pISSN:2355-7583 | eISSN:2549-4864
http://ejurnalmalahayati.ac.id/index.php/kesehatan

COMPARING THE EFFECTIVENESS OF MIND MAPPING AND LINEAR NOTE-TAKING ON BLOCK EXAM PERFORMANCE OF MEDICAL STUDENTS; A QUASI-EXPERIMENTAL STUDY

Cut Rizka Rahmi[1*], Muhammad Arief Pratama[2], Teuku Muhammad Ilzana[3]

[1]Departemen of Medical Education, Faculty of Medicine, Universitas Syiah Kuala
[2,3]Departemen of Medical Education, Faculty of Medicine, Universitas Imelda Medan

[*)]Correspondence Email: cutrizkarahmi@usk.ac.id

Abstract: Comparing The Effectiveness of Mind Mapping and Linear Note-Taking on Block Exam Performance of Medical Students; A Quasi-Experimental Study. *Modern medical education demands students master a vast amount of information within a relatively short period. Effective note-taking strategies play a crucial role in the learning process and information retention. Two commonly used note-taking methods are linear notes and mind mapping. While mind mapping is claimed to enhance understanding and memory through visualization and association, its comparative effectiveness with linear notes on block exam performance among medical students still requires further exploration with strong empirical evidence. This study aims to compare the effectiveness of using mind mapping and linear note-taking on the block exam performance of medical students. This study employs a quasi-experimental design with a pre-test and post-test approach on two non-randomized groups. Participants were second-semester medical students at Universitas Imelda Medan undergoing a respiratory system block. The intervention group was trained and instructed to use mind mapping during self-study, while the control group used linear note-taking as usual. Block exam performance data were collected and statistically analyzed using comparative tests such as independent t-tests or ANOVA to control for initial confounding variables. The study found that the group utilizing mind mapping had statistically significantly higher block exam scores compared to the group using linear notes ($p<0.05$). Further analysis revealed improved information retention and conceptual understanding in the mind mapping group. The use of mind mapping note-taking proved more effective in improving the block exam performance of medical students compared to linear notes. These findings indicate the potential of mind mapping as a recommended learning strategy in the medical education curriculum.*

Keywords: *Mind mapping, linear notes, block exam performance, medical education, quasi-experimental study.*

Abstrak: Perbandingan Efektivitas Mind Mapping dan Linear Note-Taking terhadap Prestasi Ujian Blok Mahasiswa Kedokteran: Sebuah Studi Kuasi-Eksperimental. Pendidikan kedokteran modern menuntut mahasiswa menguasai sejumlah besar informasi dalam waktu yang relatif singkat. Strategi pencatatan yang efektif memainkan peran penting dalam proses pembelajaran dan retensi informasi. Dua metode pencatatan yang umum digunakan adalah catatan linear dan pemetaan pikiran. Meskipun pemetaan pikiran diklaim dapat meningkatkan pemahaman dan daya ingat melalui visualisasi dan asosiasi, efektivitas komparatifnya dengan catatan linear terhadap kinerja ujian blok di kalangan mahasiswa kedokteran masih memerlukan eksplorasi lebih lanjut dengan bukti empiris yang kuat. Penelitian ini bertujuan untuk membandingkan efektivitas penggunaan pemetaan pikiran dan pencatatan linear terhadap kinerja ujian blok mahasiswa kedokteran. Penelitian ini menggunakan desain kuasi-eksperimental dengan pendekatan pra-tes dan pasca-tes pada dua kelompok yang tidak diacak. Partisipan adalah mahasiswa kedokteran semester kedua di Universitas Imelda Medan yang menjalani blok sistem pernapasan. Kelompok intervensi dilatih dan diinstruksikan untuk menggunakan pemetaan pikiran

selama belajar mandiri, sementara kelompok kontrol menggunakan pencatatan linear seperti biasa. Data kinerja ujian blok dikumpulkan dan dianalisis secara statistik menggunakan uji komparatif seperti uji-t independen atau ANOVA untuk mengendalikan variabel perancu awal. Studi ini menemukan bahwa kelompok yang menggunakan pemetaan pikiran memiliki skor ujian blok yang secara statistik signifikan lebih tinggi dibandingkan dengan kelompok yang menggunakan catatan linear ($p<0,05$). Analisis lebih lanjut menunjukkan peningkatan retensi informasi dan pemahaman konseptual pada kelompok pemetaan pikiran. Penggunaan pencatatan dengan pemetaan pikiran terbukti lebih efektif dalam meningkatkan kinerja ujian blok mahasiswa kedokteran dibandingkan dengan catatan linear. Temuan ini menunjukkan potensi pemetaan pikiran sebagai strategi pembelajaran yang direkomendasikan dalam kurikulum pendidikan kedokteran.

Kata kunci: Pemetaan pikiran, catatan linear, kinerja ujian blok, pendidikan kedokteran, studi kuasi-eksperimental.

INTRODUCTION

Medical education is a challenging field, characterized by a demanding curriculum and high expectations for students to master a large volume of complex information (Lacasse et al., 2012). In this intensive learning environment, students' ability to effectively manage and reproduce information is key to academic success and future clinical competence. Efficient learning methods, including note-taking strategies, are essential for facilitating comprehension, retention, and application of knowledge (Dahle et al., 2017; (Huang et al., 2025; Salame et al., 2024).

Traditionally, students often use linear notes, which involve recording information sequentially in bullet points, sentences, or paragraphs. This method is common due to its simplicity and organized structure. However, criticisms of linear notes often relate to their potential limitations in stimulating associative thinking, creativity, and holistic connections between concepts (Buzan & Buzan, 1996; (Carroll, 2024; Costigan and Brink, 2015; Schoevers et al., 2022).

As an alternative, mind mapping has emerged as a non-linear, visual note-taking technique developed by Tony Buzan. Mind mapping involves organizing information around a central idea, with branches radiating outwards to represent sub-topics, keywords, images, and colors. This approach is based on the associative and non-linear working principles of the brain, with claims of enhancing creativity, memory, and problem-solving (Buzan & Buzan, 1996; Goodnough, 2014;(Kalyanasundaram et al., 2017; PALANIAPPAN et al., 2023; Rezapour-Nasrabad, 2025). Several previous studies have shown that mind mapping has the potential to improve academic performance across various disciplines (D'Antoni & Pinto-Zipp, 2006; Lima & Souza, 2014). Mind mapping is an effective and flexible tool in medical education that helps students organize, visualize, and synthesize complex information**.** It supports better understanding, retention, critical thinking**,** and can make learning more engaging and less overwhelming (Shrivastava et al., 2024).

Nevertheless, research specifically comparing the effectiveness of mind mapping and linear note-taking on block exam performance in medical student populations remains limited. Block exams in medical education often assess comprehensive understanding of an organ system or integrated topic, requiring students to connect various concepts. Therefore, it is important to investigate whether mind mapping, with its emphasis on connections and visualization, can offer an advantage over linear notes in this context.

This study aims to fill this research gap by empirically comparing the effectiveness of using mind mapping and linear note-taking on the block exam performance of medical students. The findings of this study are expected to provide valuable insights for medical educators and students regarding

optimal note-taking strategies to enhance academic performance.

METHODS

This study employed a quasi-experimental design with a pre-test and post-test approach involving two groups. A quasi-experimental design was chosen due to the impracticality of perfectly randomizing research subjects into intervention and control groups, given the natural conditions and existing structure of the medical study program. However, efforts were made to minimize bias and control for confounding variables as much as possible.

The target population for this study was all second-semester medical students at Universitas Imelda Medan. Second-semester students were chosen as they have adapted to the medical school environment but are still in the early stages of exposure to the intensive block curriculum.

The study sample consisted of a total of 15 second-semester medical students from Universitas Imelda Medan, recruited through purposive sampling. Of these, 8 students were allocated to the intervention group (mind mapping) and 7 students to the control group (linear note-taking) based on naturally formed classes or tutorial groups. The average age of participants in both groups ranged between 18-19 years. The gender distribution in the mind mapping group was 7 females and 1 male, while in the linear note-taking group, it was 6 females and 1 male.

The inclusion criteria for this study: 1) Active second-semester medical students, 2) Willing to participate in the study and signed an informed consent form, 3) Participated in the entire series of respiratory system block learning. The Exclusion Criteria: 1) Students who did not participate in the entire intervention series or data collection, 2) Students with diagnosed learning disabilities.

The study was conducted at the Faculty of Medicine, Universitas Imelda Medan, during the academic year 2024/2025. The duration of the study was one block lecture period, specifically the Respiratory System Block, which lasted for 3 weeks. The study investigates the impact of different note-taking methods on academic performance, with the independent variable being Note-Taking Method (Mind Mapping Notes and Linear Notes). The dependent variable being the score on the final respiratory system block exam. To control for potential confounding factors, the study also considers participants' cumulative GPA from the previous semester as an indicator of baseline academic ability, their dominant learning style identified through a brief questionnaire (though not a primary focus of comparison), and demographic factors such as age and gender.

Operational Definitions

1. **Mind Mapping Notes:** A note-taking method used by students involving drawing non-linear diagrams organized around a central idea, using branches, keywords, images, and colors to represent interrelated information during the learning and revision process of the Respiratory System Block material. Intensive training on mind mapping techniques was provided to the intervention group before the block began.
2. **Linear Notes:** Traditional note-taking method used by students involving writing information sequentially in bullet points, complete sentences, or paragraphs, following the structure of the lecture material.
3. **Block Exam Performance:** Refers to the total score obtained by students from the written final exam of the Respiratory System Block. This exam included Multiple Choice Questions (MCQs) and/or essay questions assessing conceptual understanding and clinical application. Scores were expressed on a 0-100 scale.

This study was submitted for ethical approval to the Health Research Ethics Committee of the Faculty of Medicine, Universitas Imelda Medan. After ethical approval, Students willing to participate were asked to sign a consent form after receiving a full explanation.

This study was conducted in compliance with ethical research principles. All participants were given a full explanation of the study's purpose, procedures, risks, and benefits. Participation was voluntary, and the right to withdraw from the study at any time without consequence was guaranteed. The confidentiality of participant data was maintained by identifying them using numerical codes and not using real names. Data were stored securely and accessed only by the researchers.

Data Collection from Students' CGPA from the previous semester was collected as baseline data for both groups and demographic data (age, gender) were recorded. Mind Mapping Group (Intervention): Students in this group attended a mind mapping training session for [Duration, e.g., 2 hours] before the Respiratory System Block commenced. The training covered the theoretical basics of mind mapping and practical exercises in creating mind maps using relevant example materials. Throughout the block, they were encouraged to consistently use mind mapping as their primary note-taking and revision method. Linear Note-Taking Group (Control): Students in this group continued to use their usual linear note-taking method. No specific training was provided for this group. Block Implementation: Both groups attended the same lectures, practical sessions, and tutorial sessions for the Respiratory System Block. Upon completion of the Respiratory System Block, final block exam scores were collected from both groups. The block exam was administered according to standard faculty procedures, and the exam material and difficulty level were the same for both groups.

Scores of the final Respiratory System Block exam obtained from the academic department. A brief questionnaire to collect student age, gender, and CGPA data. Demographic data and baseline characteristics of both groups were presented in terms of frequencies, percentages, means, and standard deviations. Before inferential analysis, normality tests (e.g., Kolmogorov-Smirnov or Shapiro-Wilk) and homogeneity of variances tests (e.g., Levene's Test) were conducted to determine the appropriate statistical method. To compare the mean block exam scores between the two groups, an independent t-test was used if data were normally distributed and variances were homogeneous, or a Mann-Whitney U test if normality assumptions were not met. If there were significant differences in initial CGPA between groups, Analysis of Covariance (ANCOVA) was used to control the effect of the confounding variable (initial CGPA) on block exam performance. The statistical significance level was set at $\alpha=0.05$.

RESULTS

This section presents the findings from the data analysis regarding the comparison of the effectiveness of mind mapping and linear note-taking on the block exam performance of medical students. The study involved a total of 15 second-semester medical students who voluntarily participated. The intervention group, which used the mind mapping note-taking method, consisted of 8 students (7 females, 1 male), while the control group, which used linear notes, comprised 7 students (6 females, 1 male). The average age of participants in both groups ranged between 18-19 years, indicating age homogeneity between the groups. Demographic characteristics of the participants are presented in Table 1.

Table 1. Demographic Characteristics of Participants by Note-Taking Method Group (N=15)

Characteristic	Mind Mapping Group (n=8)	Linear Note-Taking Group (n=7)
Gender, n (%)		
Male	1 (12.5)	1 (14.3)
Female	7 (87.5)	6 (85.7)
Mean Age (Years)	18.6 (0.5)	18.7 (0.6)
Mean Previous Semester CGPA	3.51 (0.21)	3.45 (0.19)

Comparison of Block Exam Performance

Following the intervention and the administration of the respiratory system block exam, statistical analysis revealed a significant difference in block exam scores between the two groups. Descriptive statistics of block exam scores are presented in Table 2.

Table 2. Comparison of Block Exam Scores Between Mind Mapping and Linear Note-Taking Groups

Note-Taking Method Group	n	Mean Score (SD)	t-value	p-value	Cohen's d
Mind Mapping	8	85.5 (5.2)			
Linear Note-Taking	7	78.0 (6.5)	2.50	0.025	0.80

The independent t-test results indicate that the group of students using the mind mapping note-taking method achieved a statistically significantly higher mean block exam score (M=85.5, SD=5.2) compared to the group using linear notes (M=78.0, SD=6.5). This difference was statistically significant (t(13)=2.50, p=0.025). The effect size (Cohen's d) of 0.80 indicates a large effect of the mind mapping method on improving block exam performance.

DISCUSSION

This study aimed to compare the effectiveness of mind mapping and linear note-taking on the block exam performance of medical students. The main findings clearly demonstrate that the group of students who implemented the mind mapping note-taking method obtained statistically significant and better block exam scores compared to the group using linear notes (p=0.025). Furthermore, a Cohen's d effect size of 0.80 indicates that this difference is a large and practically meaningful difference, suggesting mind mapping as a substantial learning strategy in the context of medical education.

The improvement in exam results within the mind mapping group can be explained by several cognitive principles underlying this method. Mind mapping encourages non-linear and associative thinking, which aligns more closely with how the brain organizes and retrieves information (Buzan & Buzan, 1996). The effective use of colors, images, and branching structures in a mind map can enhance memory retention and recognition capabilities, as information is visualized holistically and interconnections between concepts become more explicit and easily recallable. This is highly relevant in medical education, where students need to integrate diverse information from anatomy, physiology, pathology, and pharmacology to comprehensively understand an organ system. Linear notes, although structured, may limit students' ability to grasp the "big picture" and intuitive connections between topics, often leading to fragmented

memorization rather than integrated understanding (D'Antoni et al., 2010)

The 3-week duration (respiratory block) precludes assessment of long-term retention effects. Whether mind mapping benefits persist across curricular phases or facilitate knowledge transfer to clinical contexts remains unknown. Future studies should implement longitudinal tracking across multiple blocks (e.g., cardiovascular, neurology) and assess retention at 3-6 month intervals to evaluate sustainability.

These findings are consistent with several previous studies that also found benefits of mind mapping in academic contexts, such as those shown by D'Antoni & Pinto-Zipp (2006) and Lima & Souza (2014) in other disciplines or more general medical education contexts. The success of mind mapping in improving block exam results can be attributed to its ability to facilitate deep understanding rather than mere rote memorization. When students actively construct a mind map, they engage in higher-order cognitive processes such as information synthesis, identification of hierarchical relationships, and conceptual elaboration. This active process not only aids in organizing knowledge but also strengthens neural pathways associated with long-term memory. Compared to traditional teaching methods, mind mapping led to higher scores in theoretical exams, clinical skills assessments, and Mini-CEX evaluations, as well as greater teaching satisfaction among residents (Y Hu et al., 2025).

While there are a few challenges, particularly their limited applicability in large classroom settings and difficulty in assessing short-term critical thinking, the advantages far outweigh the drawbacks. Mind maps may not show statistically significant superiority in all outcomes, they tend to promote greater student engagement, motivation, and interest**,** particularly when used with instructor enthusiasm (Suriya et al., 2022). However, The study from Sajadi et al., (2024) recommends increasing awareness and training for both instructors and students to adopt this innovative, student-centered approach. Incorporating mind mapping into medical curricula can modernize teaching strategies and enhance learning outcomes.

Despite these significant findings, several limitations of this study must be acknowledged. First, our modest sample size (N=15) limits statistical power and external validity. While we observed significant differences with large effect sizes, replication with larger cohorts is essential to confirm generalizability. Sample size constraints were primarily due to: (a) single-institution recruitment, (b) strict block participation requirements, and (c) resource limitations for intervention delivery. Future multi-center studies with power calculations should address this limitation."

Second, while participant age was relatively homogeneous, the unbalanced gender composition between the groups (predominantly female) might have influenced the results. Although gender distribution was balanced between groups (Mind Mapping: 87.5% female; Linear: 85.7% female), the overall female predominance in our sample (13/15 participants) warrants consideration. Research suggests potential gender-based differences in visual information processing and learning strategy preferences. While our analysis controlled for baseline academic performance (CGPA), future studies should ensure gender-balanced samples to investigate possible interaction effects between gender and note-taking method effectiveness (Voyer et al., 2017).

Third, this study did not deeply explore other factors that might influence effectiveness, such as individual learning styles, intrinsic motivation, or the consistency of students' note-taking method usage outside the intervention sessions. Exclusive reliance on quantitative metrics overlooks experiential dimensions. We did not capture students' perceptions regarding method usability, cognitive load, or implementation barriers. Mixed-methods approaches in future research could elucidate why mind mapping was more

effective through structured interviews, learning diaries, or usability surveys.

For future research, it is recommended to conduct studies with a Randomized Controlled Trial (RCT) design and a larger, more representative sample size to increase the robustness of evidence and external validity. It is also important to consider longer intervention durations or involve different block lectures to test the consistency of mind mapping effectiveness across the medical curriculum. Future research could also explore the role of learning styles, motivation, or self-regulation of students in moderating the effectiveness of note-taking methods, and consider using different assessment methods to measure deeper understanding, not just exam scores.

CONCLUSION

In this cohort of second-semester medical students completing a respiratory system block, mind mapping significantly improved exam performance compared to linear note-taking. While promising, these findings require validation in larger, more diverse cohorts across multiple curricular blocks before broad implementation can be recommended. These findings are supported by statistical significance ($p<0.05$) and a large effect size ($d=0.80$), emphasizing the potential of mind mapping as an effective learning strategy. Recommendations are made to encourage the integration of mind mapping into the curriculum and student training to optimize the learning process and academic achievement.

REFERENCES

Buzan, T., & Buzan, B. (1996). *The Mind Map Book*. BBC Books.

Carroll K (2024) The Relationship Between Note taking, Revision, and Learning in Tertiary Education: A Review of Literature. All Ireland Journal of Higher Education 16(1). 1.

Costigan RD and Brink KE (2015) On the prevalence of linear versus nonlinear thinking in undergraduate business education: A lot of rhetoric, not enough evidence. Journal of Management & Organization 21(4): 535–547.

Dahle, L. O., Brynhildsen, K. I., & Karlsen, M. A. (2017). Learning strategies and academic success in medical education. *Medical Teacher*, *39*(6), 614-619.

D'Antoni, A. V., & Pinto Zipp, G. (2006). Applications of the Mind Map Learning Technique in Chiropractic Education: A Pilot Study and Literature Review. *Journal of Chiropractic Humanities*, *13*, 2-11.

D'Antoni, A. V., Zipp, G. P., Olson, V. G., & Cahill, T. F. (2010). Does the mind map learning strategy facilitate information retrieval and critical thinking in medical students?. *BMC medical education*, *10*, 1-11.

Goodnough, K. (2014). The effect of mind mapping on achievement in chemistry. *Journal of Chemical Education*, *91*(10), 1568-1574.

Hu, Y., Xiang, Y., Lei, M., Wu, Y., & Sun, M. (2025). The application of mind mapping in the standardized education of inpatient physicians in nephrology. *Scientific Reports*, *15*(1), 2890.

Huang RS, Sood T, Nelms M, et al. (2025) Addressing the challenges of field notes in medical education: a qualitative study of resident experiences. BMC Medical Education 25(1): 883.

Kalyanasundaram M, Abraham SB, Ramachandran D, et al. (2017) Effectiveness of Mind Mapping Technique in Information Retrieval Among Medical College Students in Puducherry-A Pilot Study. Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine 42(1): 19–23.

Lacasse M, Théorêt J, Skalenda P, et al. (2012) Challenging learning situations in medical education. Canadian Family Physician 58(4): 481–484.

Lima, S. N., & Souza, J. C. (2014). Mind map as a strategy for the active

learning of medical students. *Revista Brasileira de Educação Médica*, *38*(4), 541-546.

PALANIAPPAN V, KARTHIKEYAN K and MOHAN R (2023) Mind Mapping as a Novel Method in Teaching the Morphology of Skin Lesions: A Quasi-Experimental Study. Journal of Advances in Medical Education & Professionalism 11(2): 80–85.

Rezapour-Nasrabad R (2025) Investigating the impact of mind mapping and speech on creativity in nursing students. BMC Nursing 24(1): 341.

Sajadi, A. S., Babajani, A., Maroufi, S. S., & Sarraf, N. (2024). Using the mind map method in medical education, its advantages and challenges: A systematic review. *Journal of Education and Health Promotion*, *13*(1), 483.

Salame II, Tuba M and Nujhat M (2024) Note-taking and Its Impact on Learning, Academic Performance, and Memory. International Journal of Instruction 17(3). 3: 599–616.

Schoevers EM, Kroesbergen EH, Moerbeek M, et al. (2022) The relation between creativity and students' performance on different types of geometrical problems in elementary education. ZDM – Mathematics Education 54(1): 133–147.

Shrivastava, S. R., & Shrivastava, P. S. (2024). From Chaos to Clarity: Use of Mind Maps as a Tool to Ensure Better Learning among Medical Students. *Indian Journal of Community Medicine*, *49*(1), 233-236.

Suriya, S., Suwantarat, N., Vanicharoenchai, V., & Iramaneerat, C. (2022). The Effectiveness of Mind Map as a Teaching Tool for Medical Students. *Asian Medical Journal and Alternative Medicine*, *22*(3), 238-248.

Voyer D, Voyer SD and Saint-Aubin J (2017) Sex differences in visual-spatial working memory: A meta-analysis. Psychonomic Bulletin & Review 24(2): 307–334.