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Retained mind mapping skills and learning outcomes in medical students: a mixed methods study

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Abstract

Background: Mind maps (MM), is a learning method assisting learners in the visualisation of relationships between theoretical concepts. Studies also showed enhancement of data retention, overall comprehension, and creativity in MM users. Thus, MM has been implemented in many medical schools to facilitate medical students' learning experiences. Nevertheless, retained mind mapping skills and its effect on the learning outcomes in long-term follow-up remain unknown.

Methods: A concurrent mixed-methods design with convenient sampling method. All (48) second-year medical students joined a three-day MM workshop. One year later, we surveyed the students who still use MM and those who did not. Mind Map Assessment Rubric (MMAR) and Grade Point Average (GPA) were compared between two groups. Content analysis with data triangulation method was used to explore their preferences and MM skills.

Results: We achieved a 100% response rate. 39 (81.2%) of participants were female. The mean age of participants was 20.6 years (SD = 0.5). 37 students still use MM (77.1%). With MMAR, participants in MM group scored 28.9 higher than participants in MM-free group significantly ($p = 0.01$). There were no differences in the median GPAs to both groups. However, there was a significant correlation between using MM in learning and the second trimester (year1) ($r=0.29$, $p<0.05$). Majority of participants in MM groups stated the advantages of using MM as a tool helping those organising data and their thought process. On the contrary, students in MM-free group declared the disadvantages of MM as a time-consuming and missing data from lectures.

Conclusions: Without revision in MM, participants' skills deteriorated immensely. There was a non-statistically significant trend toward increased learning outcomes with MM group. Further studies to examine whether more frequent MM use or workshop revision can boost their learning outcomes or not is recommended.

Keywords: Mind map; pre-clinic; mixed methods; assessment

Introduction

Medicine is an ever-evolving, dynamic subject that changes continuously. The amount of new knowledge that we need to understand and memorise also increasing immensely. Thus, learning tools or methods to help solidifying these memories is crucial. One of those learning methods is Mind Map (MM) which is a visual diagram used to record and organise information in a way similar to how our brain processes memories. It was invented by Tony Buzan in the 1970s. The MM use a central theme in the middle of a page with categories and subcategories that radiate peripherally (D'Antoni *et al.*, 2010). In terms of facilitating the conversion of information to memory, it consists of spider diagrams, colour, pictures, key words, association line, and highlighting key branches within a boundary known as 'chunking' (Day and Bellezza, 1983) (Howe, 1970)(Glass and Holyoak, 1986) (Bellezza, 1983). This technique augments the visualisation of relationships and links between concepts, which aids in information acquisition, data retention, and comprehension (Spencer, Anderson and Ellis, 2013).

Numerous studies support the benefit of MM. One previous study in medical students found that the factual knowledge in students using the MM was greater by ten percent (Spencer, Anderson and Ellis, 2013). The result also consistent with other two Asian studies (Kalyanasundaram *et al.*, 2017) (Ying *et al.*, 2017). Majority of medical students perceived that it was helpful for organising and memorising information (Wickramasinghe *et al.*, 2011). Besides, it was among one of the potential factors influencing high academic achievement (Abdulghani *et al.*, 2014). On the contrary, one study argued that the degree of visual imagery associated with the components of paired associate items was not indicative of the degree of visual imagery experienced during their learning or with the accuracy with which they were recalled (Day and Bellezza, 1983). And it did not have any superiority comparing to the conventional note-taking method (D'Antoni *et al.*, 2010).

MM has been implemented in many medical schools to facilitate students' learning experience. (Farrand, Hussain and Hennessy, 2002)(Zhou, Shao and Xu, 2012)(Ghanbari, Javadnia and Abdolahi, 2010). However, retained MM skills and its effect on the learning outcomes in long-term follow-up remain unknown. This study aims to investigate the retained skills in medical students who use MM and its effect on learning outcome after a long-period introduction.

Methods

A concurrent mixed-methods study with convenient sampling. In October 2015, the students joined an intensive three-day camp during the end of their first year to learn the concepts of mind mapping taught by an expert in the field. After the camp, we analysed the MMs created by the second-year Walailak University School of Medicine medical students (n=48) in the academic year 2015 and their written feedback forms after the course. One year later, one researcher (TP) surveyed if they continue using MM or not. TP also instructed students, to draw one MM of the latest subject that they learnt. Plus, Mind Map Assessment Rubric (MMAR) was used to assess the quality of student MMs. Its high intra-class correlation coefficient value indicates strong MMAR inter-rater reliability. Maps were scores in 6 categories with the following pint assignments for each component as follows: concept-likes (2 point each), cross-links (10 point each), hierarchies (5 points each), examples (1 point each), invalid components (0 points), pictures (5 points each), and colours (5 points each) (West *et al.*, 2002) Descriptive statistics were used for the demographic data. In qualitative part, we performed content analysis from student's written feedback forms. Constant comparative analysis was also used to compare the difference in MMs between students who continue using MM and those who have not. In quantitative part, the statistical analysis was performed by SPSS software version 17 (SPSS Inc., Chicago, IL, USA). Mean and standard deviation (SD) or median and range were used to describe continuous data. Frequency and percentage were used for categorical data. Analyses of categorical data were performed using Mann-Whitney U test or student *t*-test depending on data distribution. And correlations between

MMAR scores and GPA or GPAX were tested using Pearson's Correlation. A p value of < 0.05 by two-tailed tests was considered statistically significant.

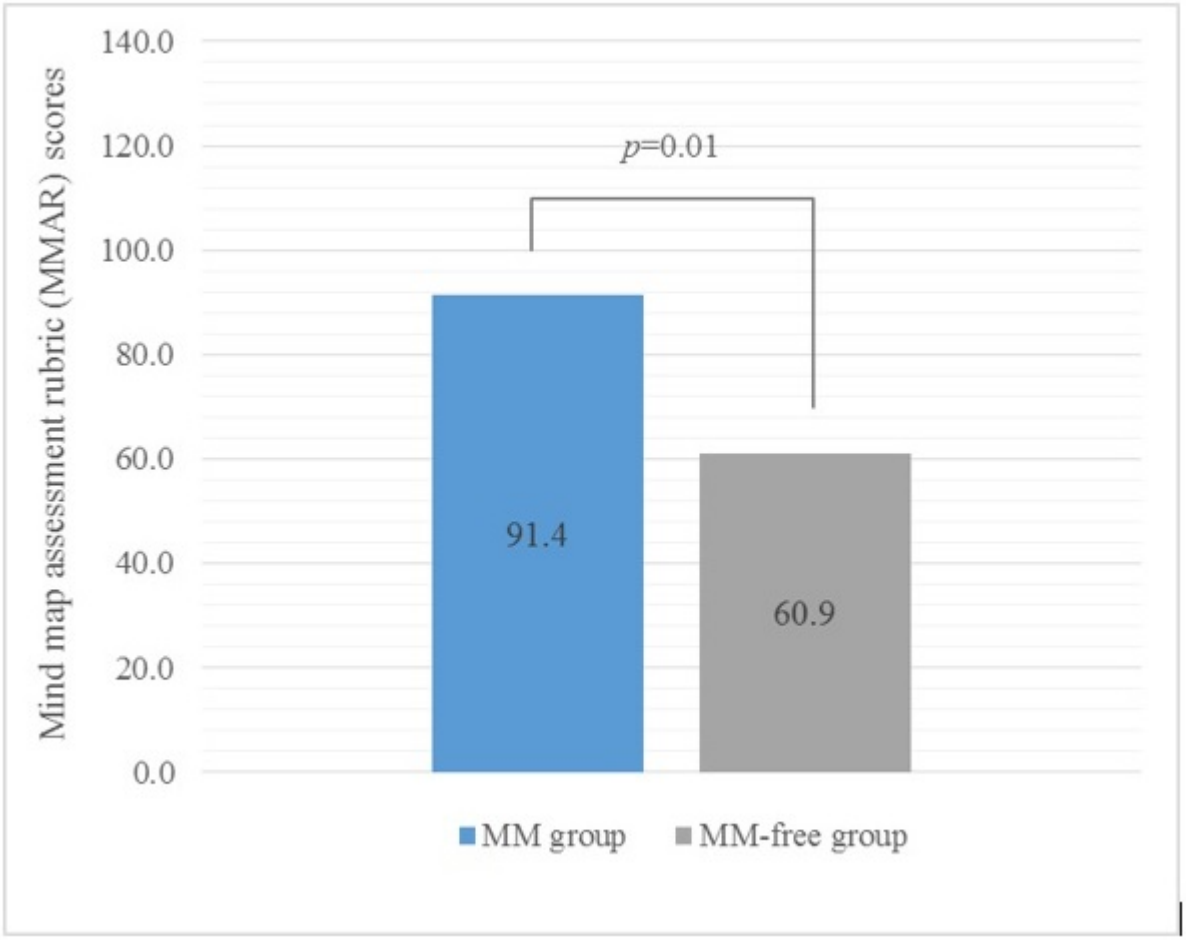
Results/Analysis

All (48) second-year students participated in the study with the response rate of 100%. 39 of them were females (81.2%). The mean age of participants was 20.6 years (SD = 0.5). Males had a mean GPA of 3.79 (SD=0.11), and females had a mean GPA of 3.73 (SD=0.15). There were no significant different between males and females in terms of GPA.

After the MM camp one year ago, 37 students (77.1%) declared that they still use MMs for their learning (MM group) while 11 of the students (22.9%) %) did not (MM-free group).

Using MMAR to assess the quality of MMs, the mean score of participants in MM group was 91.4 (SD = 34.9), and the mean score of the participant in MM-free group was 60.9 (SD = 26.8). Participants in the MM group scored 30.5 higher than participants in MM non-use group significantly (p = 0.01). (Figure 1)

Figure 1. Mindmap assessment rubric (MMAR) between two groups



MM variables each group were shown in Table 1. In MM group, median concept links, hierarchies, examples, pictures, and colours were 6.0 (IQR; 5.0-11.5), 4.0 (IQR; 3.0-5.5), 34.0 (IQR; 22.5-41.0), 0.0 (IQR; 0.0-1.5), and

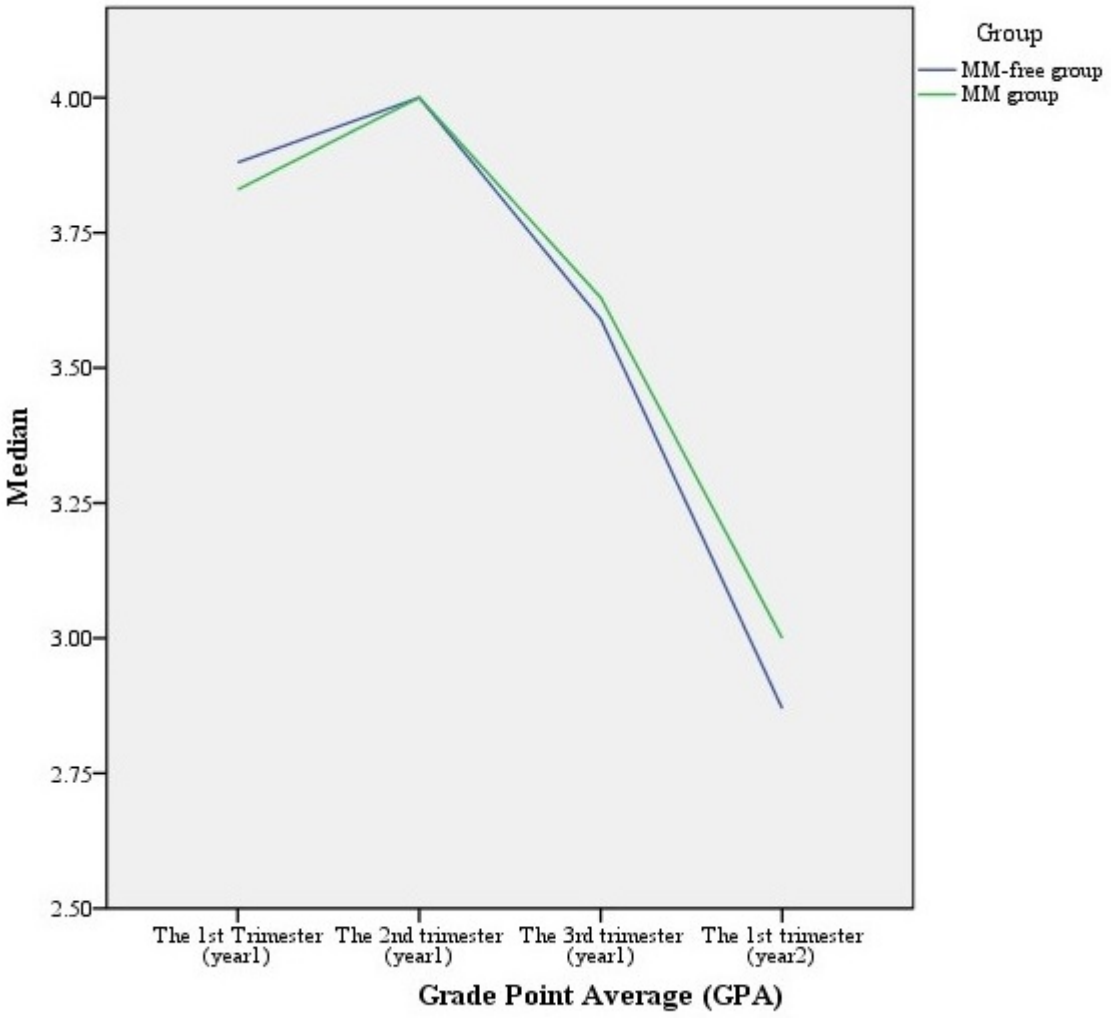
3.0 (IQR; 1.0-5.5), respectively. In MM-free group, median concept links, hierarchies, examples, and colours were 5.0 (IQR; 4.0-6.0), 3.0 (IQR; 3.0-4.0), 28.0 (IQR; 10.0-33.0), and 1.0 (IQR; 1.0-7.0), respectively. Participants in the MM group gave more concept links and pictures in their MMs than did participants in the MM-free group significantly ($p<0.05$). Neither of these groups put cross-links on their MMs.

Table 1. Mind map variables between two groups

Variables	**Median (IQR)**		***p*-value**
	MM group	**MM-free group**	
Concept links	6.0 (5.0-11.5)	5.0 (4.0-6.0)	<0.05
Cross links	0.0 (0.0-0.0)	0.0 (0.0-0.0)	-
Hierarchies	4.0 (3.0-5.5)	3.0 (3.0-4.0)	0.49
Examples	34.0 (22.5-41.0)	28.0 (10.0-33.0)	0.06
Pictures	0.0 (0.0-1.5)	0.0 (0.0-0.0)	<0.05
Colours	3.0 (1.0-5.5)	1.0 (1.0-7.0)	0.22

In MM group, the median GPAs of the first trimester (year1), the second trimester (year1), the third trimester (year1), the first trimester (year2), and GPAX were 3.83 (IQR; 3.83-3.88), 4.00 (IQR; 4.00-4.00), 3.63 (IQR; 3.40-3.72), 3.00 (IQR; 2.56-3.18), and 3.64 (IQR; 3.45-3.73), respectively. As for the MM-free group, the median GPAs of the first trimester (year1), the second trimester (year1), the third trimester (year1), the first trimester (year2), and GPAX were 3.88 (IQR; 3.83-3.88), 4.00 (IQR; 3.80-4.00), 3.59 (IQR; 3.40-3.72), 2.87 (IQR; 2.62-3.18), and 3.63 (IQR; 3.43-3.71), respectively (Figure 2). There were no differences in the median GPAs of the first trimester (year1), the second trimester (year1), the third trimester (year1), the first trimester (year2), and GPAX in both groups. There was also no correlation among MMAR scores, GPAs of the first trimester (year1), the second trimester (year1), the third trimester (year1), the first trimester (year2), and GPAX. Additionally, there was no correlation between using MM in learning and GPA or GPAX, excepting the correlation between using MM in learning and the second trimester (year1) ($r=0.29$, $p<0.05$).

Figure 2. Grade point average in the MM group and the MM-free group.



We analysed the reasons why participants still use MM or stop using them, as shown in Table 2. Majority of participants in MM groups stated the advantages of using MM as a tool helping those organising data and their thought process. On the contrary, students in MM-free group declared the disadvantages of MM as a time-consuming and missing data from the lectures.

Table 2. Categories and subcategories for mind map preferences

Currently using mind map	n (%)	Categories	Subcategories (frequency)	Explanation

Yes	37 (77.1)	Content	- Content overview (28) - Data organising (23) - Safe time for review (3)	- See content outline easier - Making notes easier - Quicker than taking notes
		Thought	- Thought organising (36) - Better understanding (16) -Quick for review (11)	- Reorganising thinking process - Thinking in a sequence - Easier to understand than taking notes - Better for a review
No	11 (22.9)	Conventional methods	- Short notes (5) - Others (6)	- Prefer conventional methods such as short notes, making tables
		Inconvenient	- Take time (5) - Not enough detail (2) - Hassles (2)	- Take longer time than making notes - Missing important details from lectures - Unmotivated to make one

Discussion

While MM is still used as a tool for assisting in learning globally, retained skills of MM without any revision and its efficacy on learning outcomes particularly in the long-term period have not been well established in medical students. To our knowledge, this is the first study to investigate the retained skills in using MM and its effect on learning outcome after a long-period introduction. We found that the mean score of participants in MM group was 91.4 (SD = 34.9) and the mean score of participants in MM-free group was 60.9 (SD = 26.8). We also found significantly higher scores (30.5) in MM group participants comparing to MM-free group ($p = 0.01$). These findings suggested that those who did not use MM had lower skill levels on making high-quality MMs. All components in MM-free group, particularly concept links and pictures, were also lower than those in MM group significantly.

Consistent with one previous study, retention of laparoscopic skills was assessed in first and second-year medical students without prior experience in surgery. One year after the short training programme, skill retention was 64.2-69.3% ($p<0.05$) compared with immediate post-training evaluation (Sant'Ana *et al.*, 2017).

These might imply that regular practice of MM is a cornerstone to keep the skills in a high level. The frequency of MM usage to maintain the skills and the cut-off period when the significant difference of MMAR scores was apparent are also noteworthy to investigate through future works.

For its efficacy on learning outcomes, we found a mild correlation between using MM and students' learning on the second trimester's GPA in year1, i.e. four months after an intensive MM course. GPAs in MM group was higher than those in MM-free group. However, the effects were not significant. Frequency of MM usage and other learning achievement factors; for instance, regular exercise, time management, lesson review,family support, sleep deprivation and internal motivation may be other factors to determine students' academic achievement (Abdulghani *et al.*, 2014).

In the MM-free group, 'time-consuming' was a major reason they rejected using MM in their learning. In this group of students, alternative learning techniques that help them learn and memorise the learning materials may be more favourable.

Overall, MMAR scores in the MM group was lower than we expected. We thus plan to follow-up whether the course revision or encouraging student to use MM more frequent will enhance their MMAR scores and GPA in the longer

period or not.

Conclusion

We found that after a one-year period, participants who did not continue using MMs made lower-quality MMs when compared to those who continue using it. Students in MM-free group declared the disadvantages of MM as a time-consuming process and missing practical knowledge from lectures. There was a trend toward increased learning outcomes with MM group. However, the result was not significant. Further study should be done to examine whether more frequent MM usage or MM skills revision can boost their learning outcome or not.

Take Home Messages

1. Mind map has been known as a visual think tool enhancing data retention, overall comprehension, and creativity.
2. Regular practice is mandatory to retain MM skills.
3. There was a trend toward increased learning outcomes in MM users.

Notes On Contributors

Dr Tharin Phenwan is a Family Medicine lecturer at Walailak University School of Medicine and is now a research student at School of Nursing and Health Science, University of Dundee. His research focuses on palliative care, qualitative research, interprofessional, and medical students assessment.
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Appendices

None.

Declarations

The author has declared that there are no conflicts of interest.

Ethics Statement

The Human Research Ethics Committee of Walailak University approved this study (WUEC-18-021-01). Informed consent was obtained from all volunteers prior to participation in the study.

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