients and Levene's Test results regarding the normal distribution of the pre-test and post-test data obtained from the ÜBFÖ-A form: Table 2 presents the skewness-skewness coefficients and Levene's Test results for the homogeneity of variances regarding the normal distribution of the pre-test and post-test data obtained from the ÜBFÖ-A form.

Table 2. Skewness-Skewness Coefficients and Levene's Test Results for the Pre-Test and Post-Test Data Obtained from the ÜBFÖ-A Form

	Test	**Grup**	**Sd**	**Skewness**	**Kurtosis**	**Levene's**	**Sd1**	**Sd2**	**p**
Cognition Knowledge	Pre test	Experiment	20	-.308	.730	6.819	1	37	.013
		Control	19	-.328	-1.332				
	Post test	Experiment	20	-.289	-1.119	2.218	1	37	.145
		Konrol	19	-.573	-.123				
Regulation of Cognition	Pre test	Experiment	20	-.575	-.459	7.815	1	37	.008
		Control	19	-.151	-.464				
	Post test	Experiment	20	-.016	-.528	.727	1	37	.399
		Konrol	19	.360	-.889				
Total	Pre test	Experiment	20	-.464	-.822	13.170	1	37	.001
		Control	19	.259	-.372				
	Post test	Experiment	20	.048	-1.228	3.457	1	37	.071
		Control	19	.167	-.348				

According to Table 2, in the context of examining whether the ÜBFÖ-A form scores are normally distributed between groups, it was seen that normal distribution was provided in total metacognitive awareness and all sub-dimensions between the scores of the experimental and control groups in the context of both pre-test and post-test. Similarly, in the context of examining whether the ÜBFÖ-A form scores were normally distributed within the group, a normal distribution was provided in total metacognitive awareness and all sub-dimensions between the pre-test and post-test scores of the experimental and control groups.

According to the results of Levene's test related to the data of the ÜBFÖ-A form, a homogeneous distribution was not observed only in the pretest scores of total metacognitive awareness. It was determined that the variances had a homogeneous distribution in terms of posttest scores of total metacognitive awareness and pre-test and post-test scores of cognition knowledge and regulation of cognition sub-dimensions (Total-pre, p= .001, Total-post, p= .071; Cognition knowledge-pre, p= .013; Cognition knowledge-post, p= .145; Regulation of cognition-pre, p= .008; Regulation of cognition-post, p= .399; p> .05). In this context

2-Comparison of the pre-test and post-test scores of the experimental and control groups in the ÜBFÖ-A form using the T Test in Dependent Groups: The results of the comparison of the pre-test and post-test scores of the experimental group's ÜBFÖ-A form using the T Test in Dependent Groups are given in Table 3.

Table 3. Dependent Groups T Test Results for the Comparison of the Experimental Group's ÜBFÖ-A Form Pre-Test and Post-Test Scores

ÜBFÖ-A			**n**	**x̄**	**Ss**	**T**	**p**
Experiment	Cognition Knowledge	Pre test	20	11.70	2.77	-.849	.406
		Post test	20	12.05	2.23		
	Regulation of Cognition	Pre test	20	17.20	3.25	.000	1.000
		Post test	20	17.20	2.19		
	Total	Pre test	20	28.90	5.61	-.419	.680
		Post test	20	29.25	3.99		

As seen in Table 3, there was a difference of .35 points in favor of the posttest between the pretest and posttest mean scores of the experimental group in the knowledge of cognition sub-dimension (X̄pre=11.70; X̄post=12.05) and total metacognitive awareness (X̄pre=28.90; X̄post=29.25), while there was no difference in the organization of cognition sub-dimension (X̄pre=17.20; X̄post=17.20). As a result of the Dependent Groups T Test, which tested whether the determined differences were significant or not, no significant difference was found between the pretest and posttest mean scores in total metacognitive awareness and all sub-dimensions (ptotal=.680; pcognition= .406; p organization of cognition= 1.000, p<.05). This finding can be interpreted as that the SCM activities applied to the experimental group did not have a significant effect on metacognitive awareness and all its sub-dimensions.

The results of the comparison of the pre-test and post-test scores of the control group using the Dependent Groups T Test are given in Table 4.

Table 4. Dependent Groups T Test Results Regarding the Comparison of the Pre-Test and Post-Test Scores of the Control Group in the PPIPS-A Form

ÜBFÖ-A			n	x̄	Ss	T	p
Control	Cognition Knowledge	Pre test	19	11.15	1.89	-1.423	.172
		Post test	19	11.89	1.76		
	Regulation of Cognition	Pre test	19	16.21	1.75	-.836	.414
		Post test	19	16.57	1.67		
	Total	Pre test	19	27.36	2.79	-1.320	.203
		Post test	19	28.47	2.85		

As seen in Table 4, there was a difference between the pre-test and post-test mean scores of the experimental group in favor of the post-test in the knowledge of cognition sub-dimension (X̄pre=11.15; X̄post=11.89) by .74, in the organization of cognition sub-dimension (X̄pre=16.21; X̄post=16.57) by .36 and in total metacognitive awareness (X̄pre=27.36; X̄post=28.47) by 1.11 points. As a result of the Dependent Groups T Test, which tested whether the differences were significant or not, no significant difference was found between the pretest and posttest mean scores in total metacognitive awareness and all sub-dimensions (ptotal=.203; pcognition= .172; pregulation of cognition= .414, $p<.05$). This finding can be interpreted as that the methods in the current MEB mathematics program do not have a significant effect on metacognitive awareness and all its sub-dimensions.

3-The analysis of the experimental group pre-test and control group pre-test scores obtained from the UBFC-A form with Independent Groups T Test: The results of the Independent Groups T Test for analyzing the pre-test scores of the ÜBFÖ-A form in the context of the experiment and the group are given in Table 5.

Table 5. ÜBFÖ-A Form Pre-Test Independent Groups T Test Results

ÜBFÖ-A			n	x̄	Ss	T	p
Experiment	Cognition Knowledge	Experiment	20	11.70	2.77	-.709	.483
		Control	19	11.15	1.89		
	Regulation of Cognition	Experiment	20	17.20	3.25	-1.173	.248
		Control	19	16.21	1.75		
	Total	Experiment	20	28.90	5.61	-1.086	.287
		Control	19	27.36	2.79		

As seen in Table 5, there was a difference in favor of the pretest between the mean pretest scores of the experimental and control groups in the knowledge of cognition sub-dimension (X̄experiment=11.70 X̄control=11.15) .55, in the organization of cognition sub-dimension (X̄experiment=17.20; X̄control=16.21)

.99 and in total metacognitive awareness ($\bar{X}$experiment=28.90; $\bar{X}$control=27.36) 1.54 points. As a result of the Independent Groups T Test, which tested whether the determined differences were significant or not, no significant difference was found between the pretest mean scores of the experimental and control groups in total metacognitive awareness and all sub-dimensions (ptotal=.287; pcognition= .483; pcognitionregulation= .248, p<.05). In other words, the experimental and control groups were equivalent to each other in terms of metacognitive awareness before the SCM activity practices.

4- Analyzing the post-test scores of the experimental group and the control group obtained from the UBFC-A form with the Independent Groups T Test: The results of the Independent Groups T Test for analyzing the post-test scores of the ÜBFÖ-A form in the context of the experiment and the group are given in Table 6.

Table 6. Independent Groups T Test Results for the Post-Test of ÜBFÖ-A Form

ÜBFÖ-A			n	x̄	Ss	T	p
Experiment	Cognition Knowledge	Experiment	20	12.05	2.23	-.240	.812
		Control	20	11.89	1.76		
	Regulation of Cognition	Experiment	20	17.20	2.19	-.990	.329
		Control	20	16.57	1.67		
	Total	Experiment	20	29.25	3.99	-.694	.492
		Control	20	28.47	2.85		

As seen in Table 6, there was a difference between the posttest mean scores of the experimental and control groups in favor of the pre-test in the knowledge of cognition sub-dimension ($\bar{X}$experiment=12.05; $\bar{X}$control=11.89) .16, in the organization of cognition sub-dimension ($\bar{X}$experiment=17.20; $\bar{X}$control=16.57) .63 and in total metacognitive awareness ($\bar{X}$experiment=29.25; $\bar{X}$control=28.47) .78 points. As a result of the Independent Groups T Test, which tested whether the determined differences were significant or not, no significant difference was found between the pretest mean scores of the experimental and control groups in total metacognitive awareness and all sub-dimensions (ptotal=.492; pcognition= .812; p organization of cognition= .329, p<.05). Accordingly, the posttest mean scores of the experimental and control groups did not differ significantly in terms of metacognitive awareness after the implementation of SCM activities.

Discussion and Conclusion

According to the findings of the study, with regard to the scores of the ÜBFÖ-A form, which was applied to determine the effect of SCM activities on students' metacognitive awareness in the context of mathematics course; after the implementation process of the research was completed, a score increase was determined in the experimental group in favor of the posttest, although it was not significant in the knowledge of cognition sub-dimension of metacognitive awareness and total metacognitive awareness. There was no score change in the organization of cognition sub-dimension of metacognitive awareness. This finding shows that CLT activities positively affected the knowledge of cognition sub-dimension and total metacognitive awareness in mathematics lesson, although not significantly, but did not cause any effect on the regulation of cognition sub-dimension. When the literature is examined, most of the studies (Balta, 2018; Bui & Kong, 2019; Chan & Aryadoust, 2023; Cho et al., 2010; Günel, 2009; Harten, 2014; Kaya & Ateş, 2016; Mansor et al, 2018; Negretti, 2012; Qin & Zhang, 2019; O "Neil, 2015; Robinson, 2007; Sato, 2022; Schakel, 2001; Shabaya, 2004; Steinbach, 2008; Strange, 2001; Sumarno, 2020; Xiao, 2016; Wang & Han, 2017; Whitebread et al., 2007; Wu et al., 2021), there is a significant and positive relationship between writing and metacognition. In this context, it has been stated that metacognition is an important factor affecting writing (Negretti, 2012; Pitenoee et al., 2017; Ruan, 2014; Stewart et al., 2015; Teng, 2016, 2019a, 2021; Teng & Yue, 2023) and that writing requires metacognitive skills (Bai et al., 2020; McCormick, 2003; Negretti & McGrath, 2018; Shub, 1998; Vincent et al., 2021). Writing has been characterized as a metacognitive practice process by some researchers (Grandy & Duschl, 2007; Hacker et al., 2009; Larkin, 2009; Teng et al., 2022).

In some studies, it has been concluded that writing performance is directly proportional to metacognitive skills (Djatmica et al., 2022; Farahian & Avarzamani, 2018; Qin & Zhang, 2019) and that students with advanced metacognitive skills have higher writing achievement (Conner, 2007; Eluemuno & Azuka-Obieke, 2013; Mansor et al, 2018; Negretti, 2012; Nelsi & Susana, 2008; Nguyen & Gu, 2013; Sumarno, 2020; Teng, 2016; Teng et al., 2022) and that metacognitive strategies are highly effective on writing performance (Graham, 2006; Teng & Zhang, 2021; Teng et al., 2022). This information shows that the activities of the SLM activities positively affect metacognition.

The positive effect of SCL activities on metacognition is supported by similar results in the mathematics course. For example, in Bicer et al.'s (2020) study examining the effect of SLM activities on mathematics achievement in the context of science, social and mathematics courses, it was found that SLM activities were effective on metacognition in relation to the success of solving mathematics problems; Craig's (2011) study examining the effect of expository writing on mathematics course found that expository writing was effective on metacognitive control in mathematics course; Özturan-Sağırlı (2010) examined the educational effects of writing activities in the context of students' views and found that writing activities were effective on the cognitive domain in mathematics and helped students understand better. Again, many studies in the literature (Gillespie et al. 2014; Powers et al. 2010; Santos & Semana, 2015; White, 2014) supported the results of this study and argued that writing positively affects metacognition in mathematics lessons. Similarly, Pugalee (2001) stated that writing improves metacognition in mathematics. In other words, in the context of the literature, it can be said that SLM activities positively affect metacognition in mathematics. In this study, although it was determined that CLM activities positively affected the sub-dimension of knowledge of cognition and total metacognitive awareness in the context of mathematics course, the fact that there was no significant effect on metacognitive awareness and all its sub-dimensions makes the study different from other studies in the literature.

In the study, regarding the ÜBFÖ-A form scores of the control group students who did not receive any additional application after the application process, an increase in all sub-dimensions of metacognitive awareness and total metacognitive awareness was determined, although not significantly. In other words, the current teaching methods in the MoNE mathematics curriculum positively affected students' metacognitive awareness, although not significantly. In the study, it is noteworthy that the teaching methods in the current MoNE mathematics curriculum caused a positive, although not significant, effect on the regulation of cognition sub-dimension. This finding can be interpreted as that SLM activities have no effect on the sub-dimension of organizing cognition in mathematics course. When the literature is examined, it is stated that writing activities are very important on cognition (De Silva & Graham, 2015; Negretti & McGrath, 2018) and regulation of cognition (Bereiter & Scardamalia, 2009; Xiao, 2016) and that writing performance depends on the use of strategies related to cognition and regulation of cognition (Teng & Yue, 2023). In the studies of Ulu (2011) and Sumarno et al. (2021), it was determined that writing significantly affected the sub-dimensions of knowledge of cognition and organization of cognition. In some studies (Teng, 2016, 2019b), it was stated that especially the organization of cognition sub-dimension has a very effective role on writing. In this study, it is a difference for the literature that the SCM activities did not have an effect on the regulation of cognition sub-dimension of metacognitive awareness in mathematics. It can be said that this result is one of the rare results in the literature. In the literature, there are very few studies (Cheong, Zhu & Liu, 2022) in which writing activities similar to this research result did not have a significant effect on metacognition. It is thought that the effect that may cause this situation may be due to the fact that metacognition includes more than one strategy (Gammil, 2006).

As a result of the comparison of the pre-test and post-test scores of the PPFC-A form between the groups, no significant difference was found between the pre-test and post-test scores of the groups in all sub-dimensions of metacognitive awareness and total metacognitive awareness. In other words, the applied SCM activities did not significantly differentiate the post-test scores of the experimental group students in the mathematics course compared to the scores of the control group students without any additional application. In this context, it can be said that the SCM activities implemented in addition to the current MoNE program in mathematics course did not differentiate metacognitive awareness and all its sub-dimensions compared to the current teaching methods in the MoNE program.

Limitations

The research is limited to 39 students selected from a village school with a low socio-economic status, selected by convenience sampling method. In addition, since the research was conducted in a quasi-experimental design, the fact that the experimental and control groups did not consist of students selected from the ramdom can be considered as a limitation.

Recommendations

In the study, it was concluded that CLM activities positively affected the cognition sub-dimension and total metacognitive awareness in the context of mathematics course, although not significantly. In addition, it was seen that there are studies in the relevant literature indicating that SCM activities have significant contributions to metacognitive awareness in the context of mathematics lessons. Accordingly, teachers can be recommended to use SCM activities in mathematics lessons.

In the study, it was determined that the effect of CLM activities on metacognitive awareness in the context of mathematics lesson was not similar to the results of many studies in the literature. Accordingly, it can be suggested to examine the effect of CLM activities on metacognitive awareness in the context of mathematics lessons with other studies.

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