Effect of Types of Mind Maps on Writing Performance Across Various Learning Styles and Genders: A Case Study at IAIN Palangka Raya

Aisyah Hafshah Saffura El-Muslimah[1*], Rudi Hartono[2], Abdurrahman Faridi[3], Puji Astuti[4,] Mohamed Nor Azhari Azman[5]

[1 2 3 4] State University of Semarang, Indonesia
saffura@students.unnes.ac.id
rudi.hartono@mail.unnes.ac.id
pakdur@mail.unnes.ac.id
puji.astati.ssu@mail.unnes.ac.id
[5]Universiti Pendidikan Sultan Idris, Tanjung Malim, Malaysia
mnazhari@ftv.upsi.edu.my
[*]Corresponding Author

Abstract: This research measured the interaction effect among learning styles, gender, and types of mind maps on writing performance at IAIN Palangka Raya, Indonesia. The design applied a posttest quasi-experiment using a 3x2x2 analysis of variance. The study involved EFL participants comprising three groups based on learning styles ($x1$): auditory, visual, kinaesthetic; gender ($x2$): male and female; model of mind map ($x3$): digital mind map/DMM and paper mind map/PMM. The total participants were 30 L2 learners. Result revealed that a significant interaction among learning styles ($x1$), gender ($x2$), and types of mind map ($x3$) exists on the learners' writing performance at the MS 129.14, $F(2.30)=3.64$, $p=0.04$. However, no interaction effect between learning styles and gender $F(2.29)=0,21$, $p=0.81$, eta 0.02; between learning styles and types of mind map $F(2.29)=0.85$, $p=0.44$, eta 0.09; between gender and types of mind map $F(1.29)=0.49$, $p=0.49$, eta 0.03 on writing performance. The main effect also confirmed that a significant difference exists on the effect of learning styles at $F(2.29)=33.65$, $p=0.00$, eta 0.79; gender at $F(1.29)=4.91$, $p=0.04$, eta 0.32; and types of mind maps at $F(1.29)=16.83$, $p=0.00$, eta 0.48 on the learners' writing performance. The study provided a new insight on teaching writing using mind map technique.

Keywords: Interaction effect, Learning styles, Gender, Mind maps, Writing performance.

1. Introduction

Writing skills are strongly needed in written communication nowadays. Communicative skill is pertinent to produce future writers (Gezmiş, 2020). Therefore, EFL learners should master writing skills as well as other language skills to produce a good composition. Rao (2007) confirmed that writing skills provide learners to arouse motivation on thinking, organizing ideas, and developing skills. Ahangari and Behzady (2011) stated that writing is a good way to keep learning. However, it is widely reported that learners had difficulties in writing. It is obvious that writing is difficult because learners should master some basic skills such as as grammar, writing mechanics, and so on. Learners

are required to develop ideas and to organize information in writing (Nik et al., 2010). EFL learners should further practice writing and use appropriate strategies in prewriting. Learners should make planning on writing. By doing so, learners will have better capability to think and brainstorm ideas efficiently (Abd Karim et al., 2020; Leontyeva, Pronkin, & Tsvetkova, 2021). In addition, writing performance is required for university students. It is the achievement level of students in writing. In this case, learners should have knowledge of writing skills and writing conventions. This study proposes mind map technique to enhance writing performance. Supporting this opinion, Buzan & Buzan suggest that Mind map is a useful way of providing a key to maximize the hemisphere (1996). Mind mapping displays visual thinking instrument and facilitates learners to structure and analyze information, understand, and recall ideas better (Brandner, 2020). Mind map is a visual tool to provide learners to structure, organize and brainstorm information in a professional procedure (Abdulbaset, 2016).

Therefore, a mind map is a method to store, organize, and learn information (Alomari & Alhorani, 2019). It activates logical thought and creative thinking effectively (Aydoğdu & Güyer, 2019). In the context of writing, a mind map is an alternative way to promote creative thinking and encourage learners to generate ideas and brainstorm (Tucker, Armstrong, & Massad, 2010). Mind maps also have a positive effect in strengthening creative writing skills (Marashi and Kangani, 2018); decision-making skills (Nurdin and Damayanti, 2020); learning motivation and scientific process skills (Anuar, Nizar, & Ismail, 2021; Prastiwi et al., 2018), and collaborative learning (Chang, Chiu, & Huang, 2018). It enables learners to elaborate numerous associative concepts and provides learners to connect statements to facts (Kurilova et al., 2019). Pribadi and Susilana (2021) found that mind mapping improved learners' motivation and increased the writing ability. Mind map also gave effect to link amongst a large number of data (Spanoudis & Demetriou, 2020). Mind map can be used to present plan, note taking, and a brainstorming scheme (Fauzi & Degeng, 2018). It is a tool to increase productivity (Bhattacharya & Mohalik, 2020). The mind map implementation has a strong influence on the learners' readiness for further activities (Liu & Yuizono, 2020); the learners' motivation and academic achievements are better (Tan, 2019; Spanoudis & Demetriou, 2020); positive educational outputs (Hidayati et al., 2020); instructional technologies (Aydogdu & Guyer, 2019). Moreover, Si et al. (2019) found that mind map supported the idea of problem-based learning. Previous investigations on mind maps indicate a variety of contribution in EFL class. For example, Kamli (2019) found that mind map gave contribution to memorization of information. It is sometimes contrasted with the linear model (Hidajat et al., 2020). Mind maps also ensured the rapid memorization (Rezapour-Nasrabad, 2019). It is related with the function of right and left brain simultanenously (Muhlisin, 2019). The present study applies argumentative mind maps both digital and paper based in argumentative essay writing. It is a visual tool displays the connection among the statement, claim and counterclaim (Nesbit et al., 2019).

In spite of the fact that mind map can be easily created in a paper, it can also be made using software to work faster (Elzaaby, 2013). Therefore, the two models of mind map: paper and digital mind map be applied in the study. The paper mind map was created by handwriting. Meanwhile, digital or electronic minds are made using application software (Kiong et al., 2012).

Dealing with the role of paper mind map, it enables learners to organize relevant information in mind map using their own creativity (Ma et al., 2022). However, digital mind maps can do more than traditional ones. Digital mind maps allow ideas to be externalized as a structured network (Jensen, 2018; Chen & Krishnamurthy, 2020). It can perform quickly and it is more effective and attractive than paper mind maps (Masoud & Ibrahim, 2017). Digital mind maps enable learners to participate in collaborative learning (Lin et al., 2020; Zipp & Deborah Deluca, 2020); and gamification (Lavoué et al., 2018). Then, learners connect lines radiating from central topic and then, creates branches. These are called sub-topic branches and each branch describes one idea connecting to the core topic. The example of mind map is illustrated in Fig. 1.
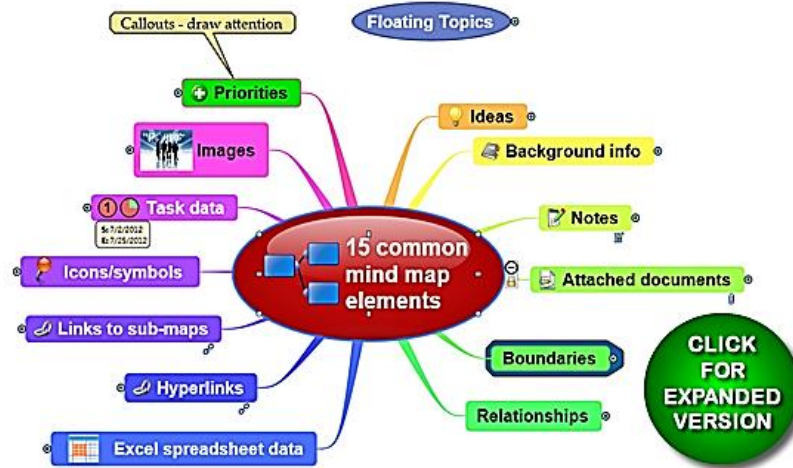
Fig. 1 Model of Mind Mapping

The figure shows that a mind map comprises a central topic which is associated with several ideas and it is drawn in colorful images. Mind mapping technique works by activating the right side of the brain, which uses color, image, rhythm, and spatial awareness, and it also uses letters and numbers. Using color and image means that they engage the left and right side of the brain.

Some investigations have been widely performed on mind maps in EFL writing class. For example, the investigation by Keengwe (2017) states that e-mind map can contribute to the process of writing since it integrates information with other relevant symbols, colors, and nodes Next, Vijayavalsalan (2016) found that mind maps have assisted students in L2 writing class. Then, Hallen and Sangeetha (2015) confirmed that the mind map has improved writing performance. It supports the theory of constructivism. The study indicates that mind maps can be beneficial to the learning process. Many studies have proven that mind map helped students in EFL writing. For example, Hdii (2015) proved that mind map provided a significant difference on students' composition. Shakoori et al. (2017) found that mind map has assisted students in making composition.

Another potential factor contributing to successful writing achievement in mind map class is gender difference. The recent investigation has shown that males and females have differences in their brain structures (Durokhim et al., 2022; Ghazali et al., 2022). It is assumed that a difference exists in the brain of men and women in terms of the cerebral cortex (Rabinowicz et al., 2002). Studies showed that males' brains were more asymmetric than females' (Frederikse et al., 1999). The similar studies also conducted by Beard & Burrell (2010) and Troia et al. (2013). They confirmed that different genders are correlated with the learners' composition. Other investigation evidenced that girl students write better than boys in various aspect of composition such as investigations performed by Adams & Simmons (2019) and Zhang et al. (2019). Those investigation confirmed that female students gained consistently better writing performance than male students. These findings motivated the researchers to include various genders as a potential factor predicted to contribute in writing class.

The other factor predicted to influence learners' writing performance is the learners' learning styles (Jamian et al., 2022). The learning style is regarded as an essential factor in EFL class (Castro & Peck, 2005; Durmus & Meral, 2020). It plays a vital role to select the appropriate teaching style, strategies and approach (Cimermanová, 2018). Vester (2005) mentions that learning style is the way a person stores data. Fleming's (2001) VAK model (visual, auditory, and kinesthetic) was applied. By identifying the learners' learning styles, it makes it easier for the teacher to provide an appropriate strategy accommodating the learners' needs and interests. Learning style is the students' way to learn better (Ajideh et al., 2018). The most frequently applied learning styles are visual auditory and

kinaesthetic (Bishka, 2010; Gilakjani, 2012). Understanding how the learners study a new language is a vital thing (Tabatabaei & Mashayekhi, 2013). It helps learners to increase their L2 learning (Liu & He, 2014). Ajideh et al. (2018) stated that learners use their own styles of learning in the classroom. A suitable atmosphere should be created by teachers to macth with the learners' needs. Because learning styles are important for successful learning, the study applied the VAK (visual, auditory and kinesthetics) model, as Fleming (2006) proposed, in learning argumentative essay. The VAK model is a type of learning focuses on three learning styles: seeing (visual), hearing (auditory), and moving (kinesthetic) (Siregar, 2018). Previous investigations revealed that the VAK model is appropriate toward improving writing skills (Rahmawati et al, 2017; Aliakbari and Tazik, 2019; Ramadian, et al. 2019; Foroozandehfar & Khalili, 2019; Setyoningsih, 2019; Kusumawarti, et al. 2020; Sabarun et al., 2020; Masela & Subekti, 2021).

Despite the fact that many investigations exist on mind map, gender difference, and learning style preference partially on learners' writing performance, no investigation exists on the effect of the three vareables simultaneously on the learners' writing performance. Therefore, the present investigation focuses on measuring the influence among learning styles (x1), gender (x2), and types of mind maps (x3) on writing performance (y) at Islamic University students. The design applied a posttest quasi-experiment using a 3x2x2 analysis of variance. The researchers of the present study used learning styles (x1), gender (x2), and types of mind maps (x3) as independent variables of the study. The novelty is that the research involves learning styles and gender, which are assumed to be the potential factors contributing to successful writing. The result of the study is expected to give some benefits. For teachers, it provides a new insight of teaching writing using a mind map. Pedagogically, it helps the teacher see learners' progress on using mind map. For learners, it encourages the students to write better. It arouses the learners' motivation to write. The result will also provide a real description on how to run EFL writing class using a mind map.

2.   Method

The study used a quasi-experiment using a 3x2x2 analysis of variance with the participants' types of learning styles (x1): visual versus auditory versus kinesthetic; gender (x2): male versus female; model of mind map (x3): digital mind map (DMM) versus paper mind map (PMM) as between-participants factors. The study involved EFL participants comprising three groups based on learning styles (x1) comprising auditory (n=10) visual (n=11) kinesthetic (n=9); gender (x2) consisting of: male (n=15), female (n=15); model of mind map (x3) comprising DMM (n=14), PMM (n=16). The 30 the EFL students were involved in this investigation. The independent variables of the study were learning styles (x1), gender (x2), and types of mind maps (x3). The dependent variable was the learners' writing performance (y). The framework of the study was presented in Fig. 2.
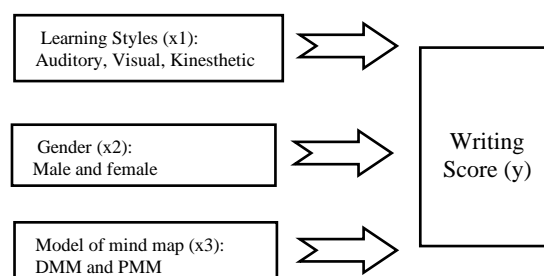
Fig. 2 Framework of the study

A 3x2x2 three-way ANOVA was applied to analysis data. It was applied to measure if the interaction among learning styles (x1), gender (x2), and types of mind maps (x3) differed significantly

on writing performance (y). Learning styles, gender, and types of mind maps were factors in the present study that have affected how well learners' writing performance. The 30 L2 learners was involved in the study, as seen in Table 1.

Table 1. The respondents of the study

| Types of mind map | Learning Styles | | | | | | Total |
| | Auditory | | Visual | | Kinesthetic | | |
	Male	Female	Male	Female	Male	Female	
Digital Mind Map	3	2	3	1	4	1	14
Paper Mind Map	1	4	2	5	2	2	16
Sub-total	4	6	5	6	6	3	
Total	10		11		9		30

Design

This investigation applied one group pre-post experiment design. The pre-posttest design was used to gather data on writing performance, as described below.
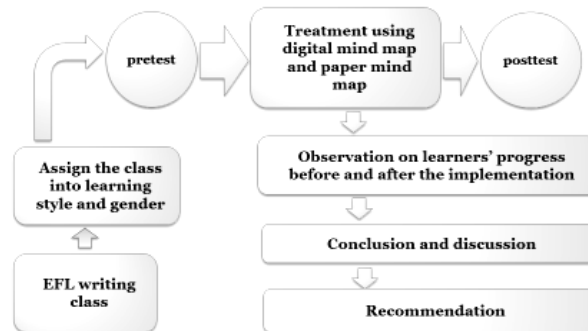
Fig. 3 Research Design

Data Collection

The data were gathered through pre-post writing test and questionnaire. The students' writing performance data were obtained from the results of the writing test. Data of the learners' genders and learning style preferences were obtained from the results of questionnaire. The participants were asked to compose an essay with around 450 to 500 words. The learners' composition was evaluated, as proposed by Weigle (2002, p. 116). Finally, the data were analyzed using a statistical analysis of variance.

Data analysis

The 3x2x2 three-way analysis of variance meant that three categorical independent variables exist. There was a total of 12 conditions, 3x2x2=12. The three-way ANOVA tested for main effects, and interaction effects amongst all combinations of three factors, on an outcome variable. An α/ alpha of 0.05 worked well. If the p value was less than 0.05, this meant that the levels in the corresponding factor differed significantly. In the present study, there were three factors contributing the learners' writing performance. They were factor A (learning styles), factor B (gender), and factor C (types of mind maps), factor two interactions (AB), (AC), and (BC); and factor three interactions (ABC). Therefore, the three-way analysis of variance design model was as follows:

$$Y_{ijk} = \mu + \alpha + \beta + \gamma + \alpha\beta + \alpha\gamma + \beta\gamma + \alpha\beta\gamma + \varepsilon_{ijkl}$$

Where:

Y_{ijk}	: the 1st observation in cell (i,j,k)
μ	: the overall (grand) mean
$\alpha\ \beta\ \gamma$	: are the main effects of factors A (learning styles), B (gender), C (types of mind map)
$\alpha\beta\ \alpha\gamma\ \beta\gamma$	: are the two way (first order) interactions(interaction effect between AB, AC, and BC
$\alpha\beta\gamma$	: is the three-way (second order) interaction amongst learning styles (x1), gender (x2), and types of mind maps (x3)
ε_{ijkl}	: are independent random variables

The null hypotheses of the study were as follows: learning styles, gender and types of mind maps did not affect the means of writing performance yield. A three-factor ANOVA was conducted. It was performed to investigate the interaction effect amongst learning styles (x1), gender (x2), and types of mind maps (x3) on writing performance (y). The analysis also measured whether a partial effect of each learning styles, gender, and model of mind maps exists.

3.   Results and discussion

There were seven questions to be replied to in the investigation RQ1. Is there any statistical significant difference in means on writing performance yielded by learning styles? RQ2. Is there any statistical significant difference in the mean scores on writing performance yielded by gender? RQ3. Is there any significant difference in the mean scores on writing performance yielded by types of mind maps? Is there any interaction effect between: RQ4. learning styles and gender on the mean scores of writing performance? RQ5. learning styles and types of mind maps on mean scores of writing performance yield? RQ6. gender and types of mind maps on means of writing performance yield? RQ7. amongst learning styles, gender and types of mind maps on means of writing performance yield? The result was as shown in Table 2.

Table 2. Descriptive Statistics

Learning Styles	Gender	Types of Mind Map	Mean	Std. Deviation	N
Auditory	Male	Digital Mind Map	83.33	5.77	3
		Paper Mind Map	60.00	0.00	1
		Total	77.50	12.58	4
	Female	Digital Mind Map	80.00	7.07	2
		Paper Mind Map	79.00	2.71	4
		Total	79.33	3.83	6
	Total	Digital Mind Map	82.00	5.70	5
		Paper Mind Map	75.20	8.85	5
		Total	78.60	7.86	10
Visual	Male	Digital Mind Map	86.00	6.56	3
		Paper Mind Map	74.50	0.71	2
		Total	81.40	7.83	5
	Female	Digital Mind Map	92.00	0.00	1
		Paper Mind Map	77.40	4.88	5
		Total	79.83	7.39	6
	Total	Digital Mind Map	87.50	6.14	4
		Paper Mind Map	76.57	4.24	7
		Total	80.55	7.24	11
Kinesthetic	Male	Digital Mind Map	56.25	8.54	4
		Paper Mind Map	55.00	7.07	2

Learning Styles	Gender	Types of Mind Map	Mean	Std. Deviation	N
Total		Total	55.83	7.36	6
	Female	Digital Mind Map	65.00	0.00	1
		Paper Mind Map	55.00	7.07	2
		Total	58.33	7.64	3
	Total	Digital Mind Map	58.00	8.37	5
		Paper Mind Map	55.00	5.77	4
		Total	56.67	7.07	9
	Male	Digital Mind Map	73.30	16.06	10
		Paper Mind Map	63.80	10.59	5
		Total	70.13	14.81	15
	Female	Digital Mind Map	79.25	11.79	4
		Paper Mind Map	73.90	10.23	11
		Total	75.33	10.51	15
	Total	Digital Mind Map	75.00	14.78	14
		Paper Mind Map	70.75	11.10	16
		Total	72.73	12.89	30

The output confirmed the average score and standard deviation (SD) for each group. It shows the mean score based on learning styles, gender, and types of mind maps. The mean score for auditory male learners using a digital mind map was 83.33 and paper mind maps with 60.00. Meanwhile, the mean score for auditory female learners using digital mind maps was 80.00 and paper mind map with 79.00. The score for visual male learners using a digital mind map was 86.00, paper mind map 74.50. Meanwhile, the mean score for visual female learner using digital mind map was 92.00, paper mind map 74.40. Next, Then, the score for kinesthetic male learner using digital mind map was 56.25, paper mind map with 55.00. The mean score for kinesthetic female learner using digital mind map was 65.00, paper mind map 55.00. The output confirmed that the participants using digital mind map achieved better than using paper mind map; and female students achieved higher scores than male students for each group.

3.1 Interaction effect amongst learning styles, gender and types of mind maps on writing performance

The main finding of the study was to look for the interaction effect amongst learning styles, gender and types of mind maps on writing performance as illustrated in Table 3.

Table 3. Tests of between-subjects effects

Source	Df	F	Sig.	Partial Eta Squared
Corrected Model	**11**	**10.70**	0.00	0.87
Learning styles * gender	2	0.21	0.81	0.02
Learning styles * Types of mind map	2	0.85	0.44	0.09
gender * Types of mind map	1	0.49	0.49	0.03
Learning styles * gender * Types of mind map	2	3.64	0.04	0.29
Error	18			
Corrected Total	29			

a. R Squared = 0.867 (Adjusted R Squared = **0.786)**

The important rows were learning styles gender types of mind maps; learning styles gender; learning styles types of mind maps; and gender types of mind map and these were highlighted. The table confirmed if the independent variables (learning styles, gender, types of mind map) had a statistically significance different on the learners' writing performance. The table confirmed that the F=10.70, significant value of corrected model was 0.00<0.05, indicating the model was valid. Then, the sig.value of intercept was 0.00<0.05, which means that it was significant. The Adjusted R Squared=0.786. It meant that the independent variables (learning styles gender types of mind map) contributed to writing performance was around 78.60%. The rest was out of the investigation. The output confirmed that significance interaction occurred among learning styles gender types of mind map at F(2.30)=3.64, *p*=0.04. The plot of the mean writing performance for each combination of groups of learning styles gender types of mind map is as presented in Fig. 5.
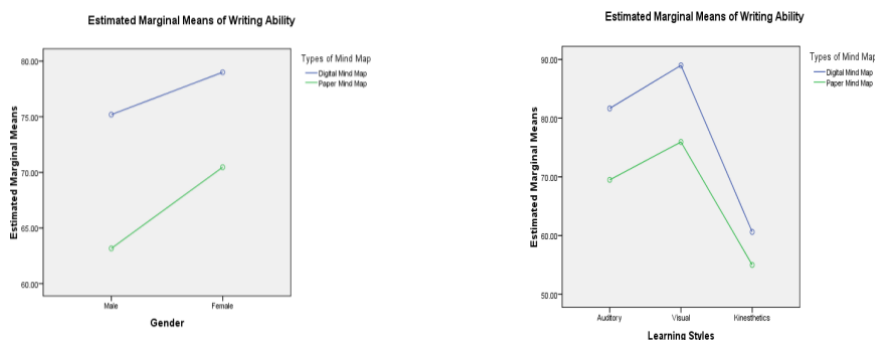

Fig. 5 The Mean Plot

The Fig. 5 indicated that the interaction among learning styles gender types of mind map was significant because there appeared to be a "strong three-way interaction." In addition, the interaction was shown in Table 2.

The output confirmed that the Estimated Marginal mean score for auditory male learner using digital mind map was 83.33, SE=3.44, paper mind map 60.00, SE=5.96. Meanwhile, the mean score for auditory female learner using digital mind map was 80.00, SE=4.21, paper mind map 79.00, SE=2.98. The score for visual male learners using digital mind map was 86.00, SE=3.44, paper mind map 74.50, SE=4.21. The mean score for visual female learner using digital mind map was 92.00 SE=5.96, paper mind map 74.40, SE=2.67. Then, the score for kinesthetic male learner using digital mind map was 56.25, SE=2.98, paper mind map 55.00, SE=4.21. The mean score for kinesthetic female learner using digital mind map was 65.00, SE=5.96, paper mind map 55.00, SE=4.21. Thus, visual learners using digital mind map outperformed better than those using paper mind maps for gender in their writing performance.

3.2 Interaction effect between learning styles and gender

Table 3 confirmed that interaction effect did not occur between learning styles and gender F (2.29)=0.21, *p*=0.81, eta 0.02 on writing performance. The further analysis was seen in Table 2.

The output confirmed that the mean score for auditory male was 71.67, SE=3.44, female 79.50, SE=2.58; visual males with 80.25, SE=2.72, female 84.70, SE=3.26); kinesthetic male 55.63, SE=2.58, female 60.00, SE=3.65. As seen from learning styles and genders, it indicated that all groups were similar.

3.3 The interaction effect between learning styles and types of mind maps on writing performance

Table 3 also confirmed that interaction effect did not occur between learning styles and types of mind maps F(2.29)=0.85, *p*=0.44, eta 0.09 on writing performance. Further analysis was shown in Table 2.

The table indicated that the average score for auditory learners using a digital mind map was 81.67, SE=2,72, using paper mind map (69.50, SE=3.31); and visual learners using digital mind map was 80.00, SE=3.44, using paper mind map (75.95 SE=2.49); kinesthetic learners using digital mind map was 60.62, SE=3.33, using paper mind map (55.00 SE=2.97). As seen from learning styles and types of mind maps, it indicated that all groups were similar and there was no interaction effect.

3.4 Interaction effect between gender and model of mind maps

Table 3 also confirmed that the interaction effect between gender and types of mind map was not occurred F(1.29)=0.48, *p*=0.49, eta 0.02) on writing performance. Further analysis was shown in Table 2.

The output confirmed that the mean score for males using digital mind maps was 75.19, SE=1.90, using paper mind maps was 63.17, SE=2.81; female learners using digital mind maps was 79.00, SE=3.14, using paper mind map was 70.47, SE=1.94. As seen from genders and types of mind maps, it indicated that all groups were similar in showing no interaction effect.

3.5 Main effect of learning styles

Table 3 shows that the mean square (MS) of learning styles on the learners' writing performance was 1194.88, F(2.29)=33.65, *p*=0.00, eta 0.79. As α was lower than 0.05, learning styles provided effects on the learners' writing performance. It was proven that visual learners achieved higher than the others, as described in Table 8.

The table evidenced that the Estimated Marginal mean score of auditory learning style was 75.58; SE=2.15. By contrast, the Estimated Marginal mean score of visual learning style was 82.48 (SE=2.12). Then, the mean score for Kinesthetic was 57.81, SE=2.24. The visual learners were the highest mean score among the other three, as described in Table 4.

Table 4. Pairwise Comparisons

(I) Learning Styles	(J) Learning Styles	Mean Difference (I-J)	Std. Error	Sig.
Auditory	Visual	-6.89	3.02	0.11
	Kinesthetic	17.77*	3.10	0.00
Visual	Auditory	6.89	3.02	0.11
	Kinesthetic	24.66*	3.08	0.00
Kinesthetic	Auditory	-17.77*	3.10	0.00
	Visual	-24.66*	3.08	0.00

The output indicated pairwise differences between (1) auditory and visual; (2) auditory and kinesthetic; and (3) visual and kinesthetic. A significant difference between all three different learning styles was observed (*p*=0.00). The output shows that the mean difference between auditory and visual was -6.89, SE=3.02, *p*=0.11. It meant that both auditory and visual were equal. Then, the output shows that the mean difference between auditory and kinesthetic was 17.77, SE=3.10, *p*=0.00. It meant that auditory and kinesthetic differed significantly. In was evidenced that auditory performed better than kinesthetic. The output then showed that the mean difference between visual and

kinesthetic was 24.66, SE=3.08, *p*=0.00. It indicated that there was a significant different between visual and kinesthetic. In was proven that visual performed better than kinesthetic.

3.6   The main effect of gender

The output showed that the mean square (MS) of types of gender on writing performance was 174.34, F(1.29)=4.91, *p*= 0.04, eta 0.32. As α was lower than 0.05, it indicated that gender difference influenced the learners' writing performance. It was proven that female learners performed better than males, as shown below.

Table 5. Gender and types of mind maps

Gender and mind map	Mean	Std. Error
Male	69.18	1.70
Female	74.73	1.85
Digital Mind Map	77.10	1.84
Paper Mind Map	66.82	1.71

The output confirmed that the score of male was 69.18 (SE=1.70). In contrast, the Estimated Marginal mean score of female was 74.73 (SE 1.85). It was said that the female learners performed better than male. It meant both male and female were not equal. It was evidenced that female was better than male.

3.7   Main effect of types of mind map

The output shows that the mean square (MS) of types of mind maps on the learners' writing performance was 597.62, F(1.29)= 6.83, *p*=0.00, eta 0.48. As α was lower than 0.05, it indicated that types of mind maps provided a significant contribution on the learners' writing performance. It was proven that digital mind map performed better than paper mind maps, as shown in Table 2.

The table shows that the Estimated Marginal mean score of digital mind maps was 77.10 (SE=1.84). By contrast, the Estimated Marginal mean score of paper mind map was 66.82 (SE=1.71). It was said that digital mind maps achieved better than paper mind maps. It meant that both were unequal. It was proven that digital mind maps achieved better than paper mind map.

4.   Discussion

Thus, the table of three-way analysis variance concluded the whole analysis of interaction effect amongst learning styles, gender, and types of mind maps on writing performance at Islamic University Students and the simple main effect of each variable, as seen in Table 6.

The output indicated that a significance interaction among learning styles (x1), gender (x2) and types of mind maps (x3) on the learners' writing performance at the MS 129.14, F(2.30)=3.64, *p*=0.04 exists. However, no interaction effect exists between learning styles and gender (F(2.29)=0.21, *p*=0.81, eta 0.02); between learning styles and types of mind map (F(2.29)=0.85, *p*=0.44, eta 0.09); between gender and types of mind map (F(1.29)=049, *p*=0.49, eta 0.03) on writing performance. The main effect also confirmed that a significant difference exists on the effect of learning styles at F(2.29)=33.65, *p*=0.00, eta 0.79; gender at F(1.29)=4.91, *p*=0.04, eta 0.32; and types of mind maps at F(1.29)=16.83, *p*=0.00, eta 0.48 on the learners' writing performance.

Previous investigations performed by Tayib (2015); Soltani and Kheirzadeh (2017); Sabarun et al. (2021); Shakoori (2016), Hallen and Sangeetha (2015); Davies (2011) revealed that mind maps are a powerful technique for improving the learners' writing skill in essay writing class. The study confirmed that a significance interaction occurred among learning styles (x1), gender (x2) and types of mind map (x3) on the learners' writing performance at the MS=129.14, F(2.30)=3.64, *p*=0.04. However, interaction effect has not occurred between learning styles and gender (F(2.29)=0.21,

p=0.81, eta 0.02); between learning styles and types of mind map (F(2.29)=0.85, *p*=0.44, eta 0.09) between gender and types of mind map (F(1.29)=0.49, *p*=0.49, eta 0.03) on writing performance. The main effect also confirmed a significant difference occurred on the influence of learning styles at F (2.29)=33.65, *p*=0.00, eta 0.79; gender at F(1.29)=4.91, *p*=0.04, eta 0.32; and types of mind maps at F (1.29)=16.83, *p*= 0.00, eta 0.48 on the learners' writing performance.

Table 6. The Three-Way Analysis of Variance

Source	Variable	df	Sums of squares	Mean square	F value	*p* value	Conclusion
Main effect (A)	learning styles	2	2389.77	1194.88	33.65	0.00	Significant
Main effect (B)	Gender	1	174.35	174.35	4.91	0.04	Significant
Main effect (C)	types of mind maps	1	597.62	597.62	16.83	0.00	Significant
Interaction effect (AB)	learning styles and gender	2	14.84	7.42	0.21	0.81	Not significant
Interaction effect (AC)	learning styles and types of mind maps	2	60.40	30.17	0.85	0.44	Not significant
Interaction effect (BC)	gender and types of mind maps	1	17.26	17.26	0.49	0.49	Not significant
Interaction effect (ABC)	learning styles, gender, and types of mind maps	2	258.28	129.14	3.64	0.04	Significant
Error		18	639.12				
Total		30	163524.00				
Corrected total		29	4819.87				

This result was consistent with Komarova et al., (2019), stating that the application of MM contributed to the learners' development of self-awareness. Then, Hallen and Sangeetha (2015) confirmed that mind map improved writing performance. Zhao also confirms that mind map supports theory of constructivism (2003). It has similar results as investigated by Hidayati et al. (2020); Sabarun et al. (2020); Liu, Tong and Yang (2018); Erdem (2017); Ziyadi and Surya (2017). The study indicates that mind maps can become beneficial in the learning process. Davies (2011) believed that mind maps are an effective tool to familiarize the process of writing. Many studies have proven that mind maps helped students. For example, Hdii (2015) proved that mind map gave a statistically significant difference on students' composition. Shakoori et al. (2017) said that mind maps assisted students in making composition. El-Muslimah et al. (2021) also confirmed that digital mind maps enable learners to brainstorm and organize ideas. The other factor on writing was that the contribution of cognitive learning theory via the intervention of mind map in writing class. This idea is relevant to this theory, stating that learning happens by processing information using cognition. It also encourages Bloom's six levels of thinking.

5.   Conclusion

Based on the study, EFL learners brainstorm ideas for mind maps in writing proccess. Then, they visualize and generate ideas. By doing so, students have a chance to understand, comprehend, analyze, and create information. In this case, the mind map is effective to stimulate Bloom's six levels of thinking abilities. The mind map intervention has proven that mind maps have contributed to writing performance. Referring to the positive result in this study, mind maps should be considered as

a potential factor contributing to writing performance. The investigation confirms that digital mind maps enable learners to write better. Learners can write easily the introduction, body and conclusion. The implementation of digital mind map is regarded to be a powerful tool for learning argumentative writing with higher efficiency. Therefore, the finding invites curriculum designers and lecturers to insert digital mind map in curriculum development. Further investigations are needed with wider sample sizes and more variables involved to validate the results.

6.   Acknowledgements

7.   References

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