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REGULAR ARTICLE

Effects of Individual and Group Metacognitive Prompts on Tertiary-Level Students' Metacognitive Awareness and Writing Outcomes

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Abstract Recent research has highlighted the value of incorporating metacognitive prompts into cooperative learning. This study explores effects of the presence or absence of metacognitive prompts in group or individual learning on metacognitive awareness and EFL writing outcomes. A total of 170 university students were assigned to one of four treatment conditions: collaborative learning with metacognitive prompts (COOP + META), collaborative learning without metacognitive prompts (COOP), individual learning with metacognitive prompts (INDI + META), and individual learning without metacognitive prompts (INDI). After treatment, learners exposed to metacognitive prompts in a cooperative learning setting outperformed the other groups in metacognitive awareness and EFL writing. Multiple regression analysis also showed that enhanced metacognitive awareness significantly predicted English writing outcomes. Results revealed metacognitive regulation was a more significant predictor of writing outcome. These findings highlight the importance of incorporating metacognitive prompts within collaborative writing settings.

Keywords Metacognition · Writing · Cooperative learning · Metacognitive prompts · Metacognitive awareness · Regulatory ability

Writing in English is an important skill for students learning English as a foreign language (EFL). Over the past few decades, language educators and researchers have recommended changing how writing is taught in EFL contexts. To help students reach satisfactory standards, the primary focus of writing instruction has been on cultivating classroom environments in which students can improve their writing. However, the process of learning to write for EFL students is challenging. This may be related to nature of writing. For example, writing is commonly acknowledged as a tool to convince readers with the writer's argument. Student writers should understand the purposes of writing and be able to relate them to practical experience. However, writing is not an automatic process; it requires recursive thinking, conscious effort, and commitment to reaching writing goals. Therefore, student writers need to build an awareness in metacognition to internalize the writing process, as well as self-correction strategies for their work (Graham & Perin, 2007). In addition, student writers should also be able to conduct conjectural emendation, select suitable syntactic representations, and develop arguments (Kellogg, 1994). Overall, writing is a self-regulatory process that includes the essential stages of plan formulation, goal setting, information organization, and evaluation (Karlen, 2017).

EFL students may encounter difficulties in planning writing, generating ideas, and organizing texts (Yarrow & Topping, 2001). They may also lack the required metacognitive knowledge and control to monitor and evaluate their writing (Santelmann et al., 2018). In an attempt to overcome such difficulties, EFL learners must develop awareness of metacognitive knowledge and regulation to facilitate writing, along with a self-regulatory mechanism to activate and sustain thoughts, behaviors, and emotions while learning to write (Teng, 2020a). In particular, student writers must internalize the writing process by retrieving prior knowledge, connecting it to the given task,

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and sorting their thoughts before transferring them to paper.

To facilitate the process of learning to write, research has shown that metacognitive strategies can strongly predict EFL students' writing performance (Teng & Huang, 2019). Metacognitive strategies, including planning, monitoring, reviewing, and evaluating, are directly related to writing. Instruction on metacognitive strategies can help learners decide how to align these strategies with their writing goals (Hayes, 2012; Hayes & Flower, 1980). Studies have also indicated that learning to write is influenced by various factors, including the nature of discourse among students from diverse sociocultural groups (Daiute & Dalton, 1993). Vygotsky (1978) proposed a theoretical basis for studying the role of social interaction in the development of cognitive process for writing. He identified the social origins of symbolic development in learners' efforts to solve concrete intellectual problems with others. The premise of this theory is that thinking occurs interpersonally (i.e., as learners interact in social contexts) before it occurs intrapersonally (i.e., in a learner's mind) (Lam & Kapur, 2017). Hence, in addition to instruction on metacognitive writing strategies, teaching students to write collaboratively is another effective way to encourage peer interaction and enhance students' writing.

However, Storch (2005) argued that although verbal and non-verbal signals during conversation can stimulate and alter language production, EFL learners may not be ready for peer-to-peer interaction that elicits deeper writing-related information processing and elaboration. Thus, revisiting the two innovative methods, i.e., metacognitive writing strategies training (e.g., Teng, 2020b) and cooperative writing (e.g., Storch, 2005), is necessary. Research has illustrated the effectiveness of metacognitive guidance on (Nguyen & Gu, 2013) and the benefits of cooperative learning (Li & Zhu, 2017) for writing. The rationale for using metacognitive guidance is that metacognition acts as a problem solver, through which learners are guided to apply a toolbox of strategies to maximize their writing performance (Santelmann et al., 2018). The rationale for using cooperative learning is that during the composition process, learners are expected to engage in various subprocesses, including information searches, argumentation, reasoning, problem-solving, evaluation, and verification (Storch, 2005). These tasks require writers to consider various perspectives and integrate them into a unified strategy to enhance EFL writing.

Research on the abovementioned methods has revealed two pertinent issues. First, although metacognitive guidance has been suggested as an effective means of improving English writing (e.g., Conner, 2007; Negretti, 2015), research on metacognition has not yet considered EFL writers' needs (Zinchuk, 2015). Second, cooperative learning may not always engender meaningful learning in the classroom. For example, some learners lack the interdependence, individual accountability, and skills essential to successful cooperative learning (Johnson & Johnson, 1994). Incorporating metacognitive writing strategy guidance into cooperative learning may compensate for these limitations and provide learners more opportunities to engage in peer interaction that facilitates writing. Some scholars, particularly those in educational psychology, have emphasized metacognitive instruction as a way to enhance students' writing (; e.g., Nguyen & Gu, 2013; Teng, 2021). Despite the potential of this technique, few studies have examined how incorporating metacognitive prompts into collaborative writing may enhance EFL students' writing and metacognitive awareness. The purpose of this research is, thus, to investigate the effects of individual and group metacognitive prompts on EFL students' writing outcomes and metacognitive awareness.

Metacognition

Recently, metacognition has garnered considerable attention in language education and is regarded as a key competency in enhancing language teaching and learning (Haukås et al., 2018). Metacognition has been found to be significantly correlated to EFL writing performance (Teng & Huang, 2019). According to Flavell (1979), *metacognition* refers to learners' awareness of their cognitive processes and their regulation of mental activities. Schraw and Dennison (1994) described metacognition using two aspects: the knowledge and regulation of metacognition. *Knowledge of metacognition* refers to learners' awareness and knowledge of cognitive processes, encompassing three dimensions: (1) declarative knowledge (an understanding of how various factors interact to influence one's learning); (2) procedural knowledge (knowledge about how to perform the procedural steps comprising a task); and (3) conditional knowledge (knowledge of skills a learner can employ to solve problems) (Jacobs & Paris, 1987). *Regulation of metacognition* comprises how learners monitor and control their cognitive processes via three dimensions: (1) planning (suitable selection of strategies and appropriate resource assignment to complete a task); (2) monitoring (awareness of task performance and targets for optimal performance); and (3) evaluation (assessment of a task and the efficiency of task performance) (Schraw, 1998). In the present study, metacognition is defined as one's awareness of and

reflections about personal knowledge, experiences, and strategies when learning to writing in English.

Metacognitive Guidance and Writing

While examining the effects of metacognitive training on university students' writing improvement, Nguyen and Gu (2013) incorporated a set of 9 h-long sessions into a writing course for Vietnamese EFL students. Learners received training on the metacognitive skills of planning, monitoring, and evaluation and worked independently on English writing. A comparison-and-contrast essay, written as a part of students' regular writing course at the beginning and end of the training period, served as a pre- and post-test, respectively. The results demonstrated that learners who received training earned significantly higher writing scores than learners without training.

Santelmann et al. (2018) examined 17 master's students' reactions to classroom instruction at an American university. Instruction included metacognitive writing strategies, self-regulation of writing practices, and text strategies. Data collection for this qualitative study were based on surveys and students' writing plans. Results revealed five themes: (1) students developed metacognitive awareness of writing practices; (2) students harnessed social support when writing; (3) students learned how to review peers' papers; (4) students discussed stressful aspects of writing; and (5) students learned more about the text structures underlying academic writing. In particular, "collaboratively developed and instructor-supported peer review and social support strategies" (p. 119) helped students meet their writing goals and reduce writing-related stress.

Cho et al. (2010) focused on 601 graduate and undergraduate students from three U.S. universities. Students attended a reciprocal peer review of the writing system. Instruction mainly focused on self-monitoring; findings revealed the role of self-monitoring in helping students prepare to write. For example, students were able to self-regulate their writing more effectively using metacognitive writing strategies (e.g., self-monitoring strategies). Students' conscious awareness of monitoring how these self-regulation strategies affected their writing was essential in enhancing their written products.

Teng (2020b) explored the effects of three conditions—group feedback guidance (GFG), self-explanation guidance (SEG), and a control group (CG) without metacognitive guidance—on students' writing outcomes. Participants consisted of 120 university students in China. Quantitative results of a writing test indicated that GFG learners achieved the highest mean scores, followed by SEG learners and CG learners. Qualitative analysis of students' written journals indicated that GFG learners tended to exhibit different metacognitive regulation processes, displayed a high level of task perception, and developed awareness and use of metacognitive strategies.

Overall, there were some similarities and differences among the above studies. Differences involved the different methods used in those studies. For example, Santelmann et al. (2018) adopted the qualitative method to explore learners' self-regulatory writing strategies. Other studies (Cho et al., 2010; Nguyen & Gu, 2013; Teng, 2020b) used quantitative method to explore the potential of metacognitive training for enhancing writing performance. Despite differences, the studies all revealed that writing was challenging for students and writing was a cognitive process requiring extensive metacognitive knowledge and regulation. The nature, components, and characteristics of metacognitive experiences are related to writing; hence, instruction around metacognitive prompts may help students internalize and activate writing-related metacognitive processes (Santelmann et al., 2018) and aid writers' self-regulation to enhance their writing performance (Teng, 2021).

Metacognitive Support in Group Work

Studies on metacognition (e.g., Santelmann et al., 2018) and collaborative writing (e.g., Yarrow & Topping, 2001) have revealed two limitations: first, focusing on metacognitive guidance alone may not delineate the complex relationship between metacognition and writing (Zinchuk, 2015); and second, instruction related to cooperative learning may not accomplish its intended goals due to learners' lack of positive interdependence, individual accountability, and collaboration skills (Johnson & Johnson, 1994). A lack of evaluation skills can also create barriers for students' cooperative learning (Slavin & Karweit, 2015).

In light of these limitations, researchers have suggested using interventions involving metacognitive strategies to train students to self-regulate their learning in cooperative settings. For instance, Kramarski (2004) divided 196 eighth graders into two groups: a group that received metacognitive instruction within cooperative learning (COOP + META) and a group that received cooperative learning without metacognitive instruction (COOP). Results from a test on graph interpretation and construction showed that COOP + META learners outperformed COOP learners. Bol et al. (2012) explored the effects of using guidelines (i.e., metacognitive strategy training) in a group or individual setting on calibration accuracy and achievement among 82 high-school students. Findings showed that students who applied the guidelines while practicing calibration in groups demonstrated the greatest calibration

accuracy. Teng (2021) focused on 160 Chinese students. The intervention of incorporating metacognitive prompts in collaborative writing lasted for 16 weeks. Results supported the positive role of incorporating metacognitive prompts in collaborative writing for reproduction of text structure knowledge, application of text structure knowledge, reduction of text content, and abstract writing.

The preceding review illustrates that the use of metacognitive prompts in a cooperative learning setting may enhance learning or even facilitate more durable and transferable learning. Self-regulation in learning can also be developed through other regulation (Vygotsky, 1978). As summarized in a review article (Gress & Hadwin, 2010), applying metacognitive strategies to support collaborative learning could be an effective approach to optimize the collaborative experience. The capacity to monitor and control one's own learning may be developed by observing others monitoring and controlling their learning via collaboration. The provision of metacognitive strategies in a cooperative learning context may offer opportunities for learners to ask questions, model strategies, and assist peers, leading students to develop metacognitive awareness to monitor and control effective learning tactics (Teng, 2016, 2021). Thus, these experiences may help learners develop self-regulation throughout the writing process.

The Present Study

This study aims to break new ground in exploring the effects of metacognitive straining on university-level learners' metacognitive awareness and EFL writing outcomes. It includes three main purposes: to compare the effects of four treatment conditions (collaborative writing with prompts, collaborative writing without prompts, individual writing with prompts, and individual writing without prompts) on students' metacognitive awareness and EFL writing performance; and to evaluate the predicting effect of metacognitive awareness on writing. This study aims to answer the following questions:

Question 1: How do the four treatment conditions affect students' development of metacognitive awareness?

Question 2: How do the four treatment conditions affect students' EFL writing development?

Question 3: To what extent does EFL students' metacognitive awareness predict their writing outcomes?

Method

Research Design

The present study employed a 2 × 2 factorial design. Independent variables included the setting (individual vs. group writing) and metacognitive prompts (learning with metacognitive prompts vs. without metacognitive prompts). Dependent variables included a writing test and a self-report metacognitive awareness inventory. The various combinations resulted in four conditions: cooperative learning combined with embedded metacognitive prompts (COOP + META), metacognitive prompts in an individual learning setting (INDI + META), cooperative learning without metacognitive prompts (COOP), and individual learning without metacognitive prompts (INDI).

Participants

This study focused on university students majoring in science and technology, who comprised the largest proportion of EFL students at the selected university in China. The students' English proficiency was not as high as that of students in prestigious universities in China. Invitations were sent to 310 students majoring in science and technology; 220 students agreed to participate. They each took a 100-point internal English test that measured English reading, vocabulary, and writing skills. Test results included three score ranges: above 80 points (30 students), below 65 points (19 students), and 70–75 points (170 students). Given the limited number of participants scoring above 80 points and below 65 points, only students scoring between 70 and 75 points were recruited. These learners possessed intermediate English proficiency. The sample consisted of 80 female and 90 male, native Chinese speakers between 18 and 20 years old. They had been learning English for at least six years. Based on students' availability, the number of students in each condition was as follows: COOP + META (40), INDI + META (42), COOP (44), and INDI (44). An ANOVA test helped ensure that participants in the four treatment conditions possessed similar English proficiency, F (3, 166) = 1.071, p = 0.71. However, removing outliers may temper the usefulness of this research; future studies could include different learners with different proficiency levels to avoid this problem.

Conditions

The present study sought to minimize potential extraneous variables when implementing the COOP + META, INDI + META, COOP, and INDI conditions. Differences across conditions were related to the respective

intervention methods and materials covering the unique components for each condition. Criteria and differences in the four treatment conditions appear in Table 1.

COOP + META Condition

Participants in this condition received metacognitive prompts in a group setting. Students were allowed to choose their members to form a group. Each group included four members and remained the same across all sessions. Metacognitive prompts consisted of self-addressed questions focusing on two components: knowledge of metacognition and regulation of metacognition (see Online Appendix). Prompts were printed on participants' worksheets and in the teacher's guide. Group members used metacognitive prompts before, during, and after their writing exercise. The teacher told participants that considering and answering the metacognitive prompts would help them write more effectively. The members in each sub-group then collaborated on a writing exercise. Collaborative writing included planning, drafting, reviewing, and revising an essay together. Each student worked on his/her essay portion, after which the group members compiled their individual parts. They then discussed and revised the essay together. The teacher helped each group as needed.

INDI + META Condition

Students in the INDI + META condition received the same metacognitive prompts as those in the COOP + META group; however, the learners worked on writing exercises independently with the metacognitive prompts in hand. Similar to the COOP + META condition, the teacher spent the first 10 min instructing the group. Students could request the teacher's help if needed.

COOP Condition

Learners in this condition formed a four-member sub-group to collaborate on the writing exercise but did not receive any instruction on metacognition. Similar to the COOP + META condition, the four-member groups remained the same across all sessions.

INDI Condition

Learners in the INDI condition worked on writing exercises independently and received no metacognitive prompts. They could request the teacher's assistance as needed.

Measures

Study measures included a writing test and metacognitive awareness inventory. All assessments were completed in using a paper-and-pencil format. Following the university's writing test time requirement, students were given 40 min to complete the writing test. They could complete the metacognitive awareness inventory at their own pace.

Writing Outcomes

The writing test required participants to compose an argumentative essay, which is a common writing test requirement in EFL learning. Learners were required to write their essay based on a given topic. The argumentative essay is a genre that requires writers to investigate a topic;

Table 1 Criteria and differences for the four treatment conditions

Conditions	Criteria
COOP + META	(a) The four conditions were implemented in a writing course;
INDI + META	(b) The participants received similar writing exercises;
COOP	(c) An experienced English writing teacher received training on the four conditions and worked as an independent instructor for the four conditions. She had not taught the participants before;
INDI	(d) The participants received the same materials covered for the course;
	(e) The four conditions were assigned with similar amount of time (two hours one week, and 16 weeks in total) allocated for each condition;
	(f) The participants received the same assessment methods;
	(g) The participants were in the same classroom setting. The teacher provided help when necessary. The students were encouraged to complete their writing after class.
	Differences
COOP + META	During the 32 sessions, students completed collaborative writing while having metacognitive prompts at their disposal
INDI + META	During the 32 sessions, students completed writing individually while having metacognitive prompts at their disposal
COOP	During the 32 sessions, students completed collaborative writing
INDI	During the 32 sessions, students completed writing exercises individually

collect, generate, and evaluate evidence; and establish a position on the given topic in a concise manner. Participants were required to choose one opinion (A or B) from the following statement pair and describe the problem, synthesize possible solutions, and present reasonable arguments about the chosen topic.

(A) Young people should continue to live with their parents after they finish their education.
(B) Young people should move away from home after they finish their education.

The test was administered before and after the experiment and served as the pre- and post-tests. Cronbach's alpha values were .77 and .79 for the pre- and post-test, respectively, indicating sound reliability (Field, 2013).

Metacognitive Awareness Inventory on Writing

A self-report metacognitive awareness inventory designed by Schraw and Dennison (1994) was adapted to assess participants' general and specific metacognitive knowledge. For the present study, statements were revised for assessing metacognition related to writing. The inventory used in Schraw and Dennison's study focused on general learning; the version in the present study focused on writing and was labeled the Metacognitive Awareness Inventory on Writing (MAIW). For example, the original inventory statement, "I consider several alternatives to a problem before I answer," was revised to "I consider several alternatives to a problem before I write" in the MAIW. The original statement, "I ask myself periodically if I am meeting my goals," was revised to "I ask myself periodically if I have met my pre-determined goals for my writing." The MAIW also included eight attributes: declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, evaluating, information management, and debugging strategies. The first three attributes were classified under knowledge of metacognition (18 statements); the remaining five attributes were categorized as regulation of cognition (34 statements). The MAIW included 52 statements that were used for subsequent data analysis. Experts in similar research areas were invited to review the questionnaire and evaluate items' construct validity. The questionnaire was administered in Chinese to avoid cross-cultural misunderstanding. Two bilingual Chinese EFL teachers were invited to translate and check the inventory. The first teacher translated, and the second verified the translation. This inventory was administered to participants before and after each intervention. Cronbach's alpha values were .75 and .77 for the pre- and post-tests, respectively, revealing acceptable reliability (Field, 2013).

Scoring System

The marking scheme was based on the Chinese writing test requirement with which raters were most familiar. The scale consisted of five components: task achievement, coherence and cohesion, punctuation, lexical resources, and grammatical range and accuracy. This scale is similar to the scale used in the International English Language Testing System (IELTS); the only difference between the two is that, in contrast to the IELTS scoring rubric, punctuation is an essential component of the Chinese EFL writing scoring system. According to You (2004), the EFL writing scoring system better reflects the characteristics of Chinese EFL students' writing and writing proficiency. All criteria were weighted equally. The rating system used a 15-point scale, with three points allowed for each component. To measure metacognitive awareness, students scored each inventory statement on a seven-point Likert scale (1 = very strongly disagree; 7 = very strongly agree).

Three experienced teachers were invited to score the writing tests and the survey. They were unaware of the treatment condition or participants' identities and did not teach any of the four groups. Each rater attended a training session prior to marking students' work. Raters were trained using anchor papers and were not informed whether answers were from the pre- or post-test. The first two raters scored the tests in the initial stage. Unanimous inter-rater agreement was observed on the metacognition measure. Inter-rater reliability for the writing outcomes was 94.1%. A third rater was consulted for discrepancies, and final score decisions were based on majority opinion.

Data Analysis

The first purpose of this study was to investigate the differential effects of the four independent variables (treatment conditions) on metacognitive awareness. Correlations between the two dependent variables (i.e., knowledge of metacognition and regulation of metacognition) ranged from .32 to .41. These correlations were suitable for MANOVA, which was used to test hypotheses about the effects of the independent variables on the dependent variables.

The second purpose was to measure potential improvements in participants' argumentative essay writing. In terms of inferential statistical analysis, a 2×2 two-way ANOVA was conducted on the post-intervention writing test. The third purpose was to examine the predicting effect of learners' metacognitive awareness on their writing. Standard multiple regressions were conducted to explore the predicting effects of metacognitive knowledge, metacognitive regulation, and their interaction on writing. Multiple regression analysis was used to examine the

simultaneous effects of two or more variables on at least one dependent variable whereby their joint effect could be significantly greater (or significantly less) than the sum of their parts (Field, 2013). An interaction effect in a regression model can reveal relationships among variables in the model. Our multiple regression included two independent variables (knowledge and regulation of metacognition) simultaneously. The interaction effect was measured based on changes in the effects of independent variables on a dependent variable (writing outcomes).

We used a Bonferroni correction to control the possibility of Type I error, which may increase due to repeated testing. The Bonferroni correction was used to counteract the problem of multiple comparisons. The *p*-value for statistical significance was set to 0.05; effect sizes were demonstrated by partial η^2.

Experimental Procedures

This study includes three sessions. In the first session, the learners took a 100-point internal English test that measured English reading, vocabulary, and writing skills. Based on this test, a total of 170 students of intermediate English proficiency were selected. All participants signed a consent form indicating their responsibilities regarding and benefits from taking part in the study. All participants could earn extra course credit. No participants dropped out of the study, although they could choose to do so at any time without penalty. This study was supported by the selected university and approved by the university's ethics committee. The participants completed the writing test (within 40 min) and MAIW (untimed) as a pre-test. In the second session, the participants were then divided into four groups as described earlier. The four groups each received instruction for 2 h per week for 16 weeks. In the third section, students completed the writing test (within 40 min) and MAIW (untimed) immediately after the treatment. An English writing teacher who was familiar with the training approach served as an independent instructor for each group. The teacher also proctored the writing test and MAIW.

Results

RQ1: How do the four treatment conditions affect students' development of metacognitive awareness?

During this research study, metacognitive awareness was assessed on the basis of metacognitive knowledge and metacognitive regulation, which were evaluated before and after the study. In terms of metacognitive knowledge, differences in pre-test scores among the four conditions ranged from 2.72 to 2.81. For metacognitive regulation, differences in pre-test scores ranged from 3.15 to 3.21. The ANOVA results revealed no significant differences in the pre-test scores among the four conditions in relation to knowledge of metacognition [$F(3, 166) = 1.95$, $p = .57$] or regulation of metacognition [$F(3, 166) = 1.82$, $p = .58$]. Therefore, comparing post-intervention tests completed by the same students who had participated in the pre-test was reasonable. Differences in post-test scores among the four conditions are shown in Table 2.

As shown in Table 2, post-test scores on metacognitive knowledge ranged from 1.14 to 4.39; scores on metacognitive regulation ranged from 2.36 to 6.31. The next step was to run MANOVA tests. Box's Test of Equality of Covariance Matrices (Box's M = 47.203, $F = 5.131$, $p < .001$) indicated unequal variance–covariance matrices. In this case, the null hypothesis (i.e., that the observed covariance matrices of the dependent variables were equal across groups) was violated. The next step was to use Pillai's criterion for multivariate tests to examine the impact of each intervention on participants' metacognitive awareness. (Table 3).

Table 3 reveals a significant effect of metacognitive prompts on metacognitive awareness, $V = .761$, $F(2, 166) = 264.037$, $p < .001$, partial $\eta^2 = .76$; a significant effect of learning setting (individual vs. collaborative learning) on metacognitive awareness, $V = .756$, $F(2, 166) = 257.211$, $p < .001$, partial $\eta^2 = .76$; and a significant effect of the interaction between metacognitive prompts and learning setting on metacognitive awareness, $V = .119$, $F(2, 166) = 11.164$, $p < .001$, partial $\eta^2 = .12$.

Univariate tests were performed after multivariate tests to explore the effects of the four conditions on the two dimensions of metacognitive awareness (Table 4).

Table 4 presents the significant effect of metacognitive prompts [$F(1, 169) = 294.604$, $p < .001$, partial $\eta^2 = .64$] and learning setting [$F(1, 169) = 242.557$, $p < .001$, partial $\eta^2 = .59$] on metacognitive knowledge. However, no

Table 2 Means and standard deviations of metacognitive knowledge and regulation (post-test)

Metacognition	Conditions	Mean	Std. deviation	*N*
Knowledge of metacognition	INDI	1.14	.347	44
	COOP	2.82	.756	44
	INDI + META	2.98	.780	42
	COOP + META	4.39	.628	41
Regulation of metacognition	INDI	2.36	.613	44
	COOP	4.82	.724	44
	INDI + META	4.76	.617	42
	COOP + META	6.31	.528	41

Table 3 Multivariate tests for metacognition

Effect	Value	*F*	Hypothesis df	Error df	Sig	Partial η^2
Metacognitive prompts						
Pillai's trace	.761	264.037	2	166	.000	.76
Learning setting (INDI/COOP)						
Pillai's trace	.756	257.211	2	166	.000	.76
Metacognitive prompts × learning setting						
Pillai's trace	.119	11.164	2	166	.000	.12

Table 4 Results on the univariate tests following multivariate tests

Source	Type III sum of squares	df	Mean square	*F*	Sig	Partial η^2
Metacognitive prompts						
MK	124.297	1	124.297	294.604	.000	.64
MR	161.561	1	161.561	412.029	.000	.71
Learning setting						
MK	102.338	1	102.338	242.557	.000	.59
MR	171.046	1	171.046	436.219	.000	.72
Metacognitive prompts * learning setting						
MK	0.766	1	0.766	1.814	.180	.01
MR	8.778	1	8.778	22.386	.000	.12

MK metacognitive knowledge, *MR* metacognitive regulation

effect of the interaction between metacognitive prompts and learning setting on metacognitive knowledge emerged [$F(1, 169) = 1.814$, $p = .18$, partial $\eta^2 = .01$]. Regarding metacognitive regulation, a significant effect was observed for metacognitive prompts [$F(1, 169) = 412.029$, $p < .001$, partial $\eta^2 = .71$] and learning setting [$F(1, 169) = 436.219$, $p < .001$, partial $\eta^2 = .72$], along with an interaction effect between them [$F(1, 169) = 22.386$, $p < .001$, partial $\eta^2 = .12$].

Post hoc analyses of adjusted mean scores based on pairwise comparison revealed that COOP + META students demonstrated significantly higher metacognitive knowledge than INDI + META students ($p < .05$), COOP students ($p < .05$), and INDI students ($p < .001$). In addition, INDI + META group students outperformed those in the INDI condition ($p < .05$), and COOP group students outperformed those in the INDI condition ($p < .05$). Likewise, COOP + META students reported significantly higher metacognitive regulation than INDI + META students ($p < .05$), COOP students ($p < .05$), and INDI students ($p < .001$). Learners in the INDI + META group also outperformed those in the INDI group ($p < .00$), and COOP students outperformed those in the INDI group ($p < .05$).

Question 2: How do the four treatment conditions affect students' EFL writing development?

Prior to the start of the study, writing-related differences among the groups ranged from 7.13 to 7.23. The ANOVA results indicated no significant differences between conditions before the study [F (3, 166) = 1.51, $p = .67$]; however, large differences were observed in the four groups' post-test writing scores (Table 5).

Table 5 shows that participants in the COOP + META condition achieved the highest writing scores ($M = 12.80$, SD .901), followed by participants in the INDI + META condition ($M = 10.43$, SD .831), COOP condition ($M = 9.02$, SD 1.171), and INDI condition ($M = 7.34$, SD 1.16).

A 2 × 2 two-way ANOVA was next conducted to explore the group effect on writing outcomes. Based on

Table 5 Descriptive statistics for the post-intervention writing test (Maximum = 15)

Conditions	Mean	Std. deviation	*N*
INDI	7.34	1.16	44
COOP	9.02	1.171	44
INDI + META	10.43	.831	42
COOP + META	12.80	.901	40
Total	9.84	2.245	170

Levene's Test for Equality of Variances [$F(3, 166) = 1.712$, $p = .166$], the assumption of equal variances was not violated. In this case, reporting the results of between-subjects effects tests (Table 6) was feasible.

Regarding writing outcomes, Table 6 indicates a significant effect from metacognitive prompts [$F(1, 169) = 473.875$, $p < .001$, partial $\eta^2 = .74$], learning setting (individual vs. collaborative learning) [$F(1, 169) = 165.358$, $p < .001$, partial $\eta^2 = .49$], and the interaction between metacognitive prompts and learning setting [$F(1, 169) = 4.843$, $p < .05$, partial $\eta^2 = .02$].

Post hoc comparisons revealed that writing outcomes were significantly better in the META + COOP condition compared to the META condition ($p < .01$), COOP condition ($p < .01$), and INDI condition ($p < .001$). In addition, META group students outperformed those in the INDI condition ($p < .01$), and COOP group students outperformed those in the INDI condition ($p < .01$). No significant difference was found between writing scores in the COOP and INDI + META conditions ($p = .061$).

Question 3: To what extent does EFL students' metacognitive awareness predict their writing outcomes?

Standard multiple regression analyses were performed to explore the predicting effect of metacognitive awareness on writing outcomes. Results are presented in Table 7.

Table 7 shows significant main effects of metacognitive knowledge and metacognitive regulation and a significant effect of metacognitive knowledge × metacognitive regulation interaction on writing outcomes. The adjusted R^2 indicated that 67% of the variance could be predicted by the three independent variables. In particular, metacognitive knowledge accounted for 26% of the variance, metacognitive regulation accounted for 46%, and the interaction between them accounted for an additional 8.8%. Hence, the introduction of metacognitive knowledge and regulation enhanced learners' writing outcomes.

Discussion

This study compared the effects of four instructional methods (COOP + META, INDI + META, COOP, and INDI) on students' metacognitive awareness and EFL writing outcomes. Results also revealed a predicting effect of metacognitive awareness on EFL writing outcomes.

Metacognitive Awareness

The findings indicated that students in the COOP + META condition exhibited the most improvement in self-reported metacognitive knowledge and regulation. In line with previous studies (Kramarski, 2004), learners' self-regulation may be directed and improved by curriculum-embedded COOP + META training. A cooperative learning setting seemed to help learners understand the use of metacognitive strategies. When learners receive metacognitive prompts while collaborating with peers, they may confront disparate interpretations, which may lead to negotiation about the meaning of learned content (Lam & Kapur, 2017). Thought-provoking questions raised during peer interactions may also foster negotiation. Therefore, learners may be more likely to reflect on their learning and presumably realize the need to plan, monitor, and evaluate their writing. As suggested in earlier studies (e.g., Yarrow & Topping, 2001), the key elements of cooperative learning, namely scaffolding, thought-provoking questions, reflective modeling, and feedback, are essential to learners' monitoring, self-reflection, and evaluation. Learners appear to be skilled at internalizing these systematically trained metacognitive skills through COOP + META training. However, caution should be exercised when interpreting

Table 7 Standard multiple regression for metacognitive awareness on writing outcome

	Variables	*B*	Std. error	*β*	sr^2
Writing outcome	MK	.596**	.278	.351	.26
	MR	.538**	.145	.371	.46
	MK* MR	.195**	.048	.859	.088
	Model summary	Intercept = 6.257			
		R^2 = .774			
		Adjusted R^2 = .67			
		R = .88			
		Std. Error of the Estimate = 1.076			

MK metacognitive knowledge, *MR* metacognitive regulation
**$p < .001$

Table 6 Tests of between-subjects effects on writing

Source	Type III sum of squares	df	Mean square	*F*	Sig	Partial η^2
Metacognitive prompts	503.921	1	503.921	473.875	.000	.74
Learning setting	175.842	1	175.842	165.358	.000	.49
Metacognitive prompts * learning setting	5.150	1	5.150	4.843	.029	.02

these results; self-report questionnaires may not provide a reliable or accurate representation of learners' metacognitive skills.

The results also revealed that COOP + META training elicited positive results related to learners' self-reported metacognitive knowledge. This finding echoed previous work in which university students were found to be well aware of their declarative and procedural metacognitive knowledge (Zinchuk, 2015), and collaborative learning conditions were potentially beneficial for gaining deep insights into adaptation of learners' metacognitive knowledge (Backer et al., 2012). However, compared to a higher level of metacognitive regulation, learners in our study initially reported lower levels of metacognitive knowledge. Therefore, it may be unreasonable to expect immediate, dramatic improvements in learners' self-reported metacognitive knowledge after a short-term intervention. Finally, metacognitive knowledge has been shown to be related to learners' beliefs about people, tasks, and strategies that influence their cognitive processes (Teng, 2016). These learners may have been less consciously aware of their self-efficacy and cognitive processes. In addition, the metacognition measure may have precluded a complete evaluation of metacognitive development; other cognitive processes might also have developed without conscious reflection.

Writing Outcomes

Results showed that learners may benefit from either metacognitive prompts or collaborative group learning. Incorporating metacognitive prompts, or placing participants in a group learning setting, may be suitable for helping learners achieve greater essay writing performance. First, the effects of metacognitive prompts on writing support a large body of research that has uncovered the beneficial effects of metacognitive training on writing (e.g., MacArthur et al., 2015; Santelmann et al., 2018; Teng, 2020a, b). Metacognitive instruction may help learners activate metacognitive processes and identify writing-related strategies (Conner, 2007). Metacognitive prompts may also enable EFL students to employ writing strategies to leverage regulatory skills for their intended goals to maximize writing performance (Teng, 2016). Introducing metacognitive prompts could also guide students in reflecting on their chosen writing strategies, which could in turn help learners optimize resources at their disposal and identify strategies to monitor, evaluate, and reflect on writing output during and after a writing task (Teng, 2021). Consistent with the positive effects of improving writing performance through metacognitive training (e.g., Nguyen & Gu, 2013; Teng, 2020a), metacognitive guidance may help learners build a repertoire of strategies from which they can draw while writing. One explanation is that growth in metacognitive regulation may sensitize learners to details and to the connections between metacognitive prompts and writing.

Second, results indicated that a cooperative learning setting may enable students to engage in peer interactions and motivate them to argue, reason, and negotiate while participating in writing-related discourse (Yarrow & Topping, 2001). The positive effect of cooperative learning on writing among EFL students was similar to effects observed in prior studies (e.g., Li & Zhu, 2017; Storch, 2005). In our case, learners in a collaborative learning setting co-planned, drafted, reviewed, and revised writing exercises. In line with Altstaedter's (2018) assertions, such cooperative learning activities may build and enhance students' capacity to pool ideas and provide each other with feedback. Such cooperative learning activities may also develop learners' self-regulatory capacity (Lam & Kapur, 2017), which could then help learners detect discrepancies between the actual and intended level of text quality (Yarrow & Topping, 2001). Accordingly, learners may be better able to identify and solve problems arising during and after writing. Therefore, a cooperative learning setting appears to positively affect EFL learners' writing outcomes because they may be willing to help partners with their writing while being engaged with their own.

Finally, our results revealed the greatest effect of COOP + META treatment on writing outcomes. Students benefited from incorporating metacognitive prompts into a cooperative learning setting; thus, metacognitive prompts and cooperative learning may operate jointly. As argued by Teng (2016), using metacognitive prompts in a collaborative writing setting may help learners process information while writing, thereby reducing their cognitive overload, and leading to better writing outcomes. Based on these findings, considering the disadvantage of merely placing learners into cooperative learning settings is also important. For example, cooperative learning does not necessarily lead to interactive group work and effective learning (Johnson & Johnson, 1994). During cooperative learning, some learners may lack positive interdependence and individual accountability (Slavin, 1996) or may not know how to monitor and reflect upon their learning process (Slavin & Karweit, 2015). Instruction on self-regulated strategies can direct learners to apply metacognitive strategies to produce arguments, engage in discussion, seek solutions to complex problems, and reflect upon the writing at hand (MacArthur et al., 2015). Metacognitive prompts may even compensate for a lack of positive

interdependence and individual accountability in a cooperative learning setting (Teng, 2021).

The Predicting Effect of Metacognitive Awareness on Writing Outcomes

Our findings suggested predicting effects of metacognitive knowledge and regulation on EFL writing outcomes. Participants' enhanced writing outcomes were related to greater metacognitive awareness. This finding was related to work in which metacognition was identified as a strong predictor of academic learning (Blankson & Blair, 2016). In the present study, metacognitive awareness appeared to afford learners the capacity to regulate cognitive resources, identify personal strengths and weaknesses in writing, and discover appropriate writing strategies. One could argue that learners with refined metacognitive awareness may be able to establish reasonable writing goals and then employ appropriate writing strategies to plan, monitor, and evaluate their writing. Such metacognitive awareness may help learners determine whether their chosen strategies work well. When these strategies are ineffective, learners may then be able to make adjustments until the strategies align with their writing goals. In addition, consistent with previous studies (Harris & Graham, 2009), learners with lower metacognitive awareness may not set appropriate writing goals and may thus find it difficult to effectively plan, monitor, and evaluate their writing.

In particular, metacognitive regulation was a more pronounced predictor of writing outcomes compared to metacognitive knowledge. Metacognitive regulation, which encompasses the self-regulatory capacity to plan, monitor, and evaluate one's thinking, can make a significant and unique contribution to predicting EFL writing scores beyond what is provided by metacognitive knowledge. This positive effect of metacognitive regulation coincides with other studies (Nguyen & Gu, 2013; Teng, 2020a; Teng & Huang, 2019). EFL students who demonstrated better metacognitive regulation were more likely to adopt or modify metacognitive strategies for writing. Learners may also find it challenging to understand knowledge about themselves and given writing tasks; it may be easier for them to build an awareness of how strategies are selected, resources are allocated, and task performance is monitored and evaluated.

Conclusion

This study contributes to research in the field of metacognition and EFL writing in several ways. First, COOP + META learners showed the greatest enhancement in metacognitive knowledge and regulation. These learners may have had sufficient context-related learning experiences to develop metacognitive awareness. Second, COOP + META students were more successful than others in improving their EFL writing outcomes. The COOP + META condition may have helped learners realize deeper information processing, develop more profound metacognitive awareness, and monitor and reflect on their writing processes more effectively. Finally, EFL students' enhanced metacognitive awareness predicted their writing outcomes. In particular, metacognitive regulation was a more significant predictor of EFL writing outcomes than metacognitive knowledge.

This study had several unavoidable limitations. First, the sample was limited to students with similar English proficiency. Future studies involving learners with different English proficiency levels would complement our work. Second, we did not conduct qualitative analysis of group talk during cooperative learning; subsequent research could involve observation of students' group work to gain a sense of metacognitive behavior that may have led to positive outcomes. In addition, interviews with some students from each of the four treatment groups may enrich the findings. Third, although writing an argumentative essay is a necessary part of the English writing test, future studies could focus on the assessment of different writing skills. Despite these limitations, this study strengthens the understanding of incorporating metacognitive prompts into a cooperative learning setting, which can enhance university students' EFL writing performance and metacognitive awareness.

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