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The Effect of Mind Mapping vs Traditional Handout on the Understanding of a Topic Among Medical Students – A Randomized Controlled Trial

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Abstract

Handouts are a linear and structured way of note taking that has been used for centuries as a method of studying but it is not known to stimulate the creativity of the students whereas mind maps are an innovative way and non-structured form of note taking devised to stimulate students creativity and thought processes. Mind maps are a very popular way of studying and it has been used throughout the ages for learning, brainstorming, visualization of ideas and problem solving by educators, students and most professionals. Previous studies had been done regarding the effectiveness of mind maps on students' understanding of a topic but very little study has been done where they compared the effectiveness of both methods against each other. This study aims to study the effects of mind mapping vs traditional handouts on understanding of a topic among medical students. Our study hypothesis states that there is a difference in the understanding of a topic between students who are using either mind maps or handouts. A randomized controlled trial study was conducted among medical students (n=60) in Muar, Johor, Malaysia. The traditional handout had 30 students and the mind map group had 30 students where both the interventions had similar information of Vitiligo. The participants were assessed through a self-administered questionnaire that consists of four sections. The knowledge scores is the primary outcome variable and the results were compared between the groups among the other outcomes in the feedback section. The mean knowledge percentage of mind map group was higher than handout group but it was not significant. Mind map had higher significant median value regarding interesting to read, useful to recall information, had better organization of thoughts and good for understanding the concepts and thoughts of the topic compared to handout group. In conclusion, mind map is an effective method in remembering and understanding a topic compared to reading a handout. Based on our study, the mind map group obtained a higher knowledge percentage than the handout group. It was found that the participants prefer to use the mind map method more compared to the handout method and it is also more convenient.

1. Introduction

Mind maps are a very popular way of studying and it has been used throughout for learning, brainstorming, visualization of ideas and problem solving by educators, students and most professionals. It was argued that 'traditional' way of note-taking requires the reader to conform to a specific way of reading, which is left to right and top to bottom but the brain will actually scan the page in a non-specific way. [1] Popular conceptions about the

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cerebral hemispheres with regards to the use of mind-mapping over other forms of note-taking states that mind maps stimulate both left and right hemispheres whereas written notes does not stimulate the right hemisphere. [1] Furthermore, multiple studies have shown that that the application of mind maps as a form of note-taking improved long term memory of medical students till up to 10% as it promotes a deeper level of processing for better memory formation as well as forming associations between multiple concepts. [2-4]

There are multiple ways of assessing a student's eligibility as a doctor, which is through both assessment of theory knowledge and application of the knowledge in clinical settings. In a private medical college, theory knowledge is evaluated through multiple choice questions (MCQ) and modified essay questions (MEQ) whereas the clinical knowledge is assessed through ward rounds (long and short case examination), objective structured clinical examinations (OSCE) and objective structured practical examination (OSPE). [5] In order to achieve good grades in these areas, the students need to have a good understanding of the topics taught in order to answer the questions. This is where effective note-taking plays an important role as it improves the thought process regarding the contents of the subject and promotes meaningful learning of the topic. [6] Students' understanding of the topics positively corresponds to their academic excellence [6] so in order to achieve good grades, it is important to identify the factors that can promote or hinder the students' ability to comprehend the information given.

The students' desire to understand the subjects taught in class can be influenced by multiple factors such as levels of motivation, interest, level of information, prior knowledge, thought organization, teaching mediums and also learning styles. [7, 8] Research has shown that more importantly than the environment, whether it is conducive for learning or not, motivation and interest level plays an important role in determining the level of academic achievement. [9] The amount of information present in the notes is also directly proportional to the understanding of a topic by the student. Prior knowledge of the topic can also increase the scores obtained by the students. [10] The thought organization in the notes also plays a huge part in the outcome of the study as lack of organization could pose challenges to the students to follow the flow of ideas. [10] The teaching mediums that are used to educate the students are also very important in determining their level of understanding of the subjects in schools. [10] For example, a visual representation of a subject allows students to be more creative and more immersed in the topic at hand whereas a linear, traditional written notes of a subject allows students to be more structured when studying and saves time spent on being

creative. The most popular methods that are used by students to make notes for a subject is by using either mind maps or traditional handouts. Previous studies had been done regarding the effectiveness of mind maps on students' understanding and recollection of a topic [2, 11] but very little study has been done where they compared the effectiveness of both methods against each other.

Therefore, the main objective of this research is to investigate the effect of mind map on understanding of a topic compared to traditional handouts among medical students in a medical college. The research questions are as follows:

Does the mind map or handout improve the understanding of the topic?

Do students prefer mind maps or traditional handout?

The hypothesis of this research is that there is a difference in understanding of a topic when students use either mind map or traditional handouts.

2. Method

2.1. Study Design and Study Population

A randomized controlled trial study was carried out where the independent variable is the learning strategy used (traditional handout and mind map) and the dependent variables (outcome) are knowledge scores, interest, better recall of information, organization of thoughts, understanding, focus, motivation, levels of information, and encouragement level. The study's primary outcome is the knowledge scores of the participants. It is a concurrent parallel study. The study population in this trial are third year medical students from a private medical college who were then divided into two groups, intervention group (mind map) and control group (traditional handout).

2.2. Study Settings

This study was conducted from February 2018 to March 2018. The students were selected from Melaka Manipal Medical College (Muar Campus), Jalan Kesang, Muar, Malaysia.

2.3. Sample Size

Sample size was calculated by using the mobile application n4 studies based on the randomized controlled trial for continuous data formula and including attrition. The values for mean and standard deviation in both mind map and traditional handout groups were taken from a previous study. Their values in the formula calculation is tabulated below:

Table 1. Mean and standard deviation value from previous study.

Group	Mean	Standard Deviation (S.D)
Mind Map	12.79	8.86
Traditional Handouts	3.41	5.85

The other values used are Alpha=0.05, Beta=0.20, ratio (r)=1 and Z value is 95% Confidence Interval. The formula used is:

Randomized controlled trial for continuous data

Formula[ref]:

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

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

Figure 1. Formula for sample size calculation.

The minimum number of participants needed was 11 participants in mind map group and another 11 participants in traditional handout group. Upon calculating the possibility of attrition the sample size in each group were rounded off to 16 participants. In the end, at the start of the experimental study, 30 students in mind map group and another 30 students in traditional handout group were selected.

2.4. Sampling and Randomization

Subjects were selected based on a fixed inclusion and exclusion criteria. A certain amount of students were excluded as they were absent on the day of data collection and for not giving consent. Purposive sampling technique was used to select the 60 students from batch 36. Stratified block randomization technique was used to assign the students into the respective intervention group. Two stratas were used which are gender and ethnicity. 30 males and 30 females were selected to be a part of the study. For ethnicity, there was 10 malay, 10 chinese and 10 indian males while for the 30 female students there was 8 malay, 8 chinese, 8 indians and 6 foreigners. All the identified individuals were then approached with a mind map and a handout on Vitiligo where they were then assessed through a self-administered questionnaire.

2.5. Intervention

A colourful mind map and a traditional handout were made by the researchers in order to standardize the intervention on the topic Vitiligo. Both the mind map and handout contains the same amount of information which was taken from a dermatology text book (Common Skin Diseases, Marks & Motley) that was recommended in our medical school. The information on the topic consists of definition of the disease, the epidemiology, clinical features and treatment.

2.6. Data Collection

On the day of data collection, the participants were called to a lecture room and they were seated according to the group they belong in. The handout group was seated on one end and the mind map group on the other end. At the start of the study, the participants were briefed about the purpose and their role in the experiment and they were informed that were allowed to quit from the study anytime they want.

They were given 10 minutes to read the intervention allocated to them and at the end of 10 minutes, a self-administered questionnaire was handed to them. The questionnaire consists of four sections where the first one is basic demographic details, the second section is the MCQ test, the third section is VARK questionnaire and the final fourth section is their feedback on the intervention used. The knowledge gained is the primary outcome variable. The MCQ assessment test included items from all areas such as definition, epidemiology, clinical features and treatment of the disease. There was a total of 15 questions and for each correct answer 1 point was given and each wrong answer is 0 point. The total points were then added and the knowledge score percentage was calculated.

VARK questionnaire is a guide to the learning style of an individual. Its components are visual (V), auditory (A), read/write (R) and kinaesthetic (K) learners. Visual learners will learn from diagrams, auditory learners from audios and spoken information, read/write learners from texts and kinaesthetic learners from touching and past experiences. There is also multi-modal (MM) learners where they have more than one type of learning styles. Their VARK scores will then be calculated from all the 16 questions asked and the highest score depicts the participant's prominent learning style. If their scores are high and equal for two styles then it is multimodal.

The feedback section has nine components such as interest, better recall of information, organization of thoughts, understanding, focus, motivation, levels of information, and encouragement to use the intervention. The participants were then asked to give marks for each 9 components, ranging from 1 (strongly disagree) to 5 (strongly agree). It was then used to see the participant's view on each components for the particular intervention used.

2.7. Data Entry, Data Processing and Data Analysis

The data was entered in Microsoft Excel version 2013 and it was double checked to avoid any duplication and missing of data. From Microsoft Excel the data were then used for statistical calculations using a software known as EpiInfo version 7.

For the 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 overall and the mean difference for each of the items in the assessment test such as definition, epidemiology, clinical features and treatment between the two groups were calculated and its standard deviation was then found. Then by using unpaired t test, the p value and t value is calculated to find the significance between the variable thus testing the hypothesis. All these data were then compiled in a table and compared between the two intervention groups.

The feedback analysis was done using Mann Whitney U Test where interquartile range and p value was calculated to find the significant difference for each of the nine components between the groups. For all the calculations and data analysis done in this randomized controlled trial study, the level of significance of 0.05 was used.

2.8. Ethical Considerations

Before the start of the study, participants were explained about the procedure of the experiment and their role in the study. All the participants participated voluntarily and no incentives were given. A written informed consent was obtained from them. An approval was taken from the ethics committee. The participants was assured that all the data collected was confidential.

3. Results

Table 2. Baseline characteristics among participants.

Variables	Frequency (%)	
	Handout (n=30)	Mind map (n=30)
Age		
<22	5 (16.67)	4 (13.33)
22-23	20 (66.67)	19 (63.34)
>23	5 (16.67)	7 (23.33)
Gender		
Male	15 (50.00)	15 (50.00)
Female	15 (50.00)	15 (50.00)
Ethnicity		
Chinese	9 (30.00)	9 (30.00)
Indian	9 (30.00)	9 (30.00)
Malay	9 (30.00)	9 (30.00)
Others	3 (10.00)	3 (10.00)
Nationality		
Malaysian	27 (90.00)	27 (90.00)
Non Malaysian	3 (10.00)	3 (10.00)
Learning style		
Visual	6 (20.00)	2 (6.67)
Auditory	5 (16.67)	5 (16.67)
Reading	5 (16.67)	3 (10.00)

Variables	Frequency (%)	
	Handout (n=30)	Mind map (n=30)
Kinaesthetic	10 (33.33)	13 (43.33)
Multi modal	4 (13.33)	7 (23.33)
Heard about the topic before		
Yes	11 (36.67)	12 (40.00)
No	19 (63.33)	18 (60.00)
Prior use of Mind map		
Yes	18 (60.00)	19 (63.33)
No	12 (40.00)	11 (36.67)
Prior use of Handout		
Yes	19 (63.33)	27 (90.00)
No	11 (36.67)	3 (10.00)

We conducted the test on 60 students (30 students for handout and 30 students for mind map). Table 2 shows baseline characteristics between mind map and handout. In each group, 15 (50%) were male and 15 (50%) were female. As for the age, the frequency of 22-23 years old was the highest in the handout group which was 20 (66.67%), followed by <22 years old and >23 years old with the same frequency which was 5 (16.67%). For the mind map group, the age group of 22-23 years old has the highest frequency which was 19 (63.34%), followed by >23 years old which was 7 (23.33) and <22 years old which was 4 (13.33). For the ethnicity, Chinese, Indian and Malay has the same frequency which was 9 (30%) for both handout and mind map groups. For others, the frequency was 3 (30%) for both groups. Majority of the participants are Malaysian with the frequency of 27 (90%) for each group and Non Malaysian with the frequency of 3 (10%) for each group. As for the learning styles, in the handout group, the highest was kinaesthetic which was 10 (33.33%) followed by visual with 6 (20%), auditory with 5 (16.67%), reading with 5 (16.67%) and multi modal with 4 (13.33%). In the mind map group, the highest was also kinaesthetic which was 13 (43.33%), followed by multi modal with 7 (23.33%), auditory with 5 (16.67%), reading with 3 (10%) and visual with 2 (6.67%). In handout group 11 (36.67%) had heard about vitiligo and 19 (63.33%) had not heard about vitiligo at all. In mind map group, 12 (40%) had heard about vitiligo and 18 (60%) had not heard about vitiligo at all. As for the use of mind map, 18 (60%) had previously used mind mapping technique and 12 (40%) never used mind mapping technique in the handout group, whereas, in the mind map group 19 (63.33%) had previously used mind mapping technique and 11 (36.67%) never used mind mapping technique. As for the use of handout, 19 (63.33%) had previously used handout and 11 (36.67%) never used handout in the handout group, whereas, in the mind map group, 27 (90%) had previously used handout and 3 (10%) never used handout.

Table 3. Analysis of knowledge percentage between mind map and handout.

Outcome variables	Groups		t- value (df)	P-value
	Handout (n=30) Mean (SD)	Mind map (n=30) Mean (SD)		
Knowledge percentage	71.11 (15.30)	75.56 (14.26)	-1.16 (58)	0.249
Definition questions percentage	75.56 (26.16)	78.89 (18.54)	-0.57 (58)	0.571
Clinical feature questions percentage	67.50 (21.92)	69.17 (23.38)	-0.28 (58)	0.777
Epidemiology questions percentage	72.00 (26.05)	80.67 (17.01)	-1.53 (58)	0.133
Treatment questions percentage	70.00 (23.73)	72.22 (21.59)	-0.38 (58)	0.706

Table 3 shows the knowledge percentage between mind map and handout. As for the knowledge, the mean percentage value of the mind map group was 75.56% which was higher compared to the handout group which was 71.11%. There was no significant difference between the 2 groups (mind map and handout) with the knowledge percentage with p-value of 0.249.

As for the definition questions, the mean percentage value of mind map group was 78.89% which was higher than the handout group which was 75.56%. There was no significant difference between the 2 groups (mind map and handout) with definition questions percentage with p-value of 0.571.

As for the clinical features questions, the mean percentage value of mind map group was 69.17% which was higher compared to the handout group which was 67.50%. There

was no significant difference between the 2 groups (mind map and handout) with the clinical features questions percentage with p-value of 0.777.

As for the epidemiology questions, the mean percentage value of mind map group was 80.67% which was higher compared to the handout group which was 72.00%. There was no significant difference between the 2 groups (mind map and handout) with the epidemiology questions percentage with p-value of 0.133.

As for the treatment questions, the mean percentage value of mind map group was 72.22% which was higher compared to the handout group which was 70.00%. There was significant difference between the 2 groups (mind map and handout) with the treatment questions percentage with p-value of 0.706.

Table 4. Analysis of knowledge percentage between mind map and handout.

Variables	Groups		P value
	Handout Median (Q1, Q3)	Mind map Median (Q1, Q3)	
Interesting to read	3.0 (3.00, 4.00)	4.0 (4.00, 5.00)	0.001*
Useful to recall information better	3.0 (3.00, 4.00)	4.0 (3.00, 5.00)	0.002*
Organization of thoughts	4.0 (3.00, 4.00)	4.0 (4.00, 5.00)	0.008*
Good for understanding	4.0 (3.00, 4.00)	4.0 (4.00, 5.00)	0.001*
Focus more on the topic of concepts and ideas	4.0 (2.00, 4.00)	4.0 (3.00, 4.00)	0.130
Gives motivation to study	3.5 (2.00, 4.00)	4.0 (3.00, 4.00)	0.053
Too little information	3.0 (2.00, 4.00)	4.0 (2.00, 4.00)	0.084
Too much information	3.0 (2.00, 3.00)	3.0 (2.00, 4.00)	0.525
More encouraging	3.0 (2.00, 3.00)	4.0 (3.00, 4.00)	0.050

Mann-Whitney U test; *Significant

Table 4 shows the feedback analysis between the mind map and handout groups. There was significant difference of interesting to read. Median value of mind map group was 4.0 (Q1 4.00, Q3 5.00) which was higher compared to handout group which was median value of 3.0 (Q1 3.00, Q3 4.00).

There was significant difference of useful to recall information better. Median value of mind map group was 4.0 (Q1 3.00, Q3 5.00) which was higher compared to handout group which was median value of 3.0 (Q1 3.00, Q3 4.00).

There was significant difference of better organization of thoughts. Median value of mind map group was 4.0 (Q1 4.00, Q3 5.00) and the median value of handout group was 4.0 (Q1 3.00, Q3 4.00).

There was significant difference of good understanding of the

concepts and ideas of the topic. Median value of mind map group was 4.0 (Q1 4.00, Q3 5.00) and the median value of handout group was 4.0 (Q1 3.00, Q3 4.00).

There was no significance difference between mindmap and handout about focusing more on the topic, giving motivation to study, too little information, too much of information and more encouraging.

4. Discussion

A randomized controlled trial (RCT), was done to investigate the effect of mind map on understanding of a topic compared to traditional handout among medical students. The students were divided into intervention group (mind map) and control group (handout) equally.

In our study, the mind map group obtained higher knowledge percentage compared to handout group but there are no significant difference between them. For the assessment of each component of the topic such as definition, clinical features, epidemiology and treatment, there is no significant difference between mind map and handout groups. Based on previous study done among medical students in India, mind map method obtained lesser mean percentage marks compared to text method, however, the result is not significant.

We collected feedback from both intervention group (mind map) and control group (handout). Regards to interesting to read, mind map group had significantly higher median score compared to handout group. Previous study found that 28.1% of the participants found mind map method was interesting compared to text method (18.6%). [2]

As to recall the information regarding the topic, mind map group had significantly higher median score compared to handout group. According to the previous study, the participants also found that mind map method was useful to recall information (40.6%) compared to text method (21.8%). [4]

For better organization of thoughts, there was significant difference between mind map and handout. Based on the previous study, 34.3% of the participants found that mind map method was useful for better organization of thoughts compared to text method (9.3%). [11]

As for good understanding of concept and ideas, there was significant difference between mind map and handouts group. Based on the previous study, 87.5% of the participants found that mind map method was useful for better organization of thoughts compared to text method (62.5%). [11]

In regards to ability to focus more on the topic, there was no significant difference between both mind map group and handout. According to previous study, about 40.6% of the students in text method group were able to give more attention to their topic compared to mind map group where only 18.7% of students were able to give attention to the topic. In our research, the mind map group had higher median score in giving motivation to study the topic compared to handout group. Furthermore mind map group had higher median score in consisting of too little and precise information regarding the topic and was more encouraging to study compared to handout group although these were not significant.

4.1. Implications

The results of this study could be beneficial for learners, teachers, researchers, and curriculum designers as the results of this study indicate that mind maps benefits students more when they are used as a study medium as compared to hand outs. When mind maps and hand outs were given as an intervention to two different groups, the mind map group obtained higher knowledge scores compared to the hand outs group. According to the students' feedback, most of the students regarded mind maps as more interesting to read. One student even remarked that 'It is better than a thick textbook'. This implies that teachers can incorporate mind mapping as a teaching medium in order to increase students' interest in the topics taught as most students think the traditional method of reading text/ books as a boring activity [2] as compared to the non-structured and more creative mind map.

Furthermore, the students believed that mind maps helped them recall information better. This is reflected in the higher knowledge scores obtained by the mind map group when compared to the hand outs group. The long term use of this method has not been studied yet. Therefore this strategy needs to be investigated to see its long term effects. Mind maps also helped organize their thoughts and understand concept and ideas. This indicates that mind mapping can help in the process of arranging the students' haywire thoughts. This would be useful in the classroom when the teacher is explaining an advanced topic as mind maps require you break down complex ideas into simpler steps and link them later on as compared to hand outs which just lists down the steps.

4.2. Limitations

There were a few limitations that we came across while doing this randomized controlled trial study. Firstly, blinding was not done as both the handout and mind map groups were aware of the intervention that was implemented on them. This could lead to social desirability bias on the feedback component as there is higher tendency for the participant's to grade the respective components high. Next, not all the extraneous variables can be controlled such as memory (both short term and long term) and IQ level. Both of these can influence participant's understanding on a topic. There was also limited amount of similar studies that were done, in fact, we found only one similar study that was done in Puducherry. India, but there were other studies that was done involving only mind map and its effect on understanding a topic.

4.3. Recommendations for Future Study

There are few gaps in our experimental study that can be used for future research as it has its benefits. Firstly, mind map can further improve a medical student's understanding on a topic so long term usage of this technique should be explored. Further studies should include more number of

medical students to make it more of a representative sample so that this technique can be implemented in medical teaching and can increase the student's knowledge. Next, short term and long term memory as dependent variables should be explored to see how mind maps and handouts can influence them. A before and after intervention assessment can be included next time to make sure prior knowledge of the topic tested does not influence the results and the results can be solely based on the intervention used. IQ level should be included as one of the independent variable to see its influence on understanding the topic given.

5. Conclusion

In conclusion, the mind map method is an effective method in remembering and understanding a topic compared to the routine way of reading a handout or text. It was shown that there is a difference in understanding a topic when the participants were given mind map and traditional handout separately to read before answering the questions. Based on our study, the mind map group obtained a higher knowledge percentage than the handout group. It was found that the participants prefer to use the mind map method more compared to the handout method. The mind map method was also suggested to be more convenient than the handout method.

Acknowledgements

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