

Effect of Highlighting Text on Concentration, Memory and Attention Among Undergraduate Medical Students: A Randomized Controlled Trial

Ng Cheng Yik*, Lim Xin Yi, Sankirta Tero Nyana Somadam, Ashraf Ezwan Bin Amirudin, Sashitharan Ananthan

Faculty of Medicine, Melaka-Manipal Medical College, Melaka, Malaysia

Abstract

Highlighting is a common studying technique used by students. However, results from previous researches showed both positive and negative effect on highlighting. The objective of this study was to determine the effectiveness of highlighting in memory and concentration as well as the most beneficial method of highlighting. A randomized controlled trial was done in a private medical college in Malaysia from July 2018 to August 2018. Participants were divided into 3 intervention groups [important points highlighted group (n=37), entire text highlighted group (n=37), not highlighted group (n=37)]. They were given a text on Viola Desmond to read and 14 MCQs to answer. The final percentage for MCQ score was calculated. Post-test feedback and students' attitude towards highlighting were taken. The results of test score percentage were calculated and analyzed using ANOVA and independent T-test with Bonferroni adjustment. Students' attitude towards highlighting was analyzed by Kruskal-Wallis test and Chi-Square test, while post-test feedback analysis was done using Fisher-Exact test. The results showed that there were no significant differences among the 3 intervention groups. The not highlighted group had the highest test score percentage mean of 73.7% and SD of 14.9, followed by entire text highlighted group with mean of 71.8% and SD of 16.3 and the lowest test score by important points highlighted group with mean of 71.6% and SD of 16.3. As the results confirm, simply the act of highlighting is not beneficial for memory retention. Rather, student should learn to identify key points to highlight, and this act of choosing what to highlight could be an important determinant of efficacy of highlighting.

Keywords

Highlighting, Studying Technique, Concentration, Memory, Attention, Randomized Controlled Trial

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1. Introduction

In their pursuit for academic success, students engaged in a variety of study strategy with the ultimate goal of enhancement of retention and later retrieval of information necessary for examination. These strategies ranges from the simple to complex, such as repetitive reading, note taking, outlining, underlining and highlighting. Of these strategies, highlighting was cited as one of the more commonly used method with

studies reporting that 60% of students using marked passage as a guide for later re-study. [1] Highlighting is no doubt a prevalent study method among college students but evidence regarding their benefit for learning is mixed. Results from previous researches shown both positive and negative influence in text marking and its benefits in learning are limited. [2]

There were various rationales to expect highlighting to be beneficial. In terms of depth-of-processing the information, it was said that the act of deciding what to highlight will

* Corresponding author
E-mail address: ncyjames@gmail.com (Ng C. Yik)

indirectly leads to student processing the text at a more evaluative level compare to simply reading it. [3] Besides, highlighting makes the portion of the text stand out and it becomes more memorable, known as von Restorff effect. [4] Marking text also enhance the effectiveness when students re-study the topic by encoding variability. Variability is presumed to increase retention and retrieval ability because students will encode to-be-learned information in a slightly different way. [5]

On the other hand, there are studies stating that highlighting can bring negative effect to learning. One of the arguments is that students often do not know how to highlight effectively. Therefore, it is more like a mechanism to track their progress instead of enhancing deep processing. [6] Also, student metacognitive belief about highlighting may impair its effectiveness. As an example, students who rely highly on highlighters may suffer from illusion of knowing, assuming that the highlighted information had been deeply encoded in the memory. [7] Meanwhile, one of the study report that highlighting text resulted in neglect of the non-highlighted text. [8] [9]

With that in mind, the research question which follows is “does highlighting actually facilitate learning and later performance?” What differs this research from previous study is that it is directed towards medical students and emphasis is given on highlighting pattern and its correlation with memory. The research objective aims to determine the effectiveness of highlighting on memory and concentration as well as the most beneficial method of highlighting. At the same time, it is to study the prevalence and highlighting habits of undergraduate medical students. The research hypothesis is that highlighting the right information will enhance memory and concentration as compared to not highlighting text.

2. Methodology

2.1. Study Design

A randomized controlled trial on effect of highlighting text on concentration, memory and attention among undergraduate medical students was carried out.

2.2. Study Place and Study Time

The study was conducted in Melaka-Manipal Medical College (MMMC), Muar and Melaka campus in Malaysia. The study was conducted from June 2018 to August 2018, total duration of 2 months.

2.3. Study Population

The study population in this trial were medical students from

MMMC who were from MBBS Batch 36 & 37.

2.4. Sample Size

The sample size was calculated using mobile application n4studies [10, 11] for a randomized controlled trial for continuous data. The values for mean and standard deviation in both intervention group and control group were taken from previous study of highlighting and its relation to distributed study and students’ metacognitive belief [12].

Mean in a treatment group (μ_{trt}) = 0.50, SD. in a treatment group (σ_{trt}) = 0.38

Mean in a control group (μ_{con}) = 0.28, SD. in a control group (σ_{con}) = 0.29

Ratio (control/treatment) = 1.00

Alpha (α) = 0.05, Z (0.975) = 1.959964

Beta (β) = 0.20, Z (0.800) = 0.841621

The formula used is:

$$n_{\text{trt}} = \frac{\left(Z_{1-\frac{\alpha}{2}} + z_{1-\beta} \right)^2 \left[\sigma_{\text{trt}}^2 + \frac{\sigma_{\text{con}}^2}{r} \right]}{\Delta^2}$$

$$r = \frac{n_{\text{con}}}{n_{\text{trt}}}, \Delta = \mu_{\text{trt}} - \mu_{\text{con}}$$

Calculated sample size: Treatments = 37, Control = 37

The minimum number of participants needed in a group was 37 participants. There were 2 intervention groups and 1 control group. Hence, totally 111 participants were required to participate in this study.

2.5. Sampling and Randomisation

Purposive sampling technique was used to select 111 participants from Melaka-Manipal Medical College (MMMC). Inclusion criteria for this study included students who were willing to provide written inform consent, students who had more than 6 hours of sleep last night and students who were not ill recently. Exclusion criteria for this study were students who suffer from colour blindness, students who were recently ill, students who did not sign the written informed consent and those who wanted to withdraw from the study.

Block randomisation technique was used to assign equal numbers of participants into the respective intervention groups, namely intervention group 1 (important points highlighted), intervention group 2 (all text highlighted) and control group (no text highlighted). Randomisation was done using randomizer.org website [13].

RESULTS

[PRINT](#)
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37 Sets of 3 Unique Numbers Per Set

Range: From 1 to 3

Set #1

1, 2, 3

Set #2

1, 2, 3

Set #3

1, 2, 3

Set #4

1, 3, 2

Set #5

3, 2, 1

Set #6

3, 2, 1

Set #7

3, 2, 1

Please note: By using this service, you agree to abide by the [SPN User Policy](#) and to hold Research Randomizer and its staff harmless in the event that you experience a problem with the program or its results. Although every effort has been made to develop a useful means of generating random numbers, Research Randomizer and its staff do not guarantee the quality or randomness of numbers generated. Any use to which these numbers are put remains the sole responsibility of the user who generated them.

Figure 1. Block randomisation done with the online application Randomizer.org.

2.6. Intervention

The intervention in all groups require the subjects to read a text entitled – The Story of Viola Desmond, which consisted of 5 paragraphs and followed by answering 14 multiple choice questions (MCQs). In intervention group 1, the important points were highlighted in yellow. In intervention group 2, all the text were highlighted in yellow. In the control group, the whole text were not highlighted. Each participant in each group was given 5 minutes to read and understand the text and was given another 5 minutes to answer the text.

2.7. Data Collection

On the day of data collection, the participants were assembled in the lecture hall and seated according to the group assigned to them. At the beginning of the study, participants were briefed on the purpose of the study and they were informed that their participation was completely

voluntary and they can withdraw from the study anytime they want.

They were given 5 minutes to read the intervention allocated to them. At the end of 5 minutes, a test consisting of 14 MCQs were handed to them. 14 MCQs included main points from each paragraph. For each correct answer, 1 point will be given. For each wrong answer did not answer, 0 point will be given. Total points were then added and the score percentage was calculated.

After that they were given a post-test survey form, which consisted of 3 parts:

- (1) Participants' demographic data (4 components: Age, Batch, Gender & Ethnicity)
- (2) Questionnaires on their usual highlighting habits and their attitude towards highlighting (6 components)
- (3) Feedback regarding the intervention and their performance (2 components)

2.8. Dependent and Independent Variables

The independent variable is the learning strategy used (highlighting style). The dependent variables (outcome) are recall of information and feedback on the intervention and their performance.

2.9. Data Entry, Data Processing, Data Analysis

The data was entered in Microsoft Excel version 2013 and it was double checked to avoid any duplication and missing data. The data was then used for statistical calculations using EpiInfo version 7.

For categorical data (demographic details) a table was created to describe the frequency and its percentage for each of the factors for the respective intervention. For the MCQ test, the difference in mean knowledge scores between the intervention and control groups were calculated and its standard deviation was calculated. The feedback analysis was done using a non-parametric test (ordinal data) known as Kruskal Wallis test, where the Q1, Q2, Q3 and interquartile range was calculated. Pie chart was used to represent the data calculated from categorical data (demographic details, highlighting habits & feedback). Bar chart/box plot was used to represent the numerical data obtained from the MCQs scores.

For hypothesis testing, ANOVA test was used to determine

the difference in recollection of information between the 3 groups. The level of significance (α) was set at 0.05. Unpaired t test was used, the p value and t value was calculated to find the difference of percentage scores between two interventions. Bonferroni adjustment was used to protect from type I error. The new p-value calculated was 0.0167 ($\alpha_{\text{altered}} = 0.05/3 = 0.0167$). Bonferroni adjustment was done for paired comparison between the:

- (1) Intervention group 1 versus control group
- (2) Intervention group 2 versus control group
- (3) Intervention group 1 versus intervention group 2

For measurement of association, relative risk between the intervention and control group and 95% confidence interval were calculated.

2.10. Ethical Consideration

Prior to the study, approval was obtained from the Ethical Committee of MMMC to conduct the study. All participants were explained about the procedure of the experiment and their role in the study. All the participants participated voluntarily in this study. A written informed consent was obtained from the participants before conducting the study. The participants were assured that all the data collected would remain confidential and solely for study purpose only.

3. Results

3.1. Participants' Demographic

Table 1. Students' demographics among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37).

Variables		Important points highlighted (n= 37) n (%)	Entire text highlighted (n=37) n (%)	Not highlighted (n=37) n (%)	Totaln (%)
Age (years) ^a		22.6 (0.8)	22.5 (1.2)	22.5 (1.0)	22.5 (1.0)
Batch	36	26 (70.3)	22 (59.5)	23 (62.2)	71 (64.0)
	37	11 (29.7)	15 (40.5)	14 (37.5)	40 (36.0)
Gender	Male	18 (48.7)	19 (52.4)	13 (35.1)	50 (45.1)
	Female	19 (51.4)	18 (48.7)	24 (64.9)	61 (55.0)
	Chinese	11 (29.7)	15 (40.5)	11 (29.7)	37 (33.3)
Ethnicity	Indian	18 (48.7)	12 (32.4)	17 (46.0)	47 (42.3)
	Malay	4 (10.8)	8 (21.6)	5 (13.5)	17 (15.3)
	Others	4 (10.8)	2 (5.4)	4 (10.8)	10 (9.0)

^aMean (SD)

Table 1 showed participants' demographics among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37). The total number of participants were 111, which were divided into three intervention groups, which were the important points highlighted group (n=37), entire text highlighted group (n=37) and the not highlighted group (n=37) that was shown in the table above with their demographic details. The average age of the participants was 22.5 with a standard deviation of 1. Among the participants,

71 (64%) of them were from Batch 36 while 40 (36%) of them were from Batch 37. As for the gender, 61 (55%) were females whereas 50 (45.1%) were males. This difference was more evident in not highlighted group where the female participants were 24 compared to 13 male participants. As for the ethnicity, the number of Chinese participants was 37 (33.3%), Indian was 47 (42.3%), Malay was 17 (15.3%) and 10 (9%) participants from other ethnicity groups.

3.2. Intervention and Test Score

Table 2. Test score percentage among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37).

Groups	n	Score (%) Mean (SD)	F-statistic (df1,df2)	P-value ^b
Important points highlighted	37	71.6 (17.9)	0.19 (2,108)	0.827 ^a
Entire text highlighted	37	71.8 (16.3)		
Not highlighted	37	73.7 (14.9)		

^bOne-way ANOVA

Table 2 showed the test score percentage between important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37). The mean for important points highlighted was 71.6% with SD of 17.9. The mean for entire text highlighted was 71.8% with SD of 16.3. The mean for not highlighted was 73.7% with SD of 14.9. The highest

mean score was obtained from the not highlighted group. One-way ANOVA test was done with level of significance set at 0.05. F-statistics calculated was 0.19. Df1 was 2 and df2 was 108. The P-value calculated was 0.827. Hence, there was no significant difference of test score obtained between the three groups.

Table 3. Mean difference of test score percentage between important points highlighted (n= 37) and not highlighted (n=37), between entire text highlighted (n=37) and not highlighted (n=37) and between important points highlighted (n=37) and entire text highlighted (n=37).

Variables	Mean (SD)	Mean difference (95% CI)	P-value ^c
Important points highlighted (n= 37)	71.6 (17.9)	2.1 (-9.8,5.1)	0.581
Not highlighted (n=37)	73.7 (14.9)		
Entire text highlighted (n=37)	71.8 (16.3)	1.9 (-9.2,5.3)	0.597
Not highlighted (n=37)	73.7 (14.9)		
Important points highlighted (n= 37)	71.6 (17.9)	0.2 (-8.1,7.8)	0.962
Entire text highlighted (n=37)	71.8 (16.3)		

^cPost-hoc analysis with Bonferroni corrections (P < 0.0167 is statistically significant)

Table 3 showed the mean differences between important points highlighted (n= 37) and not highlighted (n=37), between entire text highlighted (n=37) and not highlighted (n=37) and between important points highlighted (n=37) and entire text highlighted (n=37). Independent T-test was done with Bonferroni correction (P < 0.0167 is statistically significant).

The mean difference between important points highlighted and not highlighted was 2.1 with 95% CI of -9.8, 5.1. The t-statistic calculated was 0.55 with df of 72. The P-value calculated was 0.581. Hence, there was no significant difference in the mean score between the two groups.

The mean difference between entire text highlighted and not highlighted was 1.9 with 95% CI of -9.2, 5.3. The t-statistic calculated was 0.53 with df of 72. The P-value calculated was 0.597. Hence, there was no significant difference in the mean score between the two groups.

The mean difference between important points highlighted and entire text highlighted was 0.2 with 95% CI of -8.1, 7.8. The t-statistic calculated was 0.05 with df of 72. The P-value calculated was 0.5962. Hence, there was no significant difference in the mean score between the two groups.

3.3. Students' Attitude Towards Highlighting

Table 4. Students attitude towards highlighting among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37).

Components	Important points highlighted Median (Q1,Q3)	Entire text highlighted Median (Q1,Q3)	Not highlighted Median (Q1,Q3)	P-value ^d
I highlight notes often.	4.0 (2.0,4.0)	3.0 (2.0,4.0)	4.0 (2.0,5.0)	0.279
I think that highlighting helps me to perform better in my studies.	4.0 (3.0,4.0)	4.0 (3.0,4.0)	3.0 (3.0,4.0)	0.893
I think that highlighting helps in recalling/ answering questions.	3.0 (3.0,4.0)	4.0 (3.0,4.0)	4.0 (3.0,4.0)	0.742
I think that highlighting is time consuming.	3.0 (3.0,4.0)	4.0 (3.0,4.0)	4.0 (3.0,4.0)	0.466
I would recommend highlighting to my friends.	4.0 (3.0,4.0)	3.0 (3.0,4.0)	3.0 (3.0,4.0)	0.383
Reading highlighted text is a distraction to me.	4.0 (3.0,4.0)	4.0 (3.0,4.0)	4.0 (4.0,4.0)	0.096
Highlighting will make me neglect the non-highlighted points.	3.0 (2.0,4.0)	2.0 (2.0,3.0)	3.0 (2.0,4.0)	0.108

^dKruskal-Wallis test

Table 4 showed students' attitude towards highlighting between important points highlighted (n=37), entire text highlighted (n=37) and not highlighted (n=37). The median,

Q1 and Q3 for the score was calculated. Kruskal-Wallis test was done and the level of significance was set at 0.05.

For the 1st component (I highlight notes often), the students

in important point highlighted group had median score of 4, Q1 of 2 and Q3 of 4. The students in entire text highlighted group had median score of 3, Q1 of 2 and Q3 of 4. The students in not highlighted group had median score of 4, Q1 of 2 and Q3 of 5. The P-value calculated was 0.279, which showed that there was no significant difference among the students' attitude from the three groups towards the 1st component (I highlight notes often).

For the 2nd component (I think that highlighting helps me to perform better in my studies), the students in important point highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in entire text highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in not highlighted group had median score of 3, Q1 of 3 and Q3 of 4. The P-value calculated was 0.893, which showed that there was no significant difference among the students' attitude from the three groups towards the 2nd component (I think that highlighting helps me to perform better in my studies).

For the 3rd component (I think that highlighting helps in recalling/ answering questions), the students in important point highlighted group had median score of 3, Q1 of 3 and Q3 of 4. The students in entire text highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in not highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The P-value calculated was 0.742, which showed that there was no significant difference among the students' attitude from the three groups towards the 3rd component (I think that highlighting helps in recalling/ answering questions).

For the 4th component (I think that highlighting is time consuming), the students in important point highlighted group had median score of 3, Q1 of 3 and Q3 of 4. The students in entire text highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in not highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The P-value

calculated was 0.466, which showed that there was no significant difference among the students' attitude from the three groups towards the 4th component (I think that highlighting is time consuming).

For the 5th component (I would recommend highlighting to my friends), the students in important point highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in entire text highlighted group had median score of 3, Q1 of 3 and Q3 of 4. The students in not highlighted group had median score of 3, Q1 of 3 and Q3 of 4. The P-value calculated was 0.383, which showed that there was no significant difference among the students' attitude from the three groups towards the 5th component (I would recommend highlighting to my friends).

For the 6th component (Reading highlighted text is a distraction to me), the students in important point highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in entire text highlighted group had median score of 4, Q1 of 3 and Q3 of 4. The students in not highlighted group had median score of 4, Q1 of 4 and Q3 of 4. The P-value calculated was 0.096, which showed that there was no significant difference among the students' attitude from the three groups towards the 6th component (Reading highlighted text is a distraction to me).

For the 7th component (Highlighting will make me neglect the non-highlighted points), the students in important point highlighted group had median score of 3, Q1 of 2 and Q3 of 4. The students in entire text highlighted group had median score of 2, Q1 of 2 and Q3 of 3. The students in not highlighted group had median score of 3, Q1 of 2 and Q3 of 4. The P-value calculated was 0.108, which showed that there was no significant difference among the students' attitude from the three groups towards the 7th component (Highlighting will make me neglect the non-highlighted points).

3.4. Post-Test Feedback by Participants

Table 5. Participants' perceived performance among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37).

Intervention	Perceived performance	Good n (%)	Average n (%)	Poor n (%)	Total n (%)	X ² statistic (df)	P-value ^e
Important points highlighted		13 (35.1)	23 (62.1)	1 (2.7)	37 (33.3)	3.2 (4)	0.554
Entire text highlighted		10 (27.0)	25 (67.6)	2 (5.4)	37 (33.3)		
Not highlighted		15 (40.5)	22 (59.5)	0 (0)	37 (33.3)		
Total		38 (34.2)	70 (63.1)	3 (2.7)	111 (100)		

^eFisher Exact Test

Table 5 showed frequency and percentage of perceived performance by participants of each intervention group, important points highlighted (n=37), entire text highlighted (n=37) and not highlighted (n=37). Majority of participants feel they did average after the test, with 70 (63.1%) choose the option and it is consistent across all three intervention. Among those who perceived they did good, 15 (39.5%) are from the not highlighted group as compare to 10 (26.3%) who are from the entire text highlighted group.

Fisher exact test was done to find the association between intervention and their perceived performance, with significant level

set at 0.05. χ^2 statistic calculated was 3.2 and df was 4. The P value obtained was 0.554. Therefore there is no significant association between intervention and perceived test performance.

Table 6. Participants' preferred highlighting pattern among important points highlighted (n= 37), entire text highlighted (n=37) and not highlighted (n=37).

Intervention	Preferred highlighting pattern	Important points highlighted n (%)	Entire text highlighted n (%)	Not highlighted n (%)
Important points highlighted		29 (78.4)	2 (5.4)	6 (16.2)
Entire text highlighted		30 (81.1)	2 (5.4)	5 (13.5)
Not highlighted		32 (86.5)	6 (16.2)	4 (10.8)
Total		91 (82.0)	5 (4.5)	15 (13.5)

Table 6 depicted the preferred highlighting pattern of participants from each intervention group. Out of 111 participants, 91 (82%) prefer reading text with important points highlighted, 15 (13.5%) prefer the text to be unhighlighted while only 5 (4.5%) prefer text that are

highlighted entirely. Similar trend were observed across all 3 intervention, except in not highlighted group where 32 (86.5%) prefer important points highlighted, follow by 6 (16.2%) in favour of entire text highlighted and 4 (10.8%) choose not highlighted text.

3.5. Highlighting Practice and Habits of Participants

Table 7. Association between gender and highlighting practice among participants.

Variables	Yes highlight n (%)	No highlight n (%)	OR (95 CI)	Chi-square	P value ^f
Female	53 (86.9)	8 (13.1)	3.4 (1.3-8.8)	6.87	0.008
Male	33 (66.0)	17 (34.0)			

^fChi-square test

Table 7 depicted the comparison between gender and their highlighting practice among participants. As shown, 53 (86.9%) out of 61 female responded "yes" to frequent highlighting. In contrast, 33 (66%) out of 50 male responded "yes" to frequent highlighting.

Chi-square test was done to find the association between gender and highlighting. The level of significant was set at 0.05. The chi square value obtained is 6.87. The odds ratio is 3.4 with a 95% CI of 1.3, 8.8. The P value calculated was 0.008. Hence, there is a significant association between gender and highlighting practice. Females are 3.4 times more likely to use highlighter as compare to male.

Table 8. Prevalence of highlighting practice and its habit (colour used, choice of colour and what do they commonly highlight) among participants.

Variables	Yes n (%)	
Highlighting Practice	86 (77.5)	
Colour	Yellow	92 (82.9)
	Green	36 (32.4)
	Pink	40 (36.0)
	Orange	32 (28.8)
	Purple	10 (9.0)
Reason of colour choice	Favourite colour	15 (13.5)
	Stand out	67 (60.4)
	Helps remember	34 (30.6)
	Only available colour	14 (12.6)
What do they highlight	Important points	99 (89.2)
	Whole passage	1 (0.9)
	Title	15 (13.5)
	New Vocabulary	8 (7.2)
	Whole sentence	11 (9.9)
	Examples	11 (9.9)

Table 8 showed highlighting habits of participants. Among 111 participants, 86 (77.5%) had frequent use of highlighters. In terms of colour used, 92 (82.9%) participants chose yellow colour, followed by pink 40 (36%), green 36 (32.4%) and orange 32 (28.8%). In terms of reason for colour choice, majority (n=67, 60.4%) think the chosen colour stands out more than other colour. Second most common reason is that they feel the particular colour can help them remember better where 34 (30.6%) choose the option. When comes to item commonly highlighted by the participants, 99 (89.2%) highlights the important points as common to only a mere 8 (7.2%) who highlights new vocabulary. The participants were allowed to choose more than one option.

Table 9. Study strategies commonly practiced among participants.

Variables	Yes n (%)	No n (%)
Highlighting	72 (64.9)	39 (35.1)
Repetitive reading	76 (68.5)	35 (31.5)
Note taking	39 (35.1)	72 (64.9)
Flashcard	7 (6.3)	104 (93.7)
Underlining	35 (31.5)	76 (68.5)

Table 9 showed prevalence of different study strategies used among participants (N=111). The most commonly chosen option is repetitive reading with 76 (68.5%) responded "yes", followed by highlighting 72 (64.9%), note taking 39 (35.1%), underlining 35 (31.5%) and lastly flashcard with a mere 7 (6.3%) opt for the choice. They were allowed to choose more than one answer.

4. Discussion

This study was carried out to identify the effect of highlighting text on concentration, memory and attention among medical students. At the same time, it is to study the prevalence of highlighting and the highlighting habits of undergraduate medical students. The students were randomly divided into two intervention groups (Important points highlighted and Entire text highlighted) and a control group (Not highlighted) equally.

Based on the study, the non-highlighted group obtained the highest mean score among the three but there is no significant difference between them. However, contrary to the finding, a research done by Tayyebi Sadeghi Hasanabadi *et al* in 2016 reported that highlighted group performs better in memory recollection. [14] This could be due to the gender distribution where the non-highlighted text group has the highest gender gap in a group with 24 female students and 13 male students. Regards to gender, previous study found that females scored higher than men on two verbal subtests: Word Selective Reminding and Object Recall. [15] Besides, highlighting text might actually affect learning and recall, with various research supported the finding as well. [16] Another reason for control group performing better is that the intervention groups were given text that were already highlighted. Previous study proved that the act of selecting what to highlight actually enhance deep level thinking and processing. [17] Therefore, it is believed that participants reading text highlighted by researcher actually hindered their learning.

A post-test feedback session was conducted and it is found that most participants perceived their performance as 'average' in all three interventions. However, participants in control study thought they did good compare to other two. In fact, no participants in the control group gave poor remark. This corresponded to their test performance where they performed the best among the three groups. However, there was no significant association between intervention and perceived test performance. For preferred highlighting pattern, majority of participants preferred reading text with important points highlighted and it was consistent across all interventions. The participants prefer text with important points highlighted and they understood that highlighting correctly would improve academic performance. Similarly previous study showed that marking keywords or important points in questions with highlighter pen could have learning effects and contribute to necessary memory ability, attention capacity and cognitive capacity of learners. [18]

There was a significant association between gender and highlighting practice. Female participants highlight more frequent as compared to male counterpart. Our study found

that females are 3.4 times more likely to use highlighter than male, which was statistically significant. These findings were consistent with study of 'Gender differences in learning style preferences' where higher number of female prefer visual learning as compared to male. [19] Also, females are more motivated in learning and they also prefer neat and organized work as compare to male as stated in a study by Freeman in 2004. [20]

Further exploration regarding the usage of highlighter, highlighting practice and its habit was asked. The study reveal 86% participants use highlighter in their study with 92% of them preferred yellow colour highlighters. Participants primarily preferred highlighting with yellow colour because it helped the words to stand out. Second common reason was that they felt the particular colour could help them remember better. This was not something new as previous studies found that warm colours such as yellow and red actually improves arousal and that arousing events have the ability to increase memory. [21, 22, 23, 24] Also based on the previous study, participants had 30% higher marks with bright colour text compared to traditional text. [25] For the item commonly highlighted by the participants, highlighting the important points was the commonest respond and it was consistent with our earlier finding of their preferred highlighting pattern.

The prevalence of different study strategies used among participants, repetitive reading was the commonest option followed by highlighting, note taking, underlining and lastly flashcard. Previous study showed that high ability students who read twice had higher mean score as compared to high ability students who read once. [16] Inference can be made that participants tend to use the most effortless strategies to improve memory in their studies. On top of that, flashcard was the least preferred option, as it was the most time consuming method to memorize the topic even though it was one of the best strategies to improve memory recall, concentration and retention.

Finally, a series of components consisted of seven statement reflected upon students' attitude towards highlighting were given to the participants on each intervention. All three interventions showed neutral to positive attitude towards highlighting. Across all three interventions, participants felt that highlighting helped in recalling or answering questions, it was not time consuming and not a form of distraction. However, for the non-highlighted group, participants did not highlight notes as often as compared to the other group, and some felt that highlighting will make them neglect the non-highlighted text. This could possibly be the reason that the control group scored the highest in the test. One study concluded that anti-highlighters only have marginal benefit from use of highlighter. [12] Note that participants' opinion did not represent their intervention due to randomization was

done earlier. This showed that relationship of student attitude towards highlighting was not significant.

4.1. Limitations

There were a few limitations that may have influenced the results of the study. Firstly, this study was conducted at MMMC, which was only one of the many colleges in Malaysia and may not be a true representation of the students in other colleges. Therefore, a bigger sample size would have been more ideal for this study. Next, not all the extraneous variables could be controlled such as memory (both short term and long term) and IQ level. Both of these could influence the participant's understanding on a text given.

4.2. Recommendations for Future Studies

In the future, aspects such as gender balance and students' academic performance should be taken into account during randomization. The participants involved should be academically similar to one another in order to reduce error in the study. Alternatively, study could be carried out where one student sits for all three intervention, so that the confounding variables such as IQ level could be eliminated.

In addition, other method such as Short Answer Question (SAQs) should be use to evaluate memory performance instead of Multiple Choice Questions (MCQs). This is because SAQs provide more information in terms of understanding, concentration and memory skills than MCQs.

Besides, subsequent study should be done where highlighters are given out for the participants to highlight their own text, instead of giving a text that was highlighted. This is because the act of highlighting itself will enhance learning.

Finally, the text provided should not be just a non-medical article. As the mean age sample is 22.6 years, other factors like English language and level of difficulty must be suitable for 22 and 23 years old. This could eliminate bias towards text comprehension completely.

5. Conclusion

Based on the study, the not highlighted group obtained a higher test score percentage than the important points highlighted group and entire text highlighted group. It was found that female had higher distribution in the not highlighted group than men compared to other two groups. Also, the study shows that female is 3.4 times more likely to highlight text when they study as compare to male. Participants understood that highlighting improve their memory performance. However, participants choose repetitive reading edging out highlighting as a preferred method in their studies. It was important to note that they use

highlighter for important points. Students should learn to identify key points to highlight and this act of choosing what to highlight could be an important determinant of the efficacy of highlighting. The participants also preferred highlighter in yellow color compare to other colors because it stood out more from the rest. Lastly, it seems that anti-highlighters did not benefit as much from highlighting. The results clearly showed contradictory to the hypothesis constructed at the beginning of the study.

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