



The Use of Concept Maps as a Teaching-Learning Strategy for Medical Students

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KEYWORDS

Concept Mapping, Medical Education, Learning Outcomes, Teaching Strategies, Undergraduate Medical Students

ABSTRACT:

BACKGROUND AND OBJECTIVE:

Concept mapping offers substantial benefits to students by facilitating the development of new ideas and serving as a means to assess their comprehension. Nevertheless, the application of concept maps as an instructional strategy among medical students in India remains largely unexamined. This investigation aimed to evaluate the effectiveness of concept maps in enhancing learning outcomes for medical students.

MATERIALS AND METHODS:

The study was conducted with Phase II- MBBS students from two cohorts. It comprised two phases. Initially, a baseline assessment (pretest) was administered to gauge students' prior knowledge. Subsequently, an introductory session on poliomyelitis was delivered, employing a concept map to illustrate the topic, followed by a post-intervention assessment (post-test). In the second phase, students provided feedback on their experience with concept mapping. The pre- and post-test scores were analyzed using the Wilcoxon test.

RESULTS:

A statistically significant improvement was observed between the pretest (4 ± 2.11) and post-test (10 ± 1.26) scores ($P < 0.001$). Over half of the participants achieved perfect scores in the post-test, while none did so in the pretest. Additionally, 90% of students expressed favorable opinions regarding the use of concept maps in their feedback.

CONCLUSION:

Concept mapping proves to be an effective pedagogical tool for medical students, promoting deeper understanding and meaningful learning. Its regular incorporation into the curriculum may further enhance students' grasp of complex concepts.

1. Introduction:

Concept mapping is an innovative educational technique that visually organizes and links concepts, facilitating deeper understanding and critical thinking among learners. Originally introduced by Novak and Gowin in the 1970s, concept maps have since been recognized as valuable tools for promoting meaningful learning and encouraging students to integrate new information with

existing knowledge frameworks (1). In medical education, where the volume and complexity of information can be overwhelming, concept maps offer a structured approach to understanding intricate subjects and identifying relationships between key ideas (2,3).

Several studies have demonstrated that concept mapping enhances cognitive skills, fosters metacognitive awareness, and improves academic performance in



medical and allied health education (4-7). By encouraging active participation and collaborative learning, concept mapping not only aids in knowledge retention but also supports the development of higher-order thinking skills such as analysis, synthesis, and evaluation (5,8). Furthermore, concept maps can serve as effective assessment tools, providing insight into students' conceptual understanding and helping educators identify misconceptions or gaps in knowledge (3,9).

The foundation of concept mapping lies in David Ausubel's et al. theory of meaningful learning, which emphasizes that true understanding is achieved when new concepts are organized in a hierarchical manner, clearly differentiated within the learner's cognitive framework, and meaningfully linked to existing knowledge(10).

Despite the proven benefits of concept mapping in various educational contexts, its routine application as a teaching and learning strategy among medical students in India remains limited. There is a need to systematically evaluate its effectiveness in this setting, particularly in enhancing learning outcomes and student satisfaction. The present study was designed to assess the impact of concept mapping on knowledge acquisition and student perception among Phase II MBBS students, with the aim of informing future curriculum development and instructional practices.

2. Objectives

1. To determine whether concept mapping enhances comprehension of complex microbiology concepts.
2. To compare its effectiveness with traditional teaching.
3. To explore student perceptions and engagement with concept maps.

3. Methods

Participants and Setting

This pilot study was conducted over a period of four months at a medical college. A total of 246 Phase II MBBS students were included using a convenient sampling method. The study population was limited exclusively to Phase II MBBS students. The research was

conducted in two stages, following a pre- and post-test experimental design.

Stage 1: Pre- and Post-Test Intervention

Participants were selected from Phase II MBBS students. The study followed a pre-test/post-test experimental design. To establish a baseline understanding, students completed an initial assessment before the session. After a standard lecture on poliomyelitis, a concept mapping activity was introduced. Students were pre-informed about the session, divided into six groups, and assigned specific subtopics. Each group worked under the guidance of a faculty member to collaboratively develop a concept map.

Following this, a post-test was conducted to measure any immediate knowledge gain. The concept mapping strategy was then formally adopted as the primary instructional method for the topic. Once the session was completed, a final post-test evaluated the overall impact of the intervention. A panel of faculty experts internally assessed the effectiveness of this approach.

Stage 2: Student-Created Concept Maps and Feedback

Students were divided into six groups, each assigned a different topic for concept map creation. Groups submitted a prefinal draft, received faculty feedback, and then submitted a revised final version. The best concept map from each group was recognized and appreciated. Subsequently, students completed a predesigned satisfaction questionnaire, which used a four-point Likert scale (strongly agree, agree, disagree, strongly disagree) to assess perceptions of concept mapping. Responses were analyzed as percentages of agreement or disagreement. The first four questions addressed perceived learning enhancement, while the remainder evaluated acceptance of the method.

Ethical Consideration and Statistical Analysis

Ethical clearance was obtained from the Institutional Ethics Committee. Data analysis was performed using R software version 3.6.0 (R Foundation for Statistical Computing, Vienna, Austria). The Wilcoxon signed-rank test was employed to compare pre- and post-test scores of the participants. Categorical variables were presented as frequency tables, while pre- and post-test scores were expressed as median \pm standard deviation.



4. Results

The current study involved 246 Phase II MBBS students, including 124 males (50.4%) and 122 females (49.6%). A significant improvement was noted between pre-test and post-test scores, suggesting better knowledge retention and conceptual understanding after the concept map-based teaching intervention. Notably, more than half of the participants achieved full marks in the post-test, whereas none did so in the pre-test.

Students' perceptions of concept mapping as a learning strategy were largely favorable. Over 60% strongly agreed that it improved their conceptual clarity and helped in linking related topics. More than half also felt that concept mapping promoted independent thinking and self-directed learning.

Between 53% and 56% of students reported satisfaction and enjoyment in using concept maps, and more than 50% indicated their intent to apply the method in other areas of study. Furthermore, 62.6% endorsed concept mapping as an innovative approach suitable for medical education.

Statistical analysis using the Wilcoxon signed-rank test showed p-values less than 0.05 across all items, indicating that students' positive responses were statistically significant. These findings support the use of concept mapping as an effective and engaging active learning strategy in undergraduate medical education.

Graph:1:Pre and Post-Test scores of concept map

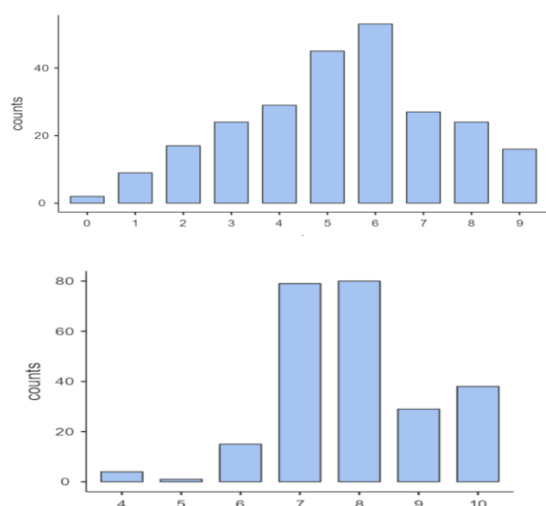


Table :1:Learners' attitudes towards concept mapping

Question	Strongly agree	Agree	Disagree	Strongly Disagree	P value
Concept mapping helped me learn	148(60.2%)	98(39.8%)	0 (0%)	0 (0%)	< 0.001
Concept mapping helped me integrate and clarify the interrelationships among curriculum contents	140(56.9%)	106(43.1%)	0 (0%)	0 (0%)	< 0.001
Concept mapping learning strategy stimulated me to learn and think independently	136(55.3%)	110(44.7%)	0 (0%)	0 (0%)	< 0.001
Concept mapping helped me reduce the barriers and enhance my interest in learning	130(52.8%)	116(47.2%)	0 (0%)	0 (0%)	< 0.001
Concept mapping can be a new medical teaching and learning approach	154(62.6%)	92 (37.4%)	0 (0%)	0 (0%)	< 0.001
I think the concept mapping strategy can be easily used in other curricula	122(49.6%)	124(50.4%)	0 (0%)	0 (0%)	0.015
I will consider using the	128(52.0%)	118 (48.0%)	0 (0%)	0 (0%)	0.008



concept mapping learning strategy in other curricula					
I was satisfied with using concept mapping to learn	138(56.1%)	108(43.9%)	0 (0%)	0 (0%)	< 0.001
I liked using concept mapping to assist me to learn	132(53.7%)	114(46.3%)	0 (0%)	0 (0%)	0.002
I can soon adapt to concept mapping	126(51.2%)	120(48.8%)	0 (0%)	0 (0%)	0.019

5. Discussion

This study aimed to evaluate the effectiveness of concept mapping as both a teaching and learning strategy. Pre- and post-tests were administered, revealing a significant improvement in student performance. Additionally, students provided positive feedback regarding the use of concept maps, indicating enhanced engagement and satisfaction with this approach.

Concept mapping is a technique and tool for visualizing the relationships between different concepts and facts. It was developed during 1970s by Novak and his team at Cornell University. (10)

Bhusnurmath used concept map as a tool to teach pathology to students and concluded that concept map is a great tool for teaching;(11) also, Kaddoura in his research which was about teaching critical thinking to a nursing student by the use of concept map achieved a similar result. (12)

The findings of this study align with previous research demonstrating that concept mapping enhances critical thinking, metacognitive awareness, and academic achievement in medical education(2,3,9,13)

Taie et al. carried out the study on the impact of concept mapping as a novel instructional approach to enhance cognitive learning (14). The results revealed a highly

significant improvement in students' knowledge after the awareness sessions compared to before. Concept mapping was found to boost meaningful learning, and the majority of students in the experimental group reported positive perceptions of this method (15).

Sargolzaie et al. conducted a study involving eighty medical interns, comparing a group taught using concept mapping with another group that learned through traditional book reading. The concept mapping group demonstrated a significantly higher mean score. Likewise, Mukhopadhyay et al.2019. reported that the group utilizing concept maps showed a greater increase in median percentage scores compared to the book reading group. The collaborative creation and iterative refinement of concept maps fostered active engagement and deeper understanding, consistent with the literature on collaborative learning (Mukhopadhyay et al.2019; Sargolzaie et al., 2019).Both studies indicate that the use of concept maps enhances students' learning abilities, which is consistent with the findings of the present study (16,17).

The overwhelmingly positive student feedback supports the integration of concept mapping into the medical curriculum, as it not only reinforces content knowledge but also develops essential skills for lifelong learning (Chiou, 2008; King & Shell, 2002) (15,18).

A similar study by Bala et al ;2016 , assessed 150 MBBS students using pre- and post-tests to measure the impact of concept mapping on learning about HIV/AIDS. Their findings revealed a statistically significant improvement in scores after the concept mapping intervention ($P < 0.05$), and students also reported favorable perceptions of this teaching method, which aligns with the outcomes of the present study (19).

A study conducted by Baliga et al., with third-year MBBS students showed significant improvement in post-test scores after concept map-based teaching (4 ± 1.593 vs. 10 ± 0.762 , $P < 0.0001$). Over 50% scored full marks post-intervention, and 82.09% of students responded positively, indicating enhanced learning and acceptance of concept mapping which resonates with our results (20).

Despite logistical challenges, such as coordinating group activities and providing timely feedback, the approach proved effective and well-received. The internal



assessment by faculty experts ensured the rigor and relevance of the intervention. Given these outcomes, concept mapping should be considered a valuable adjunct to traditional teaching methods in medical education, particularly in complex subjects requiring higher-order thinking (Rendas et al., 2006; Aein & Aliakbari, 2017) (7,21).

Limitations of the study:

This study faced certain limitations. Some participants found the process of creating concept maps to be time-intensive. Furthermore, concept mapping was applied to only a select number of topics. As this was a pilot project, the reliability of the assessment instrument was not assessed. Future studies will incorporate follow-up to evaluate whether students continue using concept mapping in their regular studies. Plans are also underway to embed this strategy into the curriculum to encourage sustained use in teaching and active student engagement.

Conclusion

This study highlights the value of concept mapping as an instructional tool in medical education, showing notable gains in student learning and positive attitudes toward its use. While some challenges were identified, such as the time required for map creation and limited application across topics, the overall results indicate that concept mapping can enhance comprehension and active participation. Incorporating this method more broadly into the curriculum may further support student success and deeper understanding of complex material. Future research should explore its sustained impact and wider applicability.

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Conflicts of interest

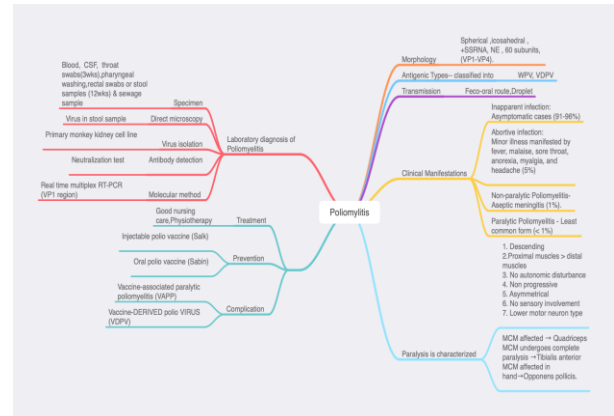
The authors declare no conflicts of interest.

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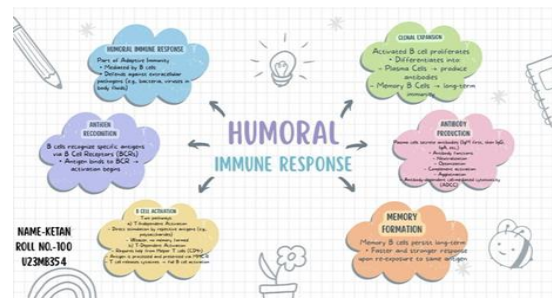
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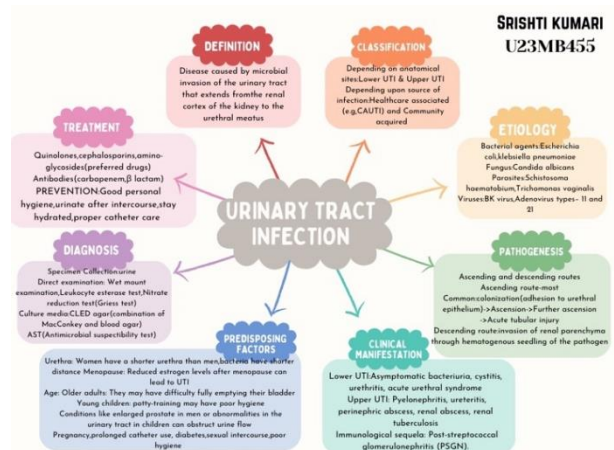
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Supplementary Figure 1: Concept map prepared by teacher



Supplementary Figure 2: Concept map prepared by students



Supplementary Figure 3: Concept map prepared by students