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Computer-Aided Argument Mapping within Metacognitive Approach: Its Impact on Students' Argumentative Writing Performance and Self-Regulated Learning

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Abstract

Digital visual mapping to date has recently been implemented in an English Foreign Language (EFL) classroom. However, there is a growing need to implement this digital mapping tool within a strategic approach for more effective and self-regulated learning. This paper aimed to investigate the effects of Computer-Aided Argument Mapping (CAAM) within the metacognitive approach on Thai EFL learners' argumentative writing performance across the development of writing content and writing coherence and their self-regulation of learning. A mixed-method type of research was employed involving a one-group of pre- and post-test design. A total of 21 Second Year college students was purposively selected as samples. A Self-Regulation of Learning Scale (SRS) was also used to

Learning	track the development of their self-regulation. Results reveal that students' argumentative writing performance made noteworthy gains as manifested by a significant difference between their pre- and post- test results. Furthermore, five of six SRL components reveal a significant relationship with students' argumentative writing performance indicative that they have become more self-regulated in their learning in terms of planning, self-monitoring, evaluation, effort, and self-efficacy. Qualitative findings reveal that the participants have positively welcomed the use of CAAM on their writing processes and self-regulation. Finally, the study findings provide thoughtful insights into utilizing digital mapping within the metacognitive approach to improve students' argumentative writing skills and self-regulated learning as well as revolutionize EFL learning classrooms in this digital period.

Introduction

Writing has been a necessary requirement for learners in their undergraduate studies; however, developing an effective writing competency is a tough undertaking for them especially writing a composition in English which is viewed as one of the main problems amongst EFL learners. There are various writing challenges that learners have been encountering. These include knowledge of the task and content, lexical complexity, coherence and cohesion, and fluency of ideas (Harrell & Wetzel, 2013; Malmir and Khosravi, 2018). These challenges are just some of the problems related to the development of effective writing ability (Malmir & Khosravi, 2018) and are sometimes observed in Thai schools and universities (Robillos & Phantharakphong, 2020). These challenges had become even more complex when a writing genre is introduced at the same time (Hyland, 2013). Writing genres (*e.g.* argumentative writing; expository writing) add to the inherent complexity involved in second language (L2) writing because of their special lexical and syntactical grammar apart from its structural organizations (Malmir & Khosravi, 2018; Weigle, 2013). These difficulties are overloading the learners' cognitive load which needs to be reduced in order to acquire new information. In order to assist the acquisition of new information which are representations of either concepts or

problem-solution procedures, Sweller (1994) recommends reducing the extraneous cognitive load during the learning process.

One common method of reducing unimportant cognitive load is by using maps and diagrams which help facilitate problem-related procedures (Davies, 2011; Harrell & Wetzel, 2013; Robillos, 2021; van Gelder, 2007). Mapping or diagramming facilitates understanding of knowledge when there is a large amount of information to work with, in a given limited time. Mapping also assists learners to have more engagement in their process of generating ideas and information as it activates their schemata necessary in organizing writing ideas and content. When learners draw their thoughts through the process of mapping, they will have a full grasp hold of their thoughts in their minds. Therefore, they will be better able to distinguish ideas that are needed to be added or deleted and reformation of mistakes would be possible. Moreover, mapping ideas can assist learners to produce more developed and coherent outputs and this can trigger their critical thinking, which is often considered a core objective of higher education (Dwyer et al., 2011), problem-solving abilities (Robillos & Phantharakphong, 2020), self-regulation (Pahlavani & Maftoon, 2015), and therefore, optimize their learning performances.

However, if students are taught of mapping their thoughts within a metacognitive approach, students can know how to plan, monitor, and evaluate what they want to do (Flavell, 1979; O'Malley & Chamot, 1990; Robillos, 2019). When students learn how to plan and monitor a task and how to evaluate their performance, they take on more responsibility for their learning which is a pre-requisite for self-regulated learning (Robillos, 2020). A great number of studies (Bozorgian, 2014; O'Malley & Chamot, 1990; Robillos, 2019) in Second Language Acquisition (SLA) proved that a metacognitive approach to second language instruction provides learners the proper guidance in EFL learning. For example, writing skill is considered a complex skill to teach (Malmir & Khosravi, 2018; Robillos & Phantharakphong, 2020). It requires a strategic approach, which is proposed by most SLA researchers (Eccius-Wellman & Santana, 2020; Flavell, 1979; O'Malley & Chamot, 1990; Robillos, 2019). The strategic approach had been proved to increase control, confidence, and eventually proficiency to EFL learners (Eccius-Wellman & Santana, 2020; Zheng, 2018). On this line of reasoning, teachers have to provide sufficient opportunities to act upon the set of rules and stages that have

already been devised (Bozorgian, 2014; Eccius-Wellman & Santana, 2020; Robillos, 2019; Robillos & Phantharakphong, 2020).

As a corollary to the above, this study is intended to delve into exploring the impact of Computer-Aided Argument Mapping (CAAM) employing metacognitive procedures that might assist Thai EFL learners to plan, monitor, and evaluate their argumentative writing task processes as well as fostering their self-regulation of learning.

Literature Review

Argument Mapping

Argument maps are visual tools that aid in understanding and evaluating arguments (Davies, 2014), and are organized in a text-based, hierarchical representation, with propositions arranged in coloured boxes and connected by arrows that highlight the relations (i.e. *because, but, however*) between propositions (Dwyer et al., 2011; van Gelder, 2007). Argument mapping or AM, on the other hand, is a way of mapping the inferential construction of an argument to represent reasoning in a clear and concise manner (Davies et al., 2021). As a pedagogical tool, AM increases the chance of meaningful learning (Davies, 2011). Recent studies (*e.g.* Davies et al., 2021; Harrell, 2007; Harrell & Wetzel, 2013; Robillos & Phantharakphong, 2020) have revealed the instructive benefits of AM. For example, AM has been used for language teaching methods in general (Robillos, 2021), and in EFL writing in particular (Davies, 2011; Harrell & Wetzel, 2013; Robillos & Phantharakphong, 2020). Further, Harrell and Wetzel (2013) supported the effectiveness of using AM method for EFL text comprehension. Results of their study reveal that well-designed argument diagrams can both improve L2 learners' critical thinking and writing performance among First-Year language learners. They highlighted that AM ignites learners' schemata which are necessary for argumentative writing.

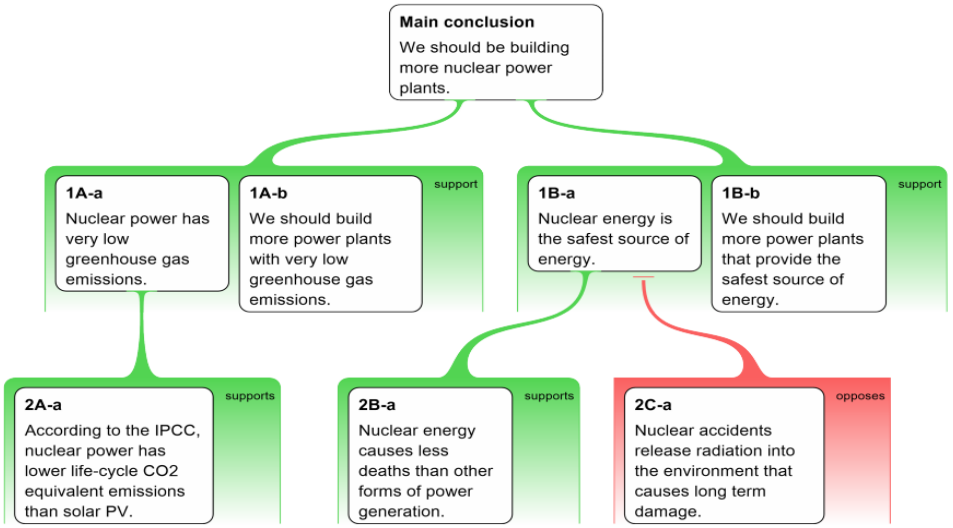
In the study conducted by Dwyer et al. (2011), they compared the influence of training critical thinking through AM with a method of extracting themes from a text and then organizing them in a hierarchical way. Both experimental and no-instruction control groups were utilized to measure critical thinking ability at a National University in Ireland. They reported that although no significant effect of AM training on

students' overall critical thinking performance, the participants in the experimental group outperformed the no-instruction control groups on tests of evaluation and inductive reasoning. AM assists EFL learners to produce more developed and coherent written outputs (Dwyer et al., 2011). AMs can trigger L2/ EFL learners' critical thinking and problem-solving abilities and therefore optimize their writing performance. Added to this is the study conducted by Pinktwart et al. (2009) reporting that the use of AM enhances second language learners' composition writing.

Davies et al. (2021) claimed that "…the process of making an argument map is advantageous since it encourages students to construct and/or reconstruct their arguments with a level of clarity and thoroughness" (p.115). Figure 1 below presents a short argument to show the main conventions used in AM:

Figure 1

An Argument Showing the Main Conventions Used in Argument Mapping



The figure demonstrates an argument showing the main conventions in AM. The main conclusion is placed at the topmost part of the map. The reasons for the main conclusion are identified by green shaded areas linked by lines to the main conclusion. The main conclusion in the example has two reasons and is labelled as 1A and 1B. Inside the green shaded areas white claim boxes are used to display individual

premises. The "premises" are placed in separate premise boxes because each premise needs its own justification. The surrounding green reason envelops groups together linked premises working together to form a reason for the conclusion. Further, objections to claims are identified by a red-shaded color. Writers designate reasons and objections using words such as *"supports"* and *"opposes"* respectively (Davies et al., 2021).

Computer-Aided Argument Mapping (CAAM)

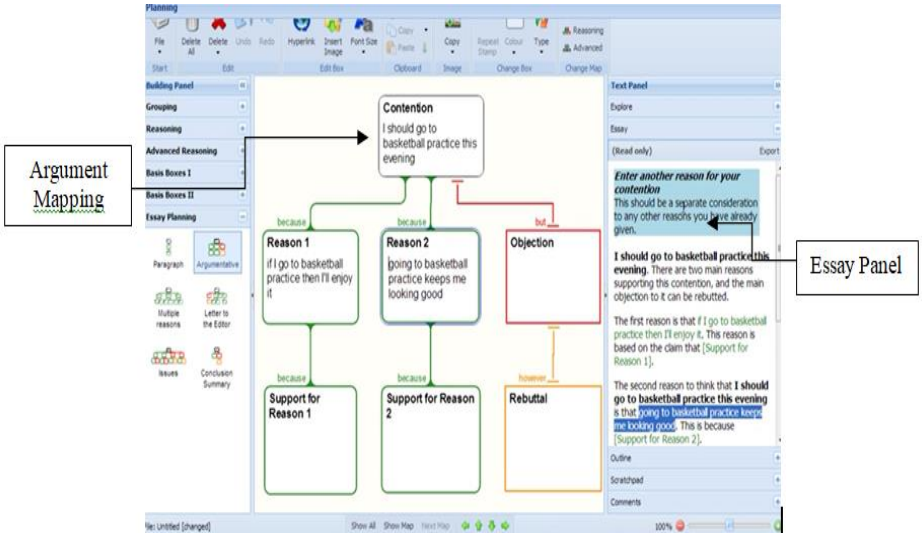
The development of software programs has facilitated the process of constructing maps for the users. Although AM can be taught effectively only by using pen and paper (Harrell, 2007) or without the assistance of a computer, AM can be augmented with CAAM that aid the mapping process in a much easier and time-saving way. Moreover, CAAM uses programs specifically designed to allow students to quickly represent arguments and reasons using box and line diagrams (Davies et al., 2021; van Gelder, 2015). CAAM is an instructional program thataims to enhance the learner's critical thinking by diagramming reasoning on any given topic (Pahlavani & Maftoon, 2015). Additionally, CAAM facilitates the construction of argument maps by providing a user-friendly workspace and a building panel (van Gelder, 2007). There are levels of reasoning boxes that aid a user to create a map by typing the text into the boxes and then dragging them to their appropriate position on the map. The boxes can be added, removed, edited, or moved to a new location. Although CAAM programs do not analyze and check the soundness of arguments, they help students to practically analyze and evaluate the arguments in a better way. According to Davies (2011), CAAM encourages students to compose arguments openly and thoroughly.

In addition, CAAM provides a platform which the learner arrives at such a conception not through an interactive process of drafting and revision, but through drawing and refining reasoning clearly before use so that they can identify the gaps and errors better and can reformulate their reasoning (Pahlavani & Maftoon, 2015). Mapping such views and reasons through CAAM is much easier because students can get better at argument analysis and evaluation. Furthermore, students using CAAM in accomplishing their AM in the panel can possibly check their essay in

another panel simultaneously as well as aiding them to be conscious of coherence and cohesion during the mapping process (see Figure 2). In addition, CAAM provides students with the opportunity to extensively practice reasoning and critical thinking through exercises at an increasing complexity which helps the learners to develop such skills (Eftekhari et al., 2016). Students can freely move the parts of an argument around and can experiment with different logical structures, thus, allowing students to gain a deeper understanding of the structure of their arguments, which is a prerequisite to critical thinking and self-regulation. Figure 2 shows an example of a student's AM produced in CAAM.

Figure 2

Example of a Student's Argument Map (AM) Produced in CAAM



Numerous studies have demonstrated empirical support for the use of CAAM in improving students' writing skills (Davies et al., 2021; Pahlavani & Maftoon, 2015; Robillos, 2021; van Gelder, 2007) and critical thinking skills (Davies et al., 2021; Robillos & Phantharakphong, 2020; van Gelder, 2015). van Gelder (2015) conducted a study using a one-subject CAAM based interventions in a course of three months. He reported that argument mapping courses improve critical thinking scores by around 0.8 of a standard deviation which over doubled that of the typical effect size for standard critical thinking courses. Pahlavani & Maftoon (2015), on the

other hand, conducted a study that investigated the impact of using CAAM to improve Iranian EFL learners' writing self-regulation. All participants completed the self-regulation questionnaire in writing skills. The 127 participants were randomly categorized into control, experimental 1, and experimental 2 groups. The experimental groups, during the course of the training, accomplished their writing assignments via CAAM software. They found that the use of CAAM aided the students to enhance their self-regulation towards writing.

Self-Regulated Learning

A number of studies (Pintrich & Schunk, 2002; Robillos, 2020; 2021; Zimmerman, 2008) that have been conducted, viewed SRL as an important new construct in the field of education. For example, Pintrich & Schunk (2002) described SRL as an active process where learners are able to self-regulate by setting goals for their learning, monitor their learning processes, self-control and regulate their own thinking, and evaluate and reflect their learning. Added to this is Zimmerman's (2008) view asserting that self-regulated learners systematically used metacognitive, motivational, and behavioral strategies and proactively participate in their own learning processes. Studies reported that individual differences such as personality traits, learning styles and strategies, motivation, beliefs, and self-regulation, could predict success in language learning (Malmir & Khosravi, 2018; Robillos, 2021).

Toering (2011) underscored that individuals who self-regulate their learning must strategically plan how to approach a task prior to actions, monitor their own progress while performing the task, evaluate the process and outcome after completing the plan, reflect on what they have accomplished and unaccomplished and further increase the number of strategies they can use, which gives them more possibilities to face and perform tasks to be completed the next time. However, apart from understanding what aspects to improve and how to improve such aspects, self-regulated learners must be motivated to progress (Zimmerman, 2008).

Pahlavani and Maftoon (2015) describe that the self-regulatory capacity can interact with cognitive factors since, as underscored by Robillos (2021), self-regulated learners can establish goals for their learning, can monitor, can assess, and can self-reflect their learning.

Thus, self-regulated learners are likely to become more able to interpret the signs of changes continuously. The processes involved in argument mapping are designed by well-planning and well-monitoring during the process which helps raise students' self-evaluation and self-reflection. With their critical thinking, reflection can optimize learners' self-regulated learning abilities because self-regulated learners have already known their position in the task.

Metacognitive Approach to Learning

Metacognition is the knowledge about and regulation of the cognitive processes during learning and thus can be referred to as "learning about learning" (Flavell, 1979). It plays an important part in optimizing self-regulation if we are to consider learners' psychological state. Thus, metacognition can be considered a building block of self-regulation, since self-regulated learners display great engagement in planning, monitoring, and evaluating their learning.

Metacognitive strategies, on the other hand, are "higher-order executive skills that may entail planning for, monitoring, or evaluating the success of activity" (O'Malley & Chamot, 1990, p. 44). A great number of studies proved that the metacognitive approach provides learners the proper guidance in EFL learning (Bozorgian, 2014; O'Malley & Chamot, 1990; Zheng, 2018). The metacognitive approach involves three main stages through which the writer progresses linearly: (i) planning stage which guides the student through the metacognitive process of planning and the related strategies of advance organization, predicting and schema building; (ii) monitoring which includes collaboration with a peer, in which comparisons of AMs are made, (*e.g.* conclusions, premises, counter-arguments are verified or altered), differences are discussed, problems are identified and plans are made for the subsequent writing process; and (iii) evaluation stage which involves the metacognitive process of evaluation and reflection, and identification of strategies used.

Training students through a strategic approach is useful for the empowerment of learners' self-regulation to learn (Robillos, 2020; 2021; Zheng, 2018). Learners who have the ability to think analytically and to learn independently are purposeful, strategic, and persistent in learning (Zimmerman, 2008) as well as possess more adaptive strategic and cognitive processes and are willing to take charge of their learning

(Toering, 2011; Zimmerman, 2008). This is one main role of metacognition in empowering self-regulation across domains.

Although previous studies have been conducted concerning teaching and learning EFL writing, *e.g.* critical writing using digital diagramming (Harrel & Wetzel, 2013); descriptive writing achievement via computer-aided argument mapping (Davies, 2011; Malmir & Khosravi, 2018); using computer-aided argument mapping to teach reasoning (Davies et al., 2021), there is no any study, to date, has concentrated on investigating the effect of CAAM within metacognitive approach on learners' argumentative writing performance and SRL. Additionally, this paper is significant in that it can offer pertinent information to those who work in the field of education, especially in the parlance of EFL. The results of the present study might give a clear lens for EFL teachers in terms of helping them to augment their understanding of language learning from the learners' viewpoints and give them more insights into the advantage of teaching EFL lessons within metacognitive approach with computer-assisted argument mapping and thereby aid them in enhancing students' argumentative writing skill and self-regulation. With the aims stated above, the present study is guided by the following research questions:

1. Is there a significant difference between the students' argumentative writing performance before and after the implementation of CAAM within the metacognitive approach? (CAAM within the metacognitive approach is the strategy intervention hereafter refer to)
2. Is there a significant relationship between the students' argumentative writing performance and their Self-regulated learning after strategy intervention was implemented on them?
3. What experiences the participants have obtained in improving their argumentative writing processes and performance after strategy intervention was provided on them?

Methodology

Research Method and Samples Used

The present study employed a mixed-method type of research which involves two methods of data collection and analysis: a

quantitative part, and the qualitative part (Creswell & Plano-Clark, 2011). While the quantitative data were used to answer whether the use of CAAM within the metacognitive approach impacted students' argumentative writing performance and self-regulated learning, qualitative data helped explore how students perceived their experiences and participation during the implementation of CAAM to help them process their argumentative writing tasks.

In this study, the researchers used a single group of pre- and post-test designs and a semi-structured interview for collecting data to explore the effect of using CAAM on the students' argumentative writing across the development of writing content and writing coherence and their self-regulation of learning. In addition, the researchers involved 10 weeks/sessions constituted of eight weeks/sessions for the implementation of the CAAM during their writing processes; one session each for the administration of the pre- and post-tests. All the 21 Second Year college students (N=4 males and N=17 females) at the study-university were purposively selected as samples, *i.e.* the sample is approached with a purpose in mind and the criteria needed for the sample has been predefined (Creswell & Plano-Clark, 2011). These Thai EFL participants are enrolled in the Approaches to Writing course which is aimed to develop their academic, critical writing ability. Each student at the study-university, (a university located in the Northeastern part of Thailand) must take the course which is the focus of this writing program. The academic writing course taken during the second year is generally one of the students' writing courses to expose them to think and write critically. Specifically, the learning objective for the writing program is for students to be able to write argumentative essays that both analyze and evaluate one or more arguments. In the aforementioned writing course, students can explore issue/s from multiple perspectives and eventually contribute an argument of their own through writing via CAAM. Implementation of CAAM within the metacognitive approach in their writing processes has not been in practice for the learners in their regular classroom.

Research Instruments and Data Collection

Four methods of data collection were employed: Firstly, a *writing pre-test*. The respondents developed an argumentative essay using at

least 250 words in an hour. The writing topic was selected from among the topics that normally appear in the IELTS writing task 2 which is as well aligned to topics in their Approaches to Writing course; however, checked by three English experts who are also lecturers at the Faculty for its cognitive and cultural level of appropriateness before using. Prior activities, such as brainstorming, posing questions, and a reading text to further develop their schemata which took 60 minutes, were carried out. Moreover, the writing scoring rubric designed by the researchers themselves was checked by the three English experts, for its cognitive and cultural level of appropriateness.

Secondly, *the Self-Regulation of Learning Scale* (SRS). This was administered to the participants before and after the strategy intervention was implemented. This questionnaire was first formulated by Toering (2011) and is composed of 46 items divided into six components namely: planning, self-monitoring, evaluation, reflection, effort, and self-efficacy. The Self-Regulation of Learning Scale is intended to measure self-regulation as a relatively stable attribute in multiple learning domains. Originally, the subscales of planning (9 items), self-monitoring (8 items), effort (10 items), and self-efficacy (10 items) were scored on a 4-point Likert rating scale: (1) never to (4) always; however, in the present study, the scale was revised into a 5-Likert scale with reliability values of 0.78, 0.73, 0.78, and 0.69 respectively to conform with the subscales of evaluation (8 items) and reflection (5 items) which were scored on a 5-point Likert rating scale. In accordance with the original scales, evaluation ranged from (1) never to (5) always, and reflection ranged from (1) strongly agree to (5) strongly disagree. Before data analysis, reflection scores were reversed to make them correspond to the scores on the other five subscales. To ensure the reliability of the questionnaire, a pilot study was conducted on 49 Third Year college students who were not the target group. The reported reliability value was 0.84.

Thirdly, the *writing post-test*. This consisted of an argumentative writing test. The writing topic was selected from among the topics that appear in the IELTS writing task 2; however, aligned to topics in their Approaches to Writing course. This writing topic was checked by three English experts who are also lecturers at the Faculty for its cognitive and cultural level of appropriateness. Participants were given 60 minutes to finish their essay using at least 250 words.

Finally, *interviews*. Interviews were conducted one week after the strategy intervention was provided to the participants to be able to gather more details about how often and when the participants would use the CAAM as well as how the approach would assist them in their argumentative writing processes across the development of writing content and writing coherence.

Treatment

Each of the eight sessions took around 90 minutes utilizing planning, monitoring, and evaluation stages involved in the metacognitive approach. The first session (2nd week) was the introduction part where the "argumentative" type of writing and key concepts of CAAM were demystified, described, and discussed.

The three stages, however, were completed within the 3rd to 5th sessions. Each stage has corresponding activities undertaken. Under the planning stage, the activities included advanced organization and schema building. Then, the teacher introduced the writing topic to develop; asked them to brainstorm and share their thoughts with their peers. Regarding the monitoring stage, the students create their argument maps and are asked to share their maps to their peers to shape their ideas before they write and to solve some issues regarding mismatched premises, incorrect counter-arguments, and the like. The teacher also provides advice to those students who had encountered problems in their work. The evaluation stage is composed of submission and discovery/reflection parts. Here, the students compose their essays and send to their teacher their argument maps via CAAM. Indirect corrective feedback is also provided by the teacher to monitor his students' writing process. After the teacher sends back the paper to his students, students will have an opportunity to self-evaluate and self-reflect their performance and have the chance to discuss to their peers how successful or unsuccessful their written outputs are and they may share some possible strategies of doing so to deal with problems that may encounter in the future. Furthermore, revising and editing checklists will also be provided to the students to revise and edit their own writing performance however, these editing checklists may or may not be used by the participants to revise their written product.

The last four sessions were two more rounds of argumentative writing activities. Two different topics would be developed using the strategy intervention to further expose them to the use of CAAM software on their writing processes.

Test Marking

Pre- and Post- writing tests were checked and given marks based on the following marking rubric: Under the Pre-test and development of the writing content, the factors marked were: conclusion, premises, evidence, and counter-arguments. "Conclusion" receives 1 mark if the student stated the conclusion of the argument correctly and 0 mark if not. "Premises" receive a mark/s that indicated how many premises the student could give based on the topic given. "Counter-Arguments" receive a mark/s that indicated how many counter-arguments the student could include. "Evidence/s receive a mark that indicated how many premises were supported by evidence. Similarly, under writing coherence, "Logical Connections 1" receives a mark/s that indicated how many connections between a premise and the conclusion the student could include. "Logical Connections 2" receive a mark/s that indicated how many connections between premises. "Signposts" receive a mark/s that indicated how many signposts were properly and correctly used: 0 mark if no signpost used; 1 mark is rewarded to a student; however, the signposts are weak; and 2 points if the signposts are strong. The same marking processes were followed in scoring the respondents' argumentative written product during the post-test in terms of the development of writing content and writing coherence.

Data Analysis

Quantitative data were evaluated based on descriptive and inferential statistics, while qualitative data were analyzed using thematic analysis. The Descriptive Statistics such as mean, frequency, percentage were calculated and presented in a tabular form. The t-test was used to compare the means of both sets of tests to indicate the effect of the intervention employed. The t-test verified whether there is a significant difference before and after the intervention is provided. Moreover, the Pearson Moment Correlation Coefficient was also used to determine the

relationship between the use of CAAM to those of participants' argumentative writing across the development of writing content and writing coherence as well as their SRL.

In the analysis of qualitative data, a thematic analysis was employed to analyze the data from the semi-structured interviews. The data obtained from interviews in this study were coded and categorized according to thematic analysis to capture the participants' opinions and understanding of the use of CAAM to process their argument writing. Creswell & Plano-Clark (2011), pointed out that the principles suggested to code the data are: transcribe the data, code the data, familiarization with the data from interviews, and generate the theory from the connections of emerging categories and concepts.

Simultaneously, the data from semi-structured interviews were analyzed independently. The researcher coded the data by using topical coding to label the text. Codes then were interpreted and modified to identify themes that emerged. The following themes emerged after the conduct of semi-structured interviews: theme 1 pertains to the benefits of using CAAM; theme 2 includes quality practice; theme 3 includes students' perception on the implementation of CAAM within metacognitive approach; theme 4 pertains to enhanced SRL of the participants.

Findings

Quantitative Analysis

Test of Difference on Respondents' Argumentative Writing Before and After the Strategy Intervention Was Implemented

The overall results from the t-test analysis showed that there was a significant difference in the participants' argumentative writing across the development of writing content and development of writing coherence before and after the strategy intervention. As shown, the overall mean scores before the intervention (x=8.93) and after the intervention (x=18.36) show that when compared statistically, the differences between the two results were significant as evidenced by a p-value of 0.000 which is less than the 0.05 level of significance. Therefore, the use of CAAM showed a significant difference on the participants'

argumentative writing across development of writing content and development of writing coherence before and after the strategy intervention indicative that CAAM improves students' argumentative writing performance.

Table 1

Overall Test of Difference on the Respondents' Argumentative Writing Performance Across Development of Writing Content and Writing Coherence Before and After the Strategy Intervention

Components	Before the Intervention		After the Intervention		*t*-computed value	*p*-value
	Mean	S.D.	Mean	S.D.		
Development of Writing Content	5.21	1.32	11.39	1.83	-21.56	0.000
Development of Writing Coherence	3.71	1.05	6.96	1.10	-18.53	0.000
Overall	8.93	1.76	18.36	2.08	-18.32	0.000

Table 2 presents the test of the difference between the participants' argumentative writing performance in terms of the development of writing content, as one component of argumentative writing before and after employing strategy intervention. This component constitutes 4 parts such as conclusion, premises, evidence, and counter-arguments. As revealed from the table, the "counter-argument" part was the most improved part in the argumentative writing performance of the respondents as it yielded Mean and SD scores of $\bar{x}$=1.68, SD=0.55 before the intervention and $\bar{x}$=3.61, SD=0.74 after the intervention, however, the "conclusion" part indicated the least improved one. Overall, all of the 4 parts in the aforementioned components of argumentative writing significantly differ before and after the implementation of the strategy intervention as evidenced by a p-value of 0.000 which is less than 0.05 level of significance.

Table 2

Test of Difference on the Respondents' Argumentative Writing Performance in Terms of Development of Writing Content Before and After the Implementation of the Strategy Intervention

Development of Writing Content	Before the Intervention		After the Intervention		*t*-computed value	*p*-value
	Mean	S.D.	Mean	S.D.		
Conclusion	0.54	0.51	1.00	0.00	-4.84	0.000
Premises	1.39	0.50	3.29	0.71	-14.62	0.000
Evidence	1.61	0.50	3.50	0.96	-10.38	0.000
Counter-Arguments	1.68	0.55	3.61	0.74	-18.92	0.000
Overall	5.21	1.32	11.39	1.83	-21.56	0.000

Table 3 presents the test of difference between the respondents' argumentative writing performance in terms of writing coherence before and after the strategy intervention. This component constitutes of 3 parts such as "Logical connections 1" (including logical connections between premises and the argument conclusion), "logical connections 2' (including logical connections between different premises), and signposts. As revealed from the table, the "logical connections 2" part was the most improved part in the argumentative writing performance of the respondents as it yielded Mean and SD scores of $\bar{x}$=1.21, SD=0.42 before the intervention and $\bar{x}$=2.43, SD=0.69 after the intervention, however, the "logical connection 1" part indicated the least improved one. Overall, the aforementioned component of argumentative writing significantly differs before and after the strategy intervention as evidenced by a p-value of 0.000 which is less than 0.05 level of significance.

Table 3

Test of Difference on The Respondents' Argumentative Writing Performance in Terms of Writing Coherence Before and After the Strategy Intervention

Development of Writing Coherence	Before the Intervention		After the Intervention		*t*-computed value	*p*-value
	Mean	S.D.	Mean	S.D.		
Logical Connection 1	1.61	0.57	2.75	0.80	-10.23	0.000
Logical Connection 2	1.21	0.42	2.43	0.69	-11.31	0.000
Signposts	0.89	0.69	1.82	0.39	-9.11	0.000
Overall	3.71	1.05	6.96	1.10	-18.53	0.000

Test of Relationship Between Participants' Argumentative Writing Performance and SRL After the Strategy Intervention Was Provided

As revealed from Table 4, there were five out of six SRL components that showed significant relationships with the aforesaid variables. The components on planning, self-monitoring, evaluation, effort, and self-efficacy yielded t-computed values of 2.21, 2.16, 2.25, 2.11, and 2.08 respectively, and are higher than the *t*-critical value of 2.06. This means that there was a significant relationship between the respondents' argumentative writing performance and the aforesaid SRL components. However, the component on reflection yielded a *t*-computed value of 1.26 found lower than the *t*-critical value of 2.06 indicating that there was no significant relationship between the respondents' argumentative writing performance and the aforementioned component. The CAAM, overall, used as a strategy intervention to improve respondents' argumentative writing performance showed a significant relationship to that of their SRL since the t-computed value of 2.08 is higher than the t-critical value of 2.06.

Table 4

Test of relationship between the respondents' argumentative writing performance and SRL after the strategy intervention

SRL Components	Pearson r-value	t-computed value	t-critical value
Planning	0.41	2.21	2.06
Self-monitoring	0.28	2.16	2.06
Evaluation	0.24	2.25	2.06
Reflection	0.21	1.26	2.06
Effort	0.69	2.11	2.06
Self-Efficacy	0.36	2.08	2.06
Overall	0.34	2.08	2.06

Qualitative Analysis

Benefits of CAAM on participants' mapping processes

This theme pertains to participants' perspectives on the benefits of using CAAM to process their argumentative writing. The sub-themes

include: better visualization of arguments, and helps ease cognitive overload.

When the participants were asked about the use of CAAM in processing their argumentative writing tasks, they responded that CAAM aided them to have a better visualization of their arguments. AM involves a clear outlining of an argument which can be augmented with CAAM. Students can be able to construct their arguments in a much easier way because CAAM aided them to quickly create their "supports", objections, and "counter-arguments" using box and line diagrams (Davies et al., 2021). The boxes can be added, removed, or moved to a new location. The participants maximized this CAAM feature effectively. One participant narrated:

> Using CAAM helps me quickly identify complex arguments and I can manage to break them into smaller parts which helped me understand my conclusion and distinguish the support and objections of my arguments (R16, 16-18).

Usually, argumentative prose is open-textured and sometimes ambiguous (Davies, 2011), and distinguishing its conclusion, supports, and objections still take extra time and effort. This is partly because of the lexical density of the prose itself. Participants in the present study narrated that they could easily distinguish conclusion and premises, and thus, helped them facilitate a better flow of knowledge in the brain, and that, avoid them from mental overloading. As R1 narrated:

> CAAM aided me to map graphically my arguments, and helped interpret them correctly which avoids overloading me mentally (R1, 37-39).

Quality Practice

Using CAAM provide plenty of practice and plenty of feedback and the activities and exercises were enjoyed by the participants. Just like R18 who felt motivated in doing those various activities because she was guided gradually in using CAAM to map out her arguments and successfully wrote down her arguments into paper.

> CAAM helps improve my writing skill because it made me practice deliberately. It also guided me what to do next and

> the scaffolding steps are directing us what to do and what activity to avoid. In CAAM, I mostly like the gradual complexity of the tasks (R18, 78-81).

Students' Perception on Implementing CAAM within Metacognitive Approach

The strategy intervention exposes the participants to metacognitive planning to help activate their prior knowledge of the topic before they proceed to the writing tasks. This activity could aid them to link their background information to the new topic. Brainstorming techniques helped participants to discover and generate more ideas that they may associate with their writing task. One participant expressed:

> The brainstorming activity triggered my background information and helped me link to the new topic to be developed (R14, 123-124).

In addition, the participants maximized the use of CAAM trying to self-monitor their ideas by double-checking their arguments and by going back and forth even how many times they wish to further edit their work and compare it to other arguments to adopt what best works on them. Furthermore, during the metacognitive monitoring stage, the students are tasked to collaborate with their peers to share their arguments for obtaining additional content, confirming answers, and making possible corrections. One participant narrated:

> Double-checking my arguments is easy because I can freely move the parts of an argument with different logical structures. Additionally, group sharing helped me attend to points of misunderstanding or not partially understood. Collaboration is giving me guidance about my arguments (R6, 98-101).

Other participants thought that the use of CAAM within a metacognitive approach enabled them to reflect on their own accomplishments whether they successfully or unsuccessfully understood the argument, whether they used effective or ineffective strategies. One participant expressed her opinion regarding this:

> I tried to self-evaluate by exploring on the soundness of my performance. I also balance the views my peers suggested to my paper (R15, 134-135).

Enhanced Students' SRL

The interviewed respondents used CAAM to process their argumentative writing and it assisted them to achieve effective writing output. Interestingly, CAAM did not only improve their writing but also enhanced their self-regulation of learning since they tend to self-monitor their learning processes. R12 expressed:

> I always try to monitor by double checking if my thesis, contention and conclusions are right and free from mismatches and errors (R12, 72-73).

Concerning self-evaluation, R13 and R15 stated their opinions about the effective use of CAAM in their argumentative writing task process. They said that evaluating one's writing performance whether the arguments are correct, or not, makes them more determined to continue writing and do their best to use correct argumentative markers next time. It also helps them to trace their performances.

> Mapping my arguments helped me assess my performance, whether I got the right arguments and evidences or not. If I fail, I make it as a challenge and think optimistically that I can do better the next time (R13, 93-95).

> After my peers' suggestions on my work, I self-evaluate by weighing the arguments they suggested to my paper (R15, 111-112).

Discussion

The study findings revealed that Thai EFL learners' use of CAAM improved their argumentative writing performance across the development of writing content and writing coherence. This might be due to the fact that the helpful features of CAAM aided the participants to improve their reasoning skills which are considered a potential factor towards a successful argumentative writing achievement. Since CAAM assisted the participants to start the process, during the process down to

the final product, they also obtained more enjoyable and more productive writing experiences. CAAM does not only trigger thinking for writing but also acts as reliable scaffolds during the writing process and even for revisions after such drafts are developed. CAAM makes the construction of maps easily and can edit them freely; therefore, students can work on many practical exercises which consequently enable them to engage in self-regulated learning as they can be able to practice different structures of arguments to decide which works best for them. CAAM also facilitates learners in the production of coherent paragraph texts since these mappings serve as a support tool to assist students to write in English.

The study findings also showed a significant relationship between the learners' writing performance across the development of writing content, and writing coherence and the use of CAAM as evidenced by a significant improvement towards their writing output after the strategy intervention was provided. It is revealed that there was a significant improvement on respondents' argumentative writing product in terms of the development of writing content since they were able to distinguish their argument conclusion and able to provide a number of different premises to support their thesis. They were also able to offer evidence/s and counter-arguments supporting the premise/s and conclusions. In addition, the findings showed a positive change in students' writing coherence. Students were able to provide discussion on their reasons by logically linking their premises to the conclusion and between premises as well as the use of their "linguistic signposts" as noticed on their written output reflected from their writing post-test.

Furthermore, CAAM helps improve EFL learners' argumentative writing skills which help them to produce more coherent and cohesive essays. In the study of Malmir and Khosravi (2018), they reported the efficacy of using CAAM on both descriptive and expository tasks in the Iranian EFL context and found out that CAAM could improve these two tasks in terms of grammar, coherence, cohesion, and task achievement but not beneficial in improving vocabulary of participant's writing. However, the present study concentrated on how the students develop the argumentative content of their writing emphasizing the statement of conclusion and how it is being supported by evidence, and counter-arguments. It also focused on how students use markers of coherence to

determine if they can be able to logically connect their premises to the conclusion and between premises.

In addition, the implementation of CAAM within the metacognitive approach might be a part of the reason why students improved their argumentative writing performance. Exercises in CAAM allow students to work on it on their own; however, the present study implemented CAAM within a metacognitive approach involving three stages such as planning, monitoring, and evaluation. With those stages, the students are guided to collaborate and interact together as they plan, self-monitor, self-evaluate and self-reflect on their written products. The significant improvement might be due to the aid of CAAM within a strategic approach. CAAM allows students to control their own information structures and increase their metacognitive awareness towards learning. By using CAAM, students develop better critical attitudes towards arguments, evaluate arguments better, and become more open-minded in their thinking process. Learners who have the ability to think analytically and to learn independently are purposeful, strategic, and persistent in learning (Zimmerman, 2008).

From the present study, results reveal that the students became more cognizant of their self-regulation of learning. CAAM within the metacognitive approach helped the learners augment their interests for accomplishing argumentative writing tasks, managing their own learning, and involving themselves in active and constructive writing procedures. However, one of the six components of SRL did not show a significant relationship with the learners' writing performance. This component is on "reflection". This might be due to the Thai traditional teaching of writing where the students are not given the chance or time to evaluate the strategies and methods they used to be able to improve their written output and to self-reflect on the mistakes they had obtained during and after the writing processes. Furthermore, students were not given the opportunity to share their difficulties and accomplishments with their peers and friends which is a potential activity to enhance writing improvement. Self-reflection is one of the phases of self-regulation which consisted of monitoring the adequacy of the content, organization, and form of one's written product, were not only cognitive but often affective processes whereby writers make different self-evaluative judgments about the text they produce (Pahlavani & Maftoon, 2015; Robillos, 2021; Zimmerman, 2008). The processes involved in CAAM are designed by

well-planning and well-monitoring during the process which helps raise students' self-evaluation and self-reflection. If CAAM is often used, students' critical thinking will be enhanced, and self-reflection can be optimized which might foster learners' SRL because self-regulated learners have already known their position in the task.

Conclusion

The present study investigated the effect of using CAAM on Thai EFL learners' argumentative writing performance and SRL. Using CAAM within the metacognitive approach could enhance learners' argumentative writing skills across the development of writing content, and writing coherence. Results also provided further empirical evidence that students' SRL is remarkably improved as manifested in their inclinations towards planning, self-monitoring, self-evaluation, effort, and self-efficacy.

Pedagogically speaking, the study findings have implications for EFL materials development which contributes to learners' improvement of argumentative writing skills and a better understanding of students' self-regulation in the process of learning in general and EFL writing in particular. Furthermore, as learners' personality traits are considered as essential predictors in their success in language processing, identifying these traits and providing facilities to enhance them would be a great accomplishment in EFL teaching and learning. Study findings likewise provide that thoughtful insights into utilizing CAAM within the metacognitive approach helped revolutionize EFL learning classrooms in this digital era.

Considering the significant results of implementing CAAM within metacognitive approach found in the current study, it is suggested that the implementation of this teaching strategy should be carried out continuously in EFL approaches to writing class, especially that lecturers are dealing with tech-savvy students who are needed to be taught by utilizing technological-based platforms for more effective and meaningful learning. Moreover, it is suggested that further research needs to be carried out especially on the utilization of other pedagogical methods to further strengthen the many benefits of CAAM.

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