The efficacy of the 'mind map' study technique

Paul Farrand,[1] *Fearzana Hussain*[2] *& Enid Hennessy*[3]

Objectives To examine the effectiveness of using the 'mind map' study technique to improve factual recall from written information.

Design To obtain baseline data, subjects completed a short test based on a 600-word passage of text prior to being randomly allocated to form two groups: 'self-selected study technique' and 'mind map'. After a 30-minute interval the self-selected study technique group were exposed to the same passage of text previously seen and told to apply existing study techniques. Subjects in the mind map group were trained in the mind map technique and told to apply it to the passage of text. Recall was measured after an interfering task and a week later. Measures of motivation were taken.

Setting Barts and the London School of Medicine and Dentistry, University of London.

Subjects 50 second- and third-year medical students.

Results Recall of factual material improved for both the mind map and self-selected study technique groups at immediate test compared with baseline. However this improvement was only robust after a week for those in the mind map group. At 1 week, the factual knowledge in the mind map group was greater by 10% (adjusting for baseline) (95% CI –1% to 22%). However motivation for the technique used was lower in the mind map group; if motivation could have been made equal in the groups, the improvement with mind mapping would have been 15% (95% CI 3% to 27%).

Conclusion Mind maps provide an effective study technique when applied to written material. However before mind maps are generally adopted as a study technique, consideration has to be given towards ways of improving motivation amongst users.

Keywords ANOVA; Education, medical, undergraduate/ *methods; educational measurement, *methods; London; *motivation; problem-based learning, *methods.

Medical Education 2002;36:426–431

Introduction

Educational materials[1] have recently emerged which aim to improve memory for medical information by representing facts in the form of 'mind maps'. Mind mapping[2] is a study technique in which information from a variety of sources is converted into a diagrammatic representation of the important key words associated with a study topic. During production, an image representing the main study topic is initially drawn in the centre of the mind map. Extending from this central image are several major branches containing keywords representing the topic subheadings, which are accompanied by an image whenever possible. The important detail included under each subheading is written upon smaller branches projecting from the subheadings with more detailed information being connected to this information. By undergoing this process, information initially contained within passages of text becomes hierarchically organized, with the most general information being presented in the centre of the mind map and material of increasing detail being presented at the extremes. When the mind map is read, the central image forms the starting point and the branch to the top right-hand of the central image is the first branch inspected. When this branch has been inspected the other branches are covered in a similar manner, working in a clockwise fashion. Throughout the whole process, imagery, colour and the visual-spatial arrangement of the material are emphasized. Whilst

[1] Department of Human Science, Barts and The London School of Medicine and Dentistry, Queen Mary College, University of London, London, UK (Now at Institute of Health Studies, University of Plymouth)
[2] Barts and The London School of Medicine and Dentistry, Queen Mary College, University of London, London, UK
[3] Department of Environmental and Preventive Medicine, Barts and The London School of Medicine and Dentistry, Queen Mary College, The University of London, London, UK

Correspondence: P A Farrand, Senior Lecturer, Institute of Health Studies, University of Plymouth, Earl Richards Road North, Exeter, Devon, EX2 6AS, UK. Tel.: 01392 475 123; Fax: 01392 475 151; E-mail: p.farrand@plymouth.ac.uk

Key learning points

Mind maps are an effective study technique when used to improve factual recall from written material.

Concern exists regarding levels of motivation amongst the medical students using mind maps.

Whilst the mind map technique would seem to be particularly suited to problem-based learning (PBL) curricula, effective training is required to both encourage and motivate students in its use.

many of the components used in mind maps have been individually incorporated into commonly used study techniques, their efficacy of use when combined within a single study technique has not been examined.

Study techniques which have separately incorporated imagery, colour or the visual-spatial arrangement of keywords have each been reported to significantly improve recall when compared with simple note taking or rote rehearsal. For example, spatially arranging a series of keywords into a distinctive pattern prior to making associations, as would be common in study techniques such as spider diagrams, significantly improved recall.[3] The use of study techniques based upon imagery, such as the method of loci,[4] improved the recall of 40 words in a study in which students were trained to associate each word with a particular campus location during learning.[5] Furthermore, study techniques based upon visual imagery have been shown to be even more effective when colour was additionally used to enhance the self-generated visual image.[6,7]

That recall improves when study techniques incorporate the use of these components is, however, not surprising. Even when used separately, these components can all be seen to support cognitive processes which have been reported to improve memory. The theory of levels of processing[8,9] proposes that the level of processing used whilst learning new material dictates the success with which it will later be recalled. The theory suggests that a deeper level of processing, such as that achieved when meaning is extracted from incoming information, will result in a better level of recall than shallow processing, used when information is simply rehearsed or written down. The elaboration of new material has been proposed as another mechanism to improve recall.[10] Elaboration requires associations to be made between the new incoming information and information already resident in memory (proactive facilitation). When such associations are made, the connection to information which has already been learnt supports the learning and retention of the new information. Additionally, the distinctiveness of information influences its memorability. New information which is more distinct, or which is made so during processing, is recalled more easily than information for which the memory trace resembles that of information already resident in memory.[11]

Whilst the effectiveness of different study techniques for improving memory has been shown empirically, the implications of the results for the design of educational materials have been disappointing. Often the study techniques have been limited in application to the recall of ordered lists of keywords.[12,13] When attempts have been made to apply these strategies to improving the recall of written information, they have been largely unsuccessful.[14,15] Furthermore, whilst many of these study methods have been shown to improve memory performance on a test of immediate recall, longer-term improvements have been more elusive.[16]

The limitations of many of the commonly adopted study techniques are particularly problematic if such techniques are applied to medical curricula based on problem-based learning (PBL). Due to the emphasis in PBL upon a self-directed approach,[17] students need a study technique which will help them improve their memory for written material whilst complementing the deeper level of learning obtained with PBL. Such a study technique is particularly important given that a current weakness of PBL is that students perform worse on tests requiring the recall of factual material when compared with students undertaking lecture-based curricula.[18] Additionally, the greater degree of organization of information afforded by mind maps may potentially overcome the further weakness of PBL in that knowledge acquired tends to remain largely unorganized.[19]

Although mind mapping may be a particularly effective study technique within PBL curricula, its efficacy needs to be established before such a technique is recommended to students. This paper examines whether mind mapping is efficacious as a study technique and whether it overcomes many limitations identified with previous study techniques.

Methods

Sample

A total of 50 second- and third-year medical undergraduate students, attending Barts and The London School of Medicine and Dentistry, University of London, volunteered to take part in the study after viewing a recruitment poster. Their mean age was 20·1 years, and there were 31 women and 19 men. Participants were alternately assigned to the between subjects conditions (mind map vs. self-selected study technique) based on the order in which they presented for the study. The allocation of students resulted in groups with similar characteristics with the exception that there were slightly fewer men in the mind map group (see Table 1). There was no subject drop-out from any of the sessions.

Materials

A 600-word sample of text was taken from an article which had appeared in *Scientific American*. The topic of the sample was unusual forms of transportation and had been chosen to minimize the possibility that subjects had prior knowledge about the material to be tested. Three question sets containing 15 questions each were developed from the study text. All questions were of a similar length and required the recall of a specific piece of information presented in the text (for example, 'Who ordered the cancellation of the atomic plane program?'). Question sets were extensively piloted to ensure that ceiling or floor effects did not arise, and each set reflected a similar level of difficulty. The order of presentation of the question sets was fully randomized by both subject and session throughout the study.

Procedure

During the baseline session of the experiment, subjects received the study text and were told to study it using their existing study techniques. Exclusively, the techniques spontaneously used were to write down the key words, re-read or underline key words. No participant used a method resembling mind mapping at this stage. After 10 minutes the study text was collected and subjects were given a 5-minute mental arithmetic test to prevent rehearsal of the study text. During recall, subjects were allowed 5 minutes to complete one of three question sets. At the end of the baseline session, subjects in the self-selected study technique condition were informed about session 1 of the experiment and asked to return 30 min later. Subjects in the mind map condition however, were given a 30-minute lesson in the mind map technique. The lesson used material totally unrelated to the study text to demonstrate the best ways to produce and memorize mind maps and gave subjects the opportunity to ask questions about the technique.

During session 1, subjects were exposed to the study text again for an additional 10-minute period. Subjects in the mind map condition were advised to divide the time between reading the study text and producing a mind map and studying it. Subjects forming the self-selected study technique condition were advised to divide their time between reading the text and using their existing study methods. None of the subjects in the self-selected study technique condition used mind maps as their preferred method of study. Following a mental arithmetic task all subjects were again given 5 minutes to complete the question set. Additionally all subjects were requested to complete a 5-point scale which assessed level of motivation in studying the material (1 = very unmotivated, 5 = very motivated). At the end of this session the mind maps were collected from the mind map group and all the subjects were told about session 2 and requested to attend 1 week later.

At session 2, all subjects were given 5 minutes to complete the final question set without any additional exposure to the study text.

Table 1 Characteristics of the mind map and self-selected study technique groups

	Mind map	Self-selected study technique
Number	25	25
Mean age, years	20	20
Male, %	32	44
Baseline score	5	4·8

Results

Analysis of variance (ANOVA) was performed, with group (mind map vs. self-selected study technique) as the independent variable and number of items correct at session 1 and session 2 separately as the dependent variables. In both cases baseline was included as a covariate to account for differences between groups, and in neither case were there statistically significant differences in the mean change from baseline in the number of correct items, although it approached significance for the results after 1 week ($P = 0{\cdot}07$) (Table 2). Non-adjusted data are presented in Fig. 1.

Significant differences however, existed between the levels of self-reported motivation for the groups ($t_{df=48} = 2{\cdot}35$, $P = 0{\cdot}02$), with the mind map group surprisingly reporting lower levels of motivation (mean-$= 2{\cdot}8$, SD $= 0{\cdot}67$) than the self-selected study technique group (mean $= 3{\cdot}2$, SD $= 0{\cdot}78$) group. As there were differences in motivation, the original data were reanalysed with motivation used as an additional covariate.

With adjustment for baseline performance and motivation, a significant difference in performance was found between the mind map and the self-selected

Table 2 Difference in mean correct answers (95% CI) between mind map and self-selected study technique groups, at session 1 (day 1) and session 2 (day 7)

	Difference between mean correct answers	% difference in proportion of correct answers	*P* value
Session 1(day 1)			
Adjusted for baseline	0·8 (−0·6 to 2·3)	5·5 (−4·3 to 15·9)	0·26
Adjusted for baseline and motivation	1·7 (0·3 to 3·1)	11·3 (2·1 to 20·4)	0·016
Session 2 (day 7)			
Adjusted for baseline	1·6 (−0·2 to 3·4)	10·7 (−1·1 to 22·5)	0·07
Adjusted for baseline and motivation	2·3 (0·5 to 4·1)	15·3 (3·3 to 27·3)	0·013

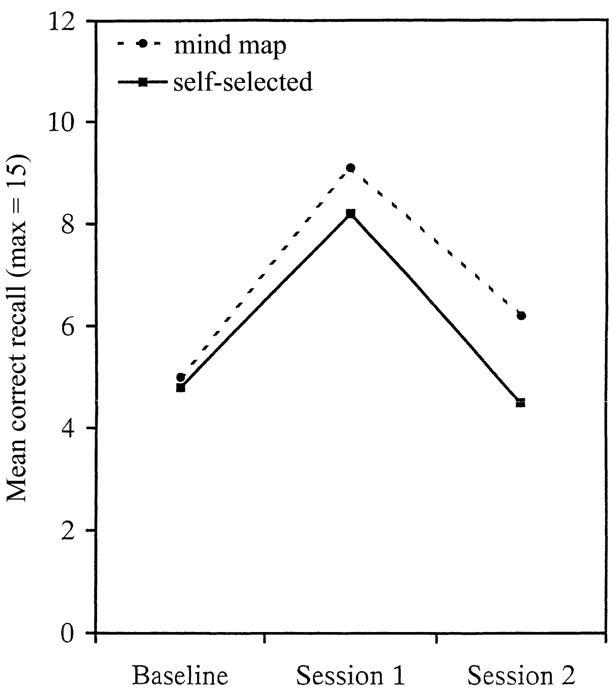

Figure 1 Mean unadjusted correct recall (maximum score = 15), using mind map and self-selected study techniques.

study groups. For both session 1 and session 2, the mind map group recalled significantly more correct items than the self-selected study group, showing a clear study advantage when the mind map was used, which was robust over a 1-week time delay (see Table 2).

That motivation may have differentially affected the mind map and self-selected study technique groups is further supported by a different pattern of partial correlations with baseline performance controlled. Motivation was significantly correlated with performance at both session 1 and session 2 for the self-selected study technique group ($r_{df=22} = 0{\cdot}57$, $P = 0{\cdot}002$; $r_{df=22} = 0{\cdot}45$, $P = 0{\cdot}039$, respectively). Correlations were, however, smaller for the mind map group, only reaching full significance at session 1 ($r_{df=22} = 0{\cdot}41$, $P = 0{\cdot}023$; $r_{df=22} = 0{\cdot}30$, $P = 0{\cdot}07$, respectively). Caution should be exercised when interpreting these partial correlations, however, because of the small sample size for each group ($n = 25$). (Additionally, all analyses were further replicated with sex as a covariate, but this did not change any of the conclusions.)

Discussion

Analysis of the data indicates that, as a strategy to improve memory for written information, the mind map technique has the potential for an important improvement in efficacy. With the mind map technique there is an estimated increase of 10% without any change in motivation, and an increase of 13% if there were such a change. Mind maps are unlikely to worsen the learning process as the lower end of the 95% confidence interval excluded a deterioration of more than 1%, and it is likely in practice that those who did not like the technique would continue with the one they currently used. At both session 1 and session 2, the mind map technique resulted in correct recall of a statistically significantly higher number of items than the self-selected study technique, when adjustments for baseline score and motivation were made. Importantly, the recall advantage with the mind map technique was robust over a week, resulting in a 24% proportional increase in correct recall when compared with baseline score. Recall performance in the self-selected study technique was actually a little worse (–6%) over the week. That improvements in recall at a week re-test remained evident with just a single exposure to the mind map technique suggests a real benefit of this study technique compared with other memory strategies where benefits have been confined only to tests of immediate recall.[16]

That differences exist between the groups in memory performance suggests that improvements that arise with mind maps are likely to be dependent upon improvements in cognitive processing. Whilst it is beyond the scope of this study to identify the nature of the cognitive processes supported when mind maps are used, it is likely that mind maps encourage a deeper level of processing than that obtained with the other, more conventional study techniques adopted in the self-selected study technique. A deeper level of information processing has been associated with better academic performance by medical students.[20] It has also been acknowledged, however, that fostering a deep level of learning is very difficult because students do not spontaneously adopt strategies that foster such learning.[21]

A highly surprising finding was that motivation in the self-selected study technique group was significantly higher than that in the mind map group, even though participants in the latter group received training in the mind map technique.

Straightforward relationships between training and motivation have been extensively reported,[22,23] with previous research also indicating that that the provision of task training is often accompanied by increased motivation in engaging with and using a study technique.[24] Training is believed to focus individuals towards directing their efforts to working on the task given rather than dividing their attention between other tasks, and to increase the amount of time the individual chooses to spend completing an activity.[25] For both groups, the well-established relationship between motivation and recall performance[26] was supported. This relationship was weaker for the mind map group, however, and was only marginally significant ($P = 0{\cdot}07$) at session 2.

A possibility which might account for the lower level of motivation in the mind map group is that there is resistance to using memory strategies as study aids. Students, especially males, have been reported to be reluctant to use many memory strategies, preferring to adopt more conventional techniques such as rehearsal, repetition and summary elaboration, techniques exclusively adopted by the students in the self-selected study group.[27] Motivation in the mind map group may therefore have been lower than in the self-selected study group as students were trained and instructed to use a strategy they were already reluctant to employ, which may potentially raise other issues such as compliance in using this study technique.[28] Higher levels of motivation might have been obtained if the medical students used as participants had believed the mind map method might improve their exam results, or if they had used it to study medically related information. Previous research indicates that students are only motivated in their use of memory strategies when they are also interested in the material being studied.[29] It should be noted, however, that if successful efforts were made to counter the reductions in motivation encountered when the mind map technique was used, significant further recall benefits of mind mapping would be expected.

This paper has shown the efficacy of using mind maps as a study aid, even when use has been limited to a single exposure. The increased use of mind maps, and the emergence of educational materials supporting the use of mind maps, within medical curricula, should therefore be cautiously welcomed. The mind map technique would seem to be particularly suited to medical curricula based around PBL, as both approaches support, and encourage students to adopt a deeper level of learning. Nevertheless, before mind maps were recommended as a study technique, a way of providing effective training would need to be established so that students were encouraged and enthusiastic about adopting this approach in preference to other more conventional study techniques. With this aim in mind, one possibility would be the incorporation of a mind map training course into the first few terms of the medical curriculum, accompanying other sessions in study skills often provided during the initial stages of a PBL curriculum.

Acknowledgements

Thanks are due to Richard Rowe for comments on an earlier draft of this paper.

Contributors

Contributions to the paper were as follows: Fearzana Hussain originated the idea behind the research and conducted the experimentation; Paul Farrand designed the experiment and wrote the paper, whilst Enid Hennessy conducted the statistical analysis.

Funding

The research was completed without external funding.

References

1 McDermott P, Clarke DN. *Mind Maps in Medicine.* Edinburgh: Churchill Livingstone; 1998.
2 Buzan T, Buzan B. *The Mind Map Book*. London: BBC Books; 1997.
3 Bellezza FS. The spatial arrangement mnemonic. *J Educ Psychol* 1983;**75**:830–7.
4 Bellezza FS, Goverdhan RB. Mnemonic devices and natural memory. *Bull Psychon Soc* 1978;**11**:277–80.

5 Ross J, Lawrence KA. Some observations on memory artifice. *Psychon Sci* 1968;**13**:107–8.

6 Jamieson DG, Schimpf MG. Self-generated images are more effective mnemonics. *J Ment Imag* 1980;**4**:25–33.

7 Bower G. Organizational factors in memory. *Cognit Psychol* 1970;**1**:18–46.

8 Craik FIM, Lockhart RS. Levels of processing: a framework for memory research. *J Verb Learn Verb Behav* 1972;**11**:671–84.

9 Lockhart RS, Craik FIM. Levels of processing: a retrospective commentary on a framework for memory research. *Can J Psychol* 1990;**44**:87–112.

10 Anderson JR, Reder LM. An elaborative processing explanation of depth of processing. In: LS Cermack, FIM Craik, eds. *Levels of Processing in Human Memory.* Hillside, NJ: Erlbaum; 1979.

11 Eysenck MW, Eysenck MC. Effects of processing depth, distinctiveness and word frequency on retention. *Br J Psychol* 1980;**71**:263–74.

12 Tess DE, Hutchinson RL, Treloar JH, Jenkins CM. Bizarre imagery and distinctiveness: implications for the classroom. *J Ment Imag* 1999;**23**:153–70.

13 Brooks JO, Friedman L, Pearman AM, Gray C, Yesavage JA. Mnemonic training in older adults: effects of age, length of training and type of cognitive pretraining. *Int Psychogeriatr* 1999;**11**:75–84.

14 De Beni R, Mo A, Cornoldi C. Learning from texts or lectures: loci mnemonics can interfere with reading but not with listening. *Eur J Cognit Psychol* 1997;**9**:401–15.

15 Hunter IHL. Imagery, comprehension and mnemonics. *J Ment Imag* 1977;**1**:65–72.

16 Thomas MH, Wang AY. Learning by keyword mnemonic: looking for long-term benefits. *J Exp Psychol App* 1996;**2**:330–42.

17 Davis MH, Harden RM. AMEE Medical education guide no. 15. Problem based learning: a practical guide. *Med Teacher* 1999;**21**:130–40.

18 Albernese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. *Acad Med* 1993;**68**:52–81.

19 Hemker HC. Critical perceptions of problem-based learning. *Adv Health Sci Educ* 1998;**3**:71–6.

20 McManus IC, Richards P, Winder BC, Sprotson KA. Clinical experience, performance in final examinations, and learning style in medical students: prospective study. *Br Med J* 1998;**316**:345–50.

21 Sandberg J, Yvonne B. Deep learning is difficult. *Instruct Sci* 1997;**25**:15–36.

22 Stipek DJ. Motivation and instruction. In: DC Berliner, RC Calfee, eds. *Handbook of Educational Psychology.* London: Prentice Hall International; 1996.

23 Lepper MR. Motivational considerations in the study of instruction. *Cognit Instruct* 1988;**5**:289–309.

24 Ford ME. *Motivating Humans: Goals, Emotions and Personal Agency Beliefs.* London: Sage; 1992.

25 Kanfer R. Motivation theory. In: MD Dunnette, ML Hough, eds. *Handbook of Industrial and Organizational Psychology, vol. 1.* California: Consulting Psychologists' Press; 1996.

26 Eagly AH, Chen S, Chaiken S, Shaw Barnes K. The impact of attitudes on memory: an affair to remember. *Psychol Bull* 1999;**125**:64–89.

27 Soler MJ, Ruiz JC. The spontaneous use of memory aids at different educational levels. *Appl Cognit Psychol* 1999;**10**:41–51.

28 Campos A, Loepoz A, Perez MJ. Non-compliance with instructions in studies of the use of imagery as a memory aid. *Imag Cognit Personal* 1999;**18**:241–9.

29 Krapp A. Interest, motivation and learning: an educational-psychological perspective. *Eur J Psychol Educ* 1999;**14**:23–40.

Received 14 *April* 2000*; editorial comments to authors* 1 *August* 2000 *and* 21 *June* 2001*; accepted for publication* 14 *August* 2001