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Research Article

Electronic and manual mind mapping as mediating tools in the EFL writing process

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This study explores the impact of mind mapping on the writing of English as a Foreign Language [EFL] among Saudi learners and the bilateral effects of mind mapping and other writing processes. Little research has been devoted to the effect of electronic mind mapping as a mediating tool. Despite the cyclical nature of writing processes, the co-effect of mind mapping—electronic or manual (a pre-writing process)—and other writing processes have barely been examined in second language writing research. The study employed an experimental design with convenience sampling and qualitative data from interviews with the participants. The participants were divided into three groups according to the type of mind mapping used: manual, electronic, and control groups. The electronic and manual mind mapping groups outperformed the control group, and the electronic mind mapping group performed significantly better than the manual group. The findings revealed that both types of mind mapping had a positive impact on overall writing achievement. The participants' responses to the interview questions clearly reflected that other writing processes changed the initial mind maps. It is hoped that the positive findings on the effects of mind mapping reported in this study will encourage EFL teachers to implement innovative min mapping techniques in order to raise EFL learners' writing standards.

Keywords: Discursive; Electronic; Manual; Mind mapping; Writing skills; EFL

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1. Introduction

Writing occupies a prominent place in the taxonomy of language skills (Hyland, 2003; Nodoushan, 2014), as it requires the orchestration of various linguistic and mental abilities (Flower & Hayes, 1981; Kroll, 1990). Furthermore, failure to address these demands may put one's educational and academic progress at risk because it is the most important measure of both (Gennaro, 2006; Hamp-Lions, 1990; Haspari, 2018; Matsuda & Matsuda, 2010). Moreover, writing is valued as an avenue for self-expression (Zamel, 1982, 1992). In writing one's ideas and unique thoughts, an individual proclaims membership in professional and academic communities. In the digital age, writing, which is a major tool of communication in most digital communication

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programs, has gained increasing importance (Lee, 2017; Weigle, 2002). Due to the omnipresent need for writing, instructors have introduced many tools and techniques to help students develop their writing abilities (Thouësny & Bradley, 2011). The process writing approach involves different cognitive activities called processes. These are the stages during which students engage in cycles of planning (deciding on the aims, developing conceptual frameworks, and organizing them), translating (enacting the plans made in the planning stage), and reviewing (assessing, gauging, and scrutinizing the efficacy of their writing (Graham & Sandmel, 2011; Kent & Wanzek, 2016). The term process encapsulates a cyclical movement of the writing processes rather than a linear, "single-shot," written product inscribed in the product-oriented approach (Hasan & Akhand, 2010). Flower and Hayes (1981) clearly state in their model of writing processes that the creation of writing plans and goals is influenced by other writing processes.

They designed the process model as cyclical and acknowledged the impact of in-writing processes on pre-writing processes. Therefore, the cycle begins at one point and ends at another. Flower and Hayes (1981) clarified this in their model of the cyclical nature of the writing process. In her review of models of process writing research, Becker (2008) focuses on the role of revision in other processes. She concluded that a little more than twenty years ago, revision was seen as a fairly simple task of reviewing, which occurred at the end of the writing process. However, through the development and study of how cognitive models function, it has proven to be a highly complex operation, which is now viewed as a starting point. Revision is an essential activity that initiates discovery, builds skill levels, and creates writing expertise over time, as writers gain maturity through practice (Becker, 2008, p.49). However, most research within the process approach on writing reflects a linear perspective of writing processes. Most research focuses on the processes that lead to one another, without the need to return to the starting point. This study distinguishes between seeing the processes as cyclical and visualizing the final point in the processes as returning to the starting point.

One of the most powerful techniques introduced to the writing classroom is mind mapping within the process approach of writing. It has been used as a pre-writing strategy to generate ideas and plans for writing (Ningrum et al., 2016). Traditionally, expert writers have created mind maps using pen and paper. Recently, researchers have begun using technology to draw and develop them. Mind mapping is defined as the visual representation of what is occurring in the head, such as connecting thoughts and ideas to a particular concept (King, 2007). Others define it as "an outline in which the major categories radiate from a central image and lesser categories are portrayed as branches of larger branches" (Budd, 2004, p. 35). Electronic mind-mapping techniques have gained popularity owing to Buzan's work on mind maps (Davies, 2011). Buzan (2005) compared a mind map to the map of a city, the center of which was compared to the central idea, and secondary roads were compared to secondary ideas. Mind mapping is the pictorial, drawing-like presentation of ideas or concepts. However, its pictorial nature does not obstruct its accessibility for learners who adopt non-visual learning styles. Electronic mind mapping was defined by Buzan (2005) and Howitt (2009) as a visual representation used strategically to create ideas, take notes, regulate thinking, and generate concepts (Al-Zyoud et al., 2017).

Mind mapping is one of the processes in the lifecycle of writing. This is viewed as a starting as well as a final point that may be affected by other writing processes. The following section sheds light on the nature of mind maps as mediation tools.

1.1. Mind mapping as a mediation tool

Mind mapping is a cultural tool used by writers to plan and organize their thoughts. A tool is "a material object that has been modified by human beings as a means of regulating their interaction with the world and each other" (Cole, 1999, p. 90). Tools mediate human thought and work (Bruner, 1990). Mediation is a fundamental concept in sociocultural theory (SCT) (Lantolf & Thorne, 2006), and refers to the cooperation between external symbolic cultural forms and artifacts (i.e., tools) of humans. These symbolic cultural forms and artifacts enhance the efficacy and

organization of human thinking; that is, they mediate human thinking (Wertsch, 1998). This is called tool affordance in SCT. Mind maps are tools that help writers create and regulate representations of their thoughts, giving them conscious control over their thinking processes. Wertsch (1998) explained that cultural tools are created in social settings and carry the sociocultural model of the knowledge of individuals who have [previously] used them. Bruner (1990) pointed out that these tools amplify human power. Mind maps extend students' ability to invent plans for their essays. Electronic mind maps [EMMs] are more professional and sophisticated than those developed by students. They, to use Rumelhart, Smolensky, McClelland, and Hinton's words, "reduce [for student writers] a very abstract conceptual problem to a series of operations that are very concrete and at which [they] can become very good" (as cited in Wertsch, 1998, p. 29).

Stenhouse (1975) states that a major concern of education is "giving mastery of the cultural tool already available as well as to make possible creative responses which go beyond what is available and help to develop and individualize it" (p. 78). Therefore, teaching mind mapping strategies could empower student writers. Vygotsky's (1978) well-established studies on tools prove that they serve "as an aid to a plan that [had] been conceived but not yet realized in behavior" (p. 28). This is called tool affordance in SCT (Wertch, 1998). Tool affordances enable the discovery and enhancement of student Zone of Proximal Development [ZPD]. ZPD is the distance between an individual's actual development and the level of development that may be achieved with the help of another, more proficient tool (Vygotsky, 1978).

In summary, tools play a major affordance role for both instructors and students owing to their mediational nature. Research on writing has explored the impact of integrating mind mapping with writing. Several studies have examined the use of manual mind mapping for writing (Bukhari, 2016; Waloyo, 2017; Yunus & Chien, 2016), and have found it to be a powerful writing strategy. This results in improvements in idea development, coherence, independent thinking skills, active learning reinforcement, and cooperation (Budd, 2004; Bukhari, 2016; Pham, 2021; Vijayavalsalan, 2016). Nevertheless, the use of electronic mind mapping in second language writing has received scant attention in the literature. Very few studies have explored the impact of electronic mind mapping on writing, and none have examined the cyclical nature of electronic mind mapping or other writing processes. This study attempts to fill the research gap by investigating the effects of introducing electronic and manual mind mapping in ESL students' opinion essays. It also explored whether in-writing processes affect mind mapping through students' responses to a review question.

2. Literature Review

2.1. Mind Mapping

The use of mind mapping assisted students in accessing different learning styles, promoting active learning, fostering creative thinking, triggering reflective thought processes, and motivating them (Betancur & King 2014). Based on empirical studies examining the impact of mapping on learning, Davies (2011) presented various merits of mind mapping. He pointed out that it enhanced meaningful learning, provided a source for properly structured prior knowledge that allowed students to construct and integrate new ideas, and aided the brain by providing easily accessible information, such as pictures, drawings, and diagrams. In conclusion, researchers and instructors have established the overall advantages of using mind mapping, both theoretically and empirically.

Both manual and electronic mind mapping share these features. However, electronic mind mapping has some distinctive features that make it better than manual mind mapping. Alodail (2020) indicated that electronic mind mapping allows users to add, delete, order, and reorder ideas easily, maps can be elaborated, and new trees can be added. Electronic mind maps can be easily emailed to other members of the team or communicated or shared with the audience in a presentation to update or suggest new ideas. To illustrate, electronic mind maps "allow all works

to be easily presented to others, for editing and collaboration purposes, though full control and permissions are kept within the original author's parameters" (Tay & Phang, 2022). Furthermore, electronic mind mapping could be considered a useful way to employ students' interests and teach complex or multifaceted topics, from the web of characters in a novel to the complex cultural challenges of a global economy, and the interplay of factors affecting climate change (Abd-Karim & Abu, 2018).

2.2. Writing and Manual Mind Mapping

Owing to its importance as a brainstorming activity, mind mapping and its role in the writing process has become the main focus of several studies. Researchers have investigated the effects of using mind mapping to develop learners' writing skills. Vijayavalsalan (2016) and Mantra et al.'s study (2021) on the use and implementation of mind mapping in EFL writing classes documented an improved quality in the essays written by these learners. Dayu and Aprilia (2022) and Muhib et al.'s (2014) concern was with finding out the effect of mind mapping on Indonesian student writers. They found a significant positive difference between their writing before and after the introduction of mind mapping. Megawati et al. (2021), Khudhair (2016), and Vijayavalsalan (2016) examined the effect of mind mapping on learners' essay writing and reported that it helped learners write more coherent, creative, and well-organized essays. They added that this also contributed to modifying students' attitudes towards essay writing by making it more joyful and fun. They also explained that illustrative tools within mind maps, such as images, arrows, circles, and colors, might facilitate knowledge acquisition and clarify the connections between ideas or relationships between the elements of a particular argument. These studies highlight the effectiveness of mind mapping in developing the writing skills of ESL/EFL learners and its effect on their attitudes toward writing skills.

A considerable amount of literature has been published investigating whether mind mapping is only useful in the prewriting stage or whether its usefulness passes into the other stages. Bukhari (2016) examined the various overall gains from Saudi intermediate level students' use of mind mapping at all stages of writing. Her study revealed improvements in the cohesion, coherence, structure, content, and length of the students' writing. Yunus and Chien (2016) have highlighted the role of mind mapping during the pre-writing stage. They stated that it increased learners' capacity to plan their writing better. They also reported that the use of mind mapping improved learners' ability to interpret all the details of a topic, have new and creative ideas, and enhance their writing skills. Similarly, other authors argued for the importance of mind mapping in promoting learners' ability to plan and organize their ideas for writing tasks and ascertained the effectiveness of using this prewriting strategy in improving learners' overall writing achievement (Al-Naqbi 2011; Riswanto & Prandika, 2012). Nemati et al. (2014) assessed mind mapping as a technique for teaching essay writing to advanced Iranian learners. They concluded that mind mapping boosted the organization and overall quality of students' essays. Saed and Al-Omari (2014) examined the use of mind mapping for summarizing skills. They found that the ideas of students who used mind mapping in their draft summaries and organizations were more developed. In effect, students' summaries showed better organization and maturity if they used mind mapping. These studies provide important insights into the intrinsic role of mind mapping at all stages of the writing process. Mind mapping is important in the prewriting and other stages of the writing process. Therefore, writers should continue revising their mind maps until they are ready for submission. Numerous studies have explored the role of mind mapping in developing learners' abilities to write particular types of essays, such as argumentative, narrative, analytical, expository, and descriptive. In a study examining the impact of mind mapping on the development of argumentative writing among Chinese EFL learners, Zhang (2018) found that mind mapping, as a prewriting activity, had a positive effect on learners' ability to write in this genre. Mind-mapping helped learners direct their thinking to the suggested organizational framework before the actual writing process and their attention to these ideas while writing.

Waloyo (2017) evaluated the influence of mind mapping on learners' ability to write narrative texts. The results revealed that mind mapping improved the learners' narrative essays. She confirmed that mind mapping encouraged learners to think in a more creative way. Anggrayani et al. (2015) assessed the role of mind mapping in learners' abilities to organize ideas while writing analytical exposition essays. They confirmed the positive effect of mind mapping on learners' ability to organize ideas in such essays. Their results were specifically relevant to five targeted aspects of the writing process: cohesion, coherence, unity, logical flow, and the use of the present tense. Moreover, several studies have examined the effect of mind mapping on learners' ability to write descriptive essays (Miftah, 2010; Nurlaila, 2013; Purnomo, 2014). Although these studies targeted different levels and nationalities, they all documented improvements in learners' abilities to write this type of essay. Improvement lies in increasing learners' vocabulary, enhancing their creativity and motivation, and developing their ability to arrange sentences and organize ideas. Hassanzadeh et al. (2021) examined the effect of software-supported concept mapping on the lexical diversity of English learners' argumentative essays within a process writing framework. The results revealed that the group that used computer mind mapping outperformed the outline group in terms of lexical diversity scores. Budiono et al. (2016) explored the effect of mind mapping on writing short stories, descriptive texts, and reports, respectively (Al-Zyoud et al. 2017). Together, these studies show that the usefulness of manual mind mapping is not restricted to a particular writing genre. Mind mapping can be used in developing argumentative writing just as effectively as it can be used in improving descriptive or any other type of writing. The studies presented thus far provide evidence that the prewriting strategy of manual mind mapping has an important role in enhancing learners' motivation and promoting their ability to organize their thoughts, create new ideas, and enrich their vocabulary. This also helps them to create better products for different essay types, as mentioned above.

2.3. Writing and Electronic Mind Mapping

Considering that we live in an era of technology, electronic mind mapping should play an important role in improving learners' writing skills. As stated above, research has proven that MMMs are a very useful tool in enhancing achievement in essay writing. EMMs offer several advantages that make them preferable to MMMs. Abd Karim et al. (2016) identified some of these advantages. They stated that the EMMs were designed with fewer materials and less time and effort, and made it easier to modify, add, or delete content. (p. 427). However, few studies have investigated the effects of electronic mind mapping on learners' writing. Tay and Phang (2022) and Al-Jarf (2009) examined the influence of using mind-mapping software on learners' writing performance. Tay and Phang (2022) reported significant improvements in pre-service teachers' academic writing. Similarly, Al-Jarf (2009) found an improvement in learners' capabilities to generate new ideas and make connections between different parts of the text.

According to Fu et al. (2019), learners' writing performance improved after using the suggested mind-mapping-based contextual gaming approach. They identified improvements in two aspects of the learners' writing: fluency and elaboration. Robillos and Thongpai (2022) indicated that the computer-aided argument mapping used in their experiment resulted in better argumentative writing among EFL learners. Abd-Karim and Abu (2018) and Liu (2011) investigated the impact of using mobile-assisted and computer-aided mind-mapping techniques during the prewriting phase on English as a second language (ESL) learners' writing performance across various proficiencies. The results indicated that both the mobile-assisted mind mapping technique and computer-aided concept mapping conditions were more productive than the no-mapping condition. In the context of EFL, Alqasham and Al-Ahdal (2021) focused on using mind mapping as a brainstorming tool to develop EFL learners' writing skills. This study proved the effectiveness of mind mapping as a digital brainstorming tool in developing Saudi learners' writing skills and their attitudes toward them.

This study utilized an opinion essay. An opinion essay is a type of writing in which the writer expresses their personal viewpoint or stance on a particular topic or issue. The primary goal of an opinion essay is to persuade the reader to share the writer's perspective or at least consider it. Opinion essays are commonly assigned in schools and universities as they help students develop critical thinking, argumentative, and persuasive writing skills.

Overall, the above-mentioned studies provide important insights into the role of mind mapping, whether manual or electronic, as a useful tool for improving learners' writing achievement. However, all these studies have focused on the effect of mind mapping as a prewriting process. Furthermore, they did not investigate the effects of other writing processes on mind maps. For example, during the drafting stage, new and creative ideas may come to mind, causing them to modify, add, or delete parts of the initial mind map. However, the impact of mind mapping on writing remains unclear. Therefore, this study gauges the overall effect of the two types of mind mapping on writing, as well as the discursive effect of mind mapping and other writing processes. This study addresses the following research questions to evaluate and investigate these issues:

RQ 1) Does the use of mind mapping (electronic and manual) improve Saudi students' achievement in writing opinion essays?

RQ 2) Is there a significant difference between the effect of electronic and manual mind mapping on writing opinion essays?

RQ 3) What effect does revising a mind map during the writing process have on the quality of opinion essays?

3. Methodology

3.1. Study Design

An experimental design with pre-and post-test was used to achieve the aims of the study. Participants were randomly assigned to three groups: two experimental groups and one control group.

3.2. Participants

Thirty Saudi undergraduate EFL students participated in the study. Participants' ages ranged from 23 to 26 years; nine of them were males and 21 were females. They were enrolled in a writing course that aimed to teach students how to write academic essays as required by the English department. They were divided into three groups (ten students each) according to the type of mind map: none (control), manual, or electronic. Their English language skills were at the A2 level according to the Common European Framework of Reference [CEFR] for languages (Council of Europe, 2001), which is deemed appropriate for learners to compose an essay.

They had been learning English for at least eight years, including at primary and secondary schools. None of the countries of the students' origins were English-speaking. They learned English at school and university, and voluntarily agreed to participate in the study and wrote opinion essays.

3.3. The Software

The XMind software, developed as a brainstorming electronic tool, was used in this study. Its application enables people to visualize ideas and organize different and complicated information. Aston (2020) states that the XMind map app allows a faster formation of mind maps and professionally and easily enables their transfer into outlines. The components of the mind map in this app are as follows: topic management; mind map structure; creating, editing, or deleting a hyperlink; file attachment; showing, creating, and editing relationships among topics and markers; grouping; and summarizing (XMind, 2023, pp. 10-15). The app makes it possible for users to revise previous versions of created maps and follow their editing histories. Moreover, the program offers easy local network sharing of the created maps. Maps shared through local networks may include

messages, instructions, or questions. This characteristic makes them ideal for teamwork. Several studies have used this software to determine its effectiveness in improving writing skills. For example, Keaver et al. (2023) used Xmind mapping software to examine how to use REM to identify undergraduate students' perceived benefits of research projects and assessed whether REM could be used to confirm the achievement of course learning objectives. They found that mind mapping was superior to the complete REM approach for objective course-learning assessments. Moreover, Bai et al. (2022) used XMind mapping to find out the effects of a self-regulated writing strategy-based intervention, supported by e-learning tools in English writing. They concluded that XMind mapping had a significant effect on students' writing skills.

3.4. Writing Test

To explore whether and how improvements occurred over time, participants underwent an identical writing test at two separate times. The test consists of one question with a total score of 10 points. Participants were asked to write an opinion essay about *which is better, staying all your life in your country or moving and living in another country*. The essay was selected by the researchers as the genre in which students wrote their responses. This is one of the genres included in writing syllabi. Moreover, the questions addressed to the students were suitable for this genre of writing. The question addressed to the participants was one of the most commonly asked questions in the Saudi context. Therefore, researchers have found it relevant to both the genre of the opinion essay and the participant setting.

3.5. Interview

The interviews were conducted face-to-face with students. After completion of the test, each participant was interviewed individually in the office of one of the authors. Only participants in the two mind map groups (N=20) responded to these questions. The interviews consisted of two questions. Question one: have you noticed any differences between the first and the second versions of the mind map? Question two: If you noticed any differences, what was the nature of these differences?

3.6. Rating Scales

The test was scored based on a scale used in many writing studies (Klimova, 2011). The scales used in this study are listed in Table 1. The participants' productions were evaluated by two non-native raters who were experienced EFL teachers. Interrater reliability was assessed using Cronbach's alpha which yielded a reliability measure of .86. This could indicate a strong level of agreement.

Table 1
Writing assessment scale

Writing Components	*Criteria*	*Scores*
Content	Extent, relevance, subject knowledge	2
Organization	Coherence, fluency, clarity, logical sequencing	2
Vocabulary	Richness, appropriate register, word form mastery	2
Language use	Accuracy (usage of articles, word order, tenses, prepositions, sentence construction)	2

3.7. Procedures

The data were collected during the second semester of the 2020 academic year. This study was conducted through four sessions over four weeks. In the first session, students wrote a pre-test essay on paper and submitted it to the instructor. The specific type of essay assigned for this pre-test was an opinion essay. In the second session, the participants were assigned into three groups: EMM, MMM, and control. The control group wrote an essay without using mind maps, whereas

the experimental group used mind maps. The EMM and MMM groups were taught mind mapping as an essay writing strategy. Students in the EMM group were instructed to download the software *XMind map* onto their mobile phones and were trained on how to use it to design mind maps for essays. They were then asked to draw an electronic mind map of the topic. After completion, they submitted their map output to the instructors. The second group was asked to draw a mind map about the same topic using pen and paper. The control group did not participate in this phase. In the third session, all the groups were asked to write an essay on the same topic. They submitted their essays to the instructors. In the fourth session, students in the two experimental groups were asked to revise their mind maps after reading the essay they had submitted. Participants were instructed to rewrite the mind map to check whether they had anything to add, before submitting new versions of their mind maps. After revising their mind maps, they participated in a short interview to elicit their opinions on using mind mapping. The participants were asked if they noticed any differences between the first and second mind maps. Each student in each group submitted two essays. The first version was submitted before the treatment started and was considered a pre-test. The second version was submitted after the treatment and was considered a post-test. Those in both experimental groups submitted two versions of their mind maps. The instructor scored both versions of the essay. Their scores were tabulated and analyzed to identify improvements among the groups. Each participant obtained a maximum score of 10 points. For rating, two professional EFL instructors were employed as raters for the essay writing based on the scale of Klimova (2011). The scores were compared to measure interrater reliability. The reliability coefficient of the writing test (Cronbach's alpha) was high at 0.98 (see Table 2).

Table 2
Inter-rater reliability

Cronbach's Alpha	*Cronbach's Alpha based on Standardized Items*	*No. of Items*
.984	.985	2

To answer the research questions, students' scores on the writing test before and after the intervention were statistically analyzed. With only 10 students in each group, we checked whether the data are normally distributed, using the Shapiro-Wilk test. The distribution of normality is presented in Table 3.

Table 3
Tests of normality

	Kolmogorov-Smirnov[a]			*Shapiro-Wilk*		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test	.175	30	.020	.943	30	.110
Post-test	.162	30	.044	.929	30	.045

Note: a. Lilliefors Significance Correction

As shown in Table 3, the distribution was not normal in the pre-test (p =.110), but was normal in the post-test (p =.045). Since the assumption of normality was not met and the sample size was small, the data from the three groups were analyzed using the Kruskal–Wallis test (Field, 2013). The level of significance was .05 for all statistical analyses. To determine the effect of using mind mapping in learning to write essays, the partial eta squared (η2) was measured. This study follows the eta-squared scale proposed by Cohen (1988) and measures the effect size. Values range from 0 to 1; .01, small, .06, medium; and >.14 ~ large. SPSS (version 23) was used for all the analyses.

4. Results

4.1. Does the Use of Mind Mapping (Electronic and manual) Improve Students' Achievement in Writing Opinion Essays?

Regarding the first research question on whether the participants' writing improved because of the intervention in the use of a mind map, a Kruskal–Wallis test was performed, as shown in Table 4.

Table 4
Kruskal Wallis Test for the three groups

	Pre-test	*Post-test*
Chi-Square	.319	9.532
df	2	2
Sig.	.853	.009

As shown in Table 4, the Kruskal-Wallis chi-square test in the pre-test for the three groups revealed no significant differences (χ^2 = 319, p =. 853). However, the chi squared test for the post-test for the three groups revealed significant differences in the rankings (χ^2 = 9.532, p =. 009). The ranks were calculated using the Kruskal-Wallis test, as shown in Table 5.

Table 5
Kruskal-Wallis test

	N	*Pre-test mean rank*	*Post-test mean rank*
EMM group	10	14.45	20.40
MMM group	10	15.45	17.25
Control group	10	14.60	15.85

Note. EMM: Electronic mind mapping; MMM: Manual mind mapping

Table 5 shows the mean ranks of the three groups on the pre-and post-tests. The mean rank of EMM in the pre-test was 14.45 and in the post-test was 20.40, indicating an improvement in writing due to the use of electronic mind mapping. The mean rank of MMM in the pre-test was 15.45 and in the post-test was 17.25, indicating a slight improvement in writing due to the use of manual mind mapping. The mean rank of the control group in the pre-test was 14.60 and in the post-test, it was 15.85, which indicated a slight improvement in writing. This slight improvement can be attributed to the effect of instruction.

4.2. Is There a Significant Difference between the Effect of Electronic and Manual Mind Mapping on Writing Opinion Essays?

To determine the difference between the effects of EMM, MMM, and no mind mapping, a pairwise comparison of groups in the post-test was performed, as shown in Table 6.

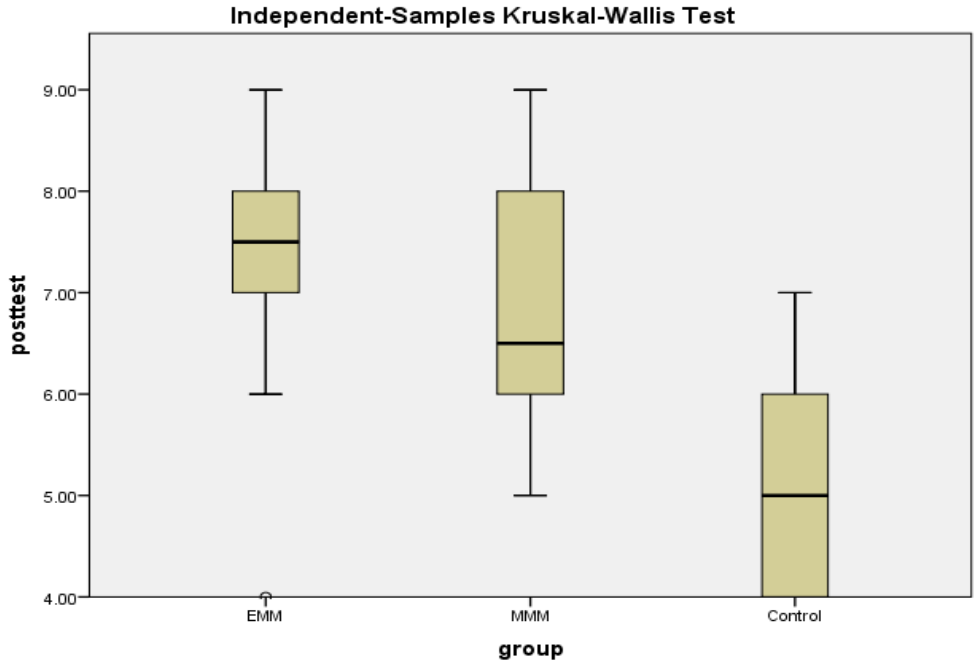
Table 6
Pairwise comparisons of groups in the post-test

Sample 1- Sample 2	*Mean*	*SE*	*Mean difference*	*Sig.*	η^2
Control-MMM	8.400	3.868	2.172	.030	.569
Control-EMM	11.550	3.868	2.986	.003	
EMM-MMM	3.150	3.868	.814	.415	

Note: *Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. The significance level is .05.*

The results of the Pairwise Comparisons of groups in the post-test revealed a significant difference between the participants in the EMM and control groups (p = .003). The results also indicated a significant difference between the scores of participants in the control and EMM groups (p = .030). However, there was no significant difference between the scores of the participants in the EMM and MMM groups (p = .415). The results are shown in Figure 1.

Figure 1
Comparisons of the Three Groups in the Post-Test



To determine the effect size of using a mind map in writing, an eta-squared test was conducted, as shown in Table 6. Eta-squared (η^2) is a measure of effect size and indicates the strength of the relationship between the independent and dependent variables in an experiment. Eta-squared quantifies how much of the variability in the outcome variable can be explained by the treatment or factor being studied. The effect size (η^2) was .56, which indicated a large effect. This indicates that mind maps, whether electronic or traditional, had a significant effect on opinion essay writing.

4.3. What Effect Does revising a Mind Map during the Writing Process have on the Quality of Opinion Essays?

The second tool comprised two questions, which was an interview of all the study participants. Participants' responses to the questions were analyzed using content analysis. The responses to these questions were analyzed for thematic consistencies, similarities, and differences, based on Braun and Clarke (2006). This analytical approach was chosen for its ability to uncover underlying themes, consistencies, as well as variations within the participants' feedback. The responses provided by the participants were systematically scrutinized, with particular attention given to identifying thematic consistencies across multiple interviews. This allowed us to discern patterns and common threads in their experiences and perceptions.

They responded positively, stating that their new drafts were different and improved. For instance, one respondent stated, '*Using mind mapping techniques helps me write well. I found that draft two is better than draft one, especially in terms of the number of sentences and the use of new vocabulary.*' The nature of the differences they identified in the drafts was primarily related to how they created their mind maps and, as a result, developed their ideas. All of them emphasized that the use of mind mapping techniques led to the generation of new ideas, significantly enhancing their writing.

5. Discussion

This study examined the effects of the two types of mind mapping on writing opinion essays and the discursive impact of mind mapping and other writing processes on each other. The first research question asked students whether mind mapping (electronic and manual) improved their opinion essay writing. The results of this study revealed that both types of mind mapping have been beneficial in improving students' ability to write opinion essays. Both the EMM and MMM

groups outperformed the control group, which did not use mind mapping. The final draft of the opinion essay of the experimental group was much better than that of the control group. This may be due to the organizational affordance that mind maps make available to EFL learners. Similar to the literature reviews, this finding reinforces the detailed value of mind mapping for opinion essay writing. Mind maps help learners organize their ideas, develop their thinking abilities, and interpret the relationships between different components of an issue. Students' opinion essays in the post-test reflected a greater control over idea development and fluency. This finding is in line with those of previous studies such as Al-Naqbi (2011), Riswanto and Prandika (2012), Yunus and Chien (2016), Mantra et al. (2021), Megawati et al. (2021), and Dayu and Aprilia (2022). These studies assert the effectiveness of mind mapping in the development of learners' writing skills. This is consistent with the findings of Anggrayani et al. (2015), Miftah (2010), Nurlaila (2013), Purnomo (2014), Waloyo (2017) and Zhang (2018) regarding the overall value of mind mapping in improving learners' essays. However, the results of this study are distinct, in that they are specific to the assistance provided by the tool in constructing opinion essays. Mind mapping performs an ancillary function, to use Vygotsky's words: "in setting up of connections in [students'] brain[s] from outside" (Lantolf & Thorne, 2006). The positive effects of writing opinion essays can be explained in terms of the mediating role of mind mapping. Using mind mapping, students gained voluntary control over their mental activities. It designates pictures to their pre-thoughts on essays and assists their constitutive ability to transform such thoughts into concrete objects (i.e., writing). Concretized, rudimentary thoughts via plans (tools) become more elaborate in the mediated action of opinion essay writing. The second research question concerned whether there was a significant difference between the effects of electronic and manual mind mapping on writing. The results of this study revealed that the EMM group slightly surpassed the MMM group, although the difference was not statistically significant. This slight difference is because EMMs are more sophisticated cultural tools than MMMs. They contain examples of maps that may be useful and relevant to students' ideas.

This saves time and effort. Moreover, it is easier for learners to modify, add, or delete items in the EMM than in the manual. However, the insignificant difference between the two groups may be attributed to the learners' limited experience in using technological facilities in mind mapping, their unfamiliarity with mind-mapping applications, and the complexity of these applications. This finding is in line with that of Abd-Karim et al. (2016) that EMMs are easier to design and more useful than other brainstorming activities. It also confirms the ideas of Al-Jarf (2009), Fu et al. (2019), and Alqasham and Al-Ahdal (2021), who proved the effectiveness of EMM in developing learners' writing performance and promoting their attitudes toward writing skills. This corroborates the ideas of Abd-Karim and Abu (2018), Robillos and Thongpai (2022), and Tay and Phang (2022), who assured the positive effect of both computer-aided software and mobile-assisted mind-mapping techniques on the writing skills of EFL/ESL learners. Although these studies reported the effectiveness of EMM on writing skills, none of them reported these results in comparison with MMP.

To answer the third research question concerning the results of rewriting mind maps, students' answers to the open-ended questions were qualitatively analyzed to find consistent patterns and similarities among their answers. They were asked if they had noticed any difference between the first and second versions of the mind map, and what the nature of the differences was. Students in both mind-map groups responded to these questions. This question is essential for identifying the development of students' abilities to cross the existing stages of development to their potential level. Gibson's notion of affordance with relevance to tool mediation identifies the developments in the "emergence of new forms of thought." Vygotsky finds "development in the emergence of new capacities for human consciousness." Wertsch (1998) explains that "a change in the cultural tool may often be a more powerful force of development than the enhancement of individuals' skills" (Wertsch, 1998, p. 38). Therefore, the authors looked for this qualitative change in consciousness, as well as tool modifications in students' writing processes. Most of the students in

this study stated that they noticed some differences, especially in relation to subtopic headings. They added some extra points to the second version of the essay when they realized that they could make several improvements to their original essays and their previous mind maps.

This new ability to redesign mind maps, both manually and electronically, indicates the development in understanding the value of mind mapping as a tool for improving writing skills. They were able to modify and transform the cultural tools they initially used and produce new tools for their thoughts. Consequently, the opinion essays they produced reflect more` improvement than the original essays.

6. Conclusion

This study explored the effect of mind mapping on opinion essay writing. The results show that mind mapping positively affects writing processes, and vice versa. This means that if students are directed to look back at their original mind maps after writing their first drafts, they will help them review their writings and consequently improve their final written work. Therefore, researchers suggest that mind maps should not be considered only as a pre-writing strategy, but rather as a while-writing strategy. This study supports the use of mind mapping (either manual or electronic) when writing opinion essays. Although the difference between the EMM and MMM groups was not significant, EMM enabled students to make up their minds more effectively regarding possible development and modifications of ideas, in the original maps. This study recommends that more studies be conducted to validate this conclusion.

7. Pedagogical Implications

It is hoped that language teachers will be able to apply mind-mapping innovations to improve learners' writing levels at different stages of academic writing. Both foreign and second language learners are expected to use the results of this study to enrich their understanding of the differences between EMM and MMM. Additionally, the findings enhance our understanding of the roles of EMM and MMM in the development of learners' writing performance in all stages of writing.

The limitations of this study should be considered when interpreting its results. The small number of participants might pose questions about the reliability of its findings. Thus, a study with a larger sample size would yield stronger evidence for generalizing the findings. Third, the study did not investigate the significant differences in the use of EMM and MMM in writing other types of essays; it was restricted to opinion essays. Therefore, further research should be conducted in different areas to expand the scope of this research. Future studies should also investigate the relationship between learners' proficiency levels, individual differences, and preferences for EMM and MMM. It would be interesting to compare learners' use of EMM and MMM in the contexts of EFL and ESL. Further research is needed to understand the roles of EMM and MMM in the earlier stages of learning, especially in Arab countries where English is not commonly used as a medium of communication.

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