

# Effect of Self-Directed Learning Module and Assessment on Learning of National Health Programme by Medical Undergraduates – A Mixed Methods Evaluation

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## Abstract

**Background:** Competency-based medical education (CBME) curriculum in India has introduced many new concepts like a foundation course, early clinical exposure, and self-directed learning (SDL). Sometimes SDL simply means self-study. Self-directed learning as defined by Knowles is a process in which individuals take the initiative with or without the help of others in diagnosing their learning needs, setting their own learning goals, identifying appropriate learning resources, and selecting appropriate learning strategies. SDL is seen as a prerequisite for life-long learners, especially medical graduates. We found poor uptake of SDL sessions in terms of learning and attendance by students. To develop and assess the effect of the SDL module in Community Medicine for Phase -3 MBBS students. **Materials and Methods:** The study design was a program development and evaluation design. The program development consists of free listing and Nominal Group Technique (NGT). The evaluation design consists of a formative assessment, an end-of-module assessment, and feedback from undergraduate students, postgraduates, and faculties. Data collection procedure: SDL module was developed, agreed and implemented among undergraduates of Phase – 3 MBBS students. **Results:** Free listing was conducted among undergraduate students who had completed the phase 3 MBBS examination and Nominal Group Technique was conducted among the faculties (n = 7) and Postgraduates of the Department of Community Medicine (n = 2) to explore the appropriate topics for SDL in Community Medicine. The topic with the highest ranking and which was finalized for preparation of the SDL module was “National Health Programme”. Three fourth 118 (75%) of the students scored  $\geq 50\%$  at the end of the module assessment. Manual content analysis for the feedback was categorized into three themes such as facilitating factors, challenges, and solutions. **Conclusions:** Effective implementation and assessment of SDL sessions are one of the new concepts in the CBME curriculum.

**Keywords:** Community medicine, feedback, module, nominal group technique, perception

## INTRODUCTION

Competency-based medical education (CBME) curriculum in India has introduced many new concepts like a foundation course, early clinical exposure, and self-directed learning. Sometimes SDL simply means self-study. Self-directed learning as defined by Knowles is a process in which individuals take the initiative with or without the help of others in diagnosing their learning needs, setting their own learning goals, identifying appropriate learning resources, and selecting appropriate learning strategies.<sup>[1]</sup>

Although there are several definitions and interpretations, the essence of SDL remains in its words, i.e., self (learner-oriented), directed (facilitated and monitored), and learning (applicable to lifelong learning).<sup>[2]</sup> Some of the examples currently

being used to cultivate skills of self-directed learning and reflection are problem-based learning, small group learning, self, and peer evaluation, self-study materials, library works, projects, and computer-assisted learning. Now we could see a movement from pedagogy to andragogy in this transformational learning model of SDL in medical education.<sup>[3]</sup>

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SDL adds variety to teaching-learning methods and provides an option for curriculum makers to choose this method in alignment with some learning objectives. The conduct of SDL is quite variable at different places.<sup>[2,4,5]</sup> In several instances, it is confused with self-learning or just asking students to read from books but remaining unobserved. Students and teachers have shown apprehension about the freedom of learning in countries where teacher-oriented learning has been there for a long time.

SDL is an active learning approach with the teacher acting as a facilitator of learning. A medical graduate, being a lifelong learner, should instill the habit of SDL. SDL has been receiving increasing attention since the implementation of competency-based medical education (CBME) by the Medical Council of India (MCI).<sup>[4,5]</sup> Even though dedicated time has been allotted to SDL in the CBME curriculum in each specialty, implementation of SDL is challenging and has become mandatory. Hence in the present study, we developed, implemented, and assessed module-based SDL sessions in Community Medicine for the current batch of students. The challenges faced in implementing the SDL module were also explored by qualitative technique.

## METHODS

The study was carried out among medical undergraduates of Phase - 3, part 1 MBBS, postgraduates, and faculties of the Community Medicine Department in a private medical college located at Puducherry Union Territory. The college admits 150 undergraduate medical students per academic year and is affiliated with Pondicherry University. National Health Programme (NHP) is a part of the medical undergraduate's curriculum and only the must-know components mentioned in the syllabus are taught during lectures.

It was a program development and evaluation design. The program development consists of qualitative techniques like free listing and Nominal Group Technique (NGT). The evaluation design consists of a formative assessment, an end-of-module assessment, and feedback from undergraduate students, postgraduates, and faculties. The module was delivered to 158 Phase - 3, part 1 students of the academic year 2018, over a period of 2 months from November 2021 to December 2021.

### The steps for the conduct of the SDL session are as follows:

Step 1: Selection of topic and development of module

Step 2: Actual conduct of the session

Step 3: End-of-module assessment

Step 4: Feedback

#### Step 1: Selection of topic and Development of module:

Free listing was conducted among undergraduate students who had completed the phase 3 MBBS examination to explore the difficult topics for SDL in Community Medicine. [Table 1]

A Nominal Group Technique (NGT) was conducted among the faculties (n = 7) and Postgraduates of the Department

of Community Medicine (n = 3) to explore the appropriate topics for SDL in Community Medicine. The technique was conducted by a trained Principal investigator in a place and time convenient for the participants using a semi-structured interview guide with a broad open-ended question. The question in the Nominal Group Technique was “*List the appropriate topics for SDL in Community Medicine for Phase -3 MBBS students*”.

Firstly, every participant in the study was asked to give their suggested list of topics for the SDL session. Secondly, all the participants were asked to proceed to rank the topics according to priority as 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and so on. Thirdly participants were encouraged to share and discuss the reasons for their choices. It helped to identify common ground and plurality of ideas and approaches by each participant. Fourthly, the rank for each topic received was totalled, and the topic with the highest (i.e., most difficult) total ranking was selected as the final decision for the development of the module. The topic with the highest ranking and which was finalized for preparation of the SDL module was “National Health Programme”. Then participants were again asked to rank all the National Health Programmes according to priority. Finally, among all the National Health Programmes, the top four National Health Programmes with the highest total ranking were selected for the preparation of the module. The top four National Health Programmes were National AIDS Control Program (NACP), National Tuberculosis Elimination Program (NTEP), the Reproductive and Child Health (RCH) program, and National Leprosy Eradication Program (NLEP) were included in the module. All the interviews were audio recorded and the transcripts were prepared verbatim in English [Table 2]. The module was drafted by the first author by following the competencies given by NMC. The draft module was shared with the faculties of community medicine for review and was approved by the curriculum committee. The module consists of subtopics under each National Health Programme with inbuilt self-assessments like Multiple choice questions, short answer questions, fill-in-the-blanks, and case-based or problem-based questions.

#### Step 2: Actual conduct of the session:

- **First contact session:** Orientation on the process of SDL like division of students into small batches, fixing of learning goals and the milestone by the students, sharing of resources during the intersession period, implementation of the self-directed module, and assessment at the end of each day of the SDL session was briefed to the students. The role of the facilitator was to help students find the resources, and the fixing of venue and timetable adjustments was also briefed. A Whatsapp group for coordination with the students was formed.

- **Intersession period:** During the intersession period documents and websites related to National Health Programme (NACO, NTEP, NHM, NPCDCS) were shared through the Whatsapp group and SMVMCH Learning Management System to engage them in learning.

• **Second contact session:** Before the start of the second contact session, an interactive workshop was held for the facilitators (n = 10) using faculty guide on the implementation of the module and assessment. Through the second contact session, module-based SDL sessions were implemented in Phase - 3, part 1 MBBS students. Students were divided into five small batches. Each batch contains 30 students who were moderated by a faculty and postgraduate. The number of hours allotted for each NHP was six hours, total there were four NHPs and the total time allotted for all the NHPs was 24 hours. The content of each NHP in the SDL module includes important subtopics under each NHP followed by assessment in the form of multiple-choice questions, short answer questions, fill-in-the-blanks, and case-based or problem-based questions. Following the implementation of the module, debriefing was

also done by discussing answers to the assessment questions asked at the end of each NHP, and the modules were also marked by the facilitators with the areas to be improved and handed over to the students individually after the end of the module assessment.

### Step 3: Feedback:

Feedback was collected from all the students and facilitators about the implementation of the SDL module. The online feedback was also obtained from the students who appeared in the final Pondicherry University summative examination.

### Step 4: End-of-module assessment:

Students learning was assessed by,

- Written examination consisting of short answer questions and was evaluated with answer key by the principal investigator.

- Submission of all the completed modules.

**Ethical issues:** The present study was cleared by the Research Committee and the Institutional Ethics Committee (Human Studies) (Ref no: IEC No- EC/91/2021). Permission was also obtained from the Head of the Institution for implementing module-based SDL sessions. Students' marks were not displayed on the noticeboard and were communicated individually to students. Marks were stored separately in HOD's computer.

**Data analysis:** The following analysis was done in the study.

- The free listing data was entered and analyzed using the Visual Anthropac 1.0 software package and the salience value was calculated.

- Manual content analysis was done by the first author for feedback obtained from students, postgraduates, and faculties regarding the SDL session.

- For written assessment frequency was calculated and the Marks were categorized into less than 50%, 50 – 75%, and >75 percentage. The average of marks was also expressed in mean  $\pm$  SD.

**Table 1: Perceived as difficult topics by students**

Item	Frequency (%)	Average Rank	Salience
Health programmes in India	100	1	1
Communication for health education	100	2.2	0.82
Health planning and management & Health care of the community	70	3	0.484
Medicine and social sciences	70	4	0.376
Preventive Medicine in OBS, Peds, and geriatrics	70	5.14	0.276
Communicable diseases	60	5.33	0.194
Environment and health	50	6	0.143
Concept of health and disease	30	5	0.129
International Health	30	6	0.086
Health information and basic medical statistics	30	7	0.043
Health planning and management	20	3.5	0.129
Epidemiology	20	5	0.086
Health care of the community	10	5	0.043
Demography and family planning	10	5	0.043

**Table 2: Consensus score by Nominal Group Technique**

Topics	Score by each respondent				Total
	1	2	3	4	
Health programs in India	5	4	-	3	12
Environment & health	-	-	4	5	9
MDG to SDG	4	-	-	4	8
Surface infections	-	3	5	-	8
Preventive obstetrics, pediatrics	2	-	3	-	5
Health planning	-	5	-	-	5
Sociology	-	1	1	2	4
Health care of the community	3	-	-	-	3
Concept of health and disease	1	-	-	1	2
Rickettsial infection	-	2	-	-	2
Demography	-	-	2	-	2

## RESULTS

### Program development

Out of 158 students, 86 (54.4%) were females and 72 (45.6%) were males.

As shown in Table 1, an Exhaustive list of responses that were obtained during the free listing activity was fed into Visual Anthropac software, and 14 salient items were obtained with a Smith salient score. The topic with the highest Smith salient score was National Health Programmes in India.

The Nominal Group Technique was conducted among facilitators to obtain consensus for the selection of topics for the development of the SDL module. The topic which was obtained the highest consensus was National Health Programme in India. [Table 2]

## Program evaluation

### End of module assessment

At the end of all four modules, there was an end-of-module assessment for 50 marks. Out of 50 marks, 30 marks were given to written assessment consisting of structured short answer questions and 20 marks (five marks for each module) for the assignment submission i.e., submission of four completed modules. The average mark at the end of the module assessment was  $64 \pm 19$  (standard deviation). Out of 158 students 25.4%, 41%, and 33.6% of students scored marks <50%, 50-75%, and >75% respectively. [Table 3]

### Feedback from students, postgraduates, and faculties

In Table 4, content analysis of students, postgraduates, and faculties feedback was categorized into three themes, the facilitating factors, challenges, and solutions. The categories which were emerged under each theme were the SDL session, session frequency, module development, and assessment. The students felt that the module stressed difficult topics in the curriculum, the simple and easily understandable module, and discussion with peers during activities and assessment was the facilitating factors regarding the SDL session and facilitators felt that students learned new terminologies in NHP. Fewer case scenarios and less space for writing in the module were the few challenges in the module. This was the Kirkpatrick model of level 1, which assesses the immediate reactions of the stakeholders.

### Feedback on the performance of questions on NHP in the University Exam (Kirkpatrick level 4)

Feedback was also collected from the students after the completion of the university theory and practical examination regarding the SDL module on the National Health Programme. Although the program was implemented on 158 students, feedback after the University examination could be obtained only from 50 students. The module helped to recollect relevant points and many abbreviations in NHP to perform better in university theory and practical examination was the feedback received from the students. This was the Kirkpatrick model of level 4, which analyzes the final results. A male student had given feedback that.

*I was able to write two NHPs such as NPCDCS and RMNCH+A well only because of the SDL module, which helped me in last-minute revision and remembering the sub-topics under each program.* [Table 5]

**Table 3: End of module assessment scores of all modules of SDL**

Gender of students	Mark category n (%)		
	< 50%	50-75%	>75%
Female	22 (55)	37 (57)	27 (51)
Male	18 (45)	28 (43)	26 (49)
Total	40	65	53

## DISCUSSION

We developed, implemented, and evaluated module-based SDL on NHP. The current module-based SDL teaching demonstrated significant knowledge gains in National Health Programme among medical undergraduates. This was very well evident from the results of the end-of-module assessment, 118 (75%) students scored more than 50 percent. Further as informed by the students they could recollect and answer appropriately the questions related to NHP in the recently conducted summative examination by Pondicherry University. The facilitators felt

**Table 4: Feedback from students, postgraduates, and faculties regarding the SDL session**

Students	Postgraduates and Faculties
<b>Facilitating factors</b>	
<ul style="list-style-type: none"> <li>Stressed on difficult topics for UG students</li> <li>Time allotment for each topic was sufficient</li> <li>Student-centered learning</li> <li>Discussion with peers during activities</li> <li>Avoids monotony of regular lecture classes</li> <li>Continuous sessions on SDL</li> <li>Module was simple and clear, easy to understand, simple language, well organized, easy to revise before exams</li> <li>Module has problem-based questions in the assessment</li> <li>Need a similar type of module for communicable diseases</li> <li>Daily tests can be conducted</li> </ul>	<ul style="list-style-type: none"> <li>Students learned new terminologies in NHP</li> <li>Both learning and writing practice was given</li> <li>Marking of module and feedback by the facilitators</li> </ul>
<b>Challenges</b>	
<ul style="list-style-type: none"> <li>Only a few NHPs were included in the module.</li> <li>There was less space for writing in the module and also contains fewer case scenarios</li> </ul>	<ul style="list-style-type: none"> <li>Students lost enthusiasm because of continuous SDL sessions</li> </ul>
<b>Solutions</b>	
<ul style="list-style-type: none"> <li>All topics in NHP can be included</li> <li>Need more space to write after each question</li> <li>Instruction page at the beginning of the module</li> <li>Discuss how to present each question in the examination</li> </ul>	<ul style="list-style-type: none"> <li>SDL sessions can be scheduled once or twice a week.</li> <li>Consensus can be developed for the selection of questions in the module</li> <li>Questions in the module can be simplified.</li> <li>Binding of the module can be done</li> <li>Applied type of questions should be included more</li> <li>Credits in the form of bonus marks for successful submission of the completed module to motivate the students</li> <li>Post-test at the end of each day can be included.</li> </ul>

that the module was simple, well-organized, and easy for the students to understand. Further, the problem-based questions in the module exercise were easy to understand and avoided the monotony of the lecture class.

According to NMC, the number of hours allotted for SDL in Community Medicine in second and third-year MBBS was 20 and 5 hours respectively and it has been made compulsory in the curriculum.

Similar SDL sessions were happening in the Department of Community Medicine in the Medical College of Delhi and CMC Vellore well before the new NMC curriculum.<sup>[6,7]</sup>

Patra S *et al.*<sup>[6]</sup> in Delhi found that students were satisfied and motivated to study the allotted topic further and they also felt that facilitators could have been more active in imparting knowledge and skills. Previous studies showed that the SDL willingness between batches of students was declining, hence the current curriculum should promote SDL by increasing teaching-learning activities. Factors such as curriculum, assessments, and culture do impact SDL readiness.<sup>[8]</sup>

Teaching students regarding SDL usually takes place in the experiential or co-curricular setting, the skills necessary for SDL should be introduced and developed in the didactic portion of the curriculum, which allows students to develop scaffolding. Flipped classrooms have the potential to move students toward self-directed learning and it is one of the strategies to develop self-directed learners.<sup>[9]</sup> A study showed that e-learning or blended learning requires SDL and may benefit students to know the goals of learning that may impact their engagement. In our study, we developed a module to facilitate SDL.<sup>[7]</sup>

Kohan *et al.*<sup>[10]</sup> stated that higher levels of self-direction are essential for successful online learning in higher education institutes. The factors such as information overload, mind wandering, role ambiguity, inadequate coping skills, heavy workload, and inadequate writing skills were the barriers to self-directed learning.

However, the study also identified facilitating factors, challenges, and solutions regarding SDL sessions. Some of

the facilitating factors were a simple and clear module, which is easy to understand, simple language, well organized, easy to revise before exams and problem-based questions in the assessment. They also suggested the need for a similar type of module for communicable diseases. In the present study, the students felt that SDL sessions were effective which helped them to answer the questions on National Health Programme in the University examination. Facilitators felt that students learned new terminologies in NHP, they were given both learning and writing practice, and marking of modules and feedback by the facilitators was the facilitating factors. They also suggested developing consensus for the selection of questions in the module, simplifying questions in the module, binding the module, and including more applied types of questions. A study done in Delhi also reported positive feedback that sixty-seven percent of students were satisfied and 66% also reported as motivated to study the allotted topic further.<sup>[6]</sup>

The gap between learners' cognitive development and scientific reasoning must be bridged as a way forward toward a more accurate and integrated understanding of self-directed learning.<sup>[11]</sup>

Our educational project helped students to find the answers to the learning objectives decided by them by thinking, searching, and group discussion. We have used a qualitative design and involved the students and faculties in finalizing the topic for SDL. The problem-solving activities planned during SDL sessions made learners utilize available resources, read, discuss, and come up with solutions, which they might not have done otherwise following lectures or small group teaching. Assessing SDL, which was also included in the module, which usually not done in the didactic teaching-learning process. Each group of students with allotted facilitators identified their objectives, resources, and teaching-learning activities, which might have created experiences that were not uniform for all the students. However, each student was a unique learner with their learning preferences. The SDL sessions can be further improved based on feedback from students, postgraduates, and faculties.

Our study found that students enjoyed and were satisfied with the SDL sessions and the assessment methods. Factors such as simple and easily understandable modules, discussion with peers during activities, and assessment were the facilitating factors regarding SDL sessions. As recommended by the students, postgraduates, and faculties scheduling SDL sessions once or twice a week and a few changes in the module suggested were the prioritized action points to improve the SDL session further.

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**Table 5: Feedback on the performance of questions on NHP in the University Exam (Kirkpatrick level 4) (n=50)**

- Module helped to recollect relevant points to perform better in university theory and practical examination. (18)
- Module helped in last minute revision of NHP and remember the subtopics in each programme in exam. (16)
- Two NHP such as NPCDCS and RMNCH + A were directly from the SDL module. (13)
- With the help of the Module on NHP we were not new to many abbreviations in NHP in examination. (11)
- Module helped to realize the importance of NHP at the level of UG. (10)
- Without SDL module it would have not been possible to write about NHP in paper 2 Community Medicine theory examination. (8)

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## Conflicts of interest

There are no conflicts of interest.

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## Mind Mapping as a Novel Method in Teaching the Morphology of Skin Lesions: A Quasi-Experimental Study

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### Abstract

**Introduction:** Mind mapping is a visual mapping technique used in a few disciplines of medical education to represent ideas linked to and arranged around a central core idea or topic through different subtopics/categories. We aimed to utilize this technique to teach the undergraduate medical students the morphology of skin lesions and assess its effectiveness.

**Methods:** This pre- and post-test quasi-experimental study was done among 144 undergraduate medical students. A total of 144 students were selected, and odd and even roll numbers were categorized into two groups using simple random sampling. Group 1 (intervention group) students were taught using mind mapping technique and Group 2 (control group) with traditional lecture-based teaching. A Computer-Assisted pre-test and post-test were carried out. A feedback questionnaire was administered to the intervention group to explore the students' perceptions regarding mind mapping as a learning tool. The data were analysed using SPSS software (version 16), and the difference in the mean pre- and post-test scores was found using independent sampled-t-test.

**Results:** Pre and post-test score distribution was  $5.04 \pm 1.27$  and  $11.44 \pm 2.52$  ( $P \leq 0.001$ ), respectively, in the intervention group. In the control group, the pre and post-test score distributions were  $4.83 \pm 1.39$  and  $8.04 \pm 1.63$ , respectively. The mean rank of the mind mapping group was higher (76.43) than the lecture group (67.5). Among the students, 97.2% agreed on the fact that mind mapping enhanced their interest in learning, and 91.7% of the students were satisfied with mind mapping as the learning method.

**Conclusion:** To kindle the interest and develop critical thinking skills in students, faculty members should continue to explore and evaluate the efficacy of various learning and teaching strategies. Mind mapping could be a novel and integral part of conventional teaching techniques in medical education as evidenced by our student's performances.

**Keywords:** Mind mapping, Dermatology, Medical education

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### Introduction

Mind mapping is a visual mapping technique first developed by Tony Buzan inspired by the notes of Leonardo da Vinci (1). A mind map

is a simple learning tool that is used to represent the ideas linked to and arranged around a central core idea or topic using different subtopics/categories. It is structured in a centrifugal and

more horizontal manner with the study topic in the centre and its details diverged in the periphery. All these core characteristics of mind maps are entrenched in the development of semanti networks, a strategy for representing knowledge in the 1950s (2, 3).

Mind mapping, as a teaching tool, has been used in medical education in general as well as in specific subjects like Anatomy, Community Medicine, Physical therapy, and Chiropractic education (4-7). A mind map presents the content in a visual, non-linear format. This engages the learner to think and explore the concepts using visuospatial relationships and pictorial descriptions, and consequently helps the students to organize and retain information (7, 8).

An age-old proverb apt for diagnosis of skin disorders is "The eyes see only what the mind knows". A piece of sound knowledge on the fundamentals of the description of the morphology of skin lesions (e.g., primary lesion such as macule, secondary lesion such as lichenification) is of utmost importance for the characterization and recognition of skin diseases. Hence, the morphology of skin diseases is the first course that undergraduate students usually learn in their dermatology curriculum. In our department, that topic is routinely taken in a lecture-based format describing the various lesions of dermatology. The students listen to the topic and usually linearly take notes; write down the content in their notebook.

The present study was conducted to evaluate the effectiveness of the mind map technique as a teaching tool for the morphology of skin lesions and to compare its effectiveness with conventional lecture-based teaching of the same topic in medical undergraduates. Also, we explored the perceptions of the students regarding mind mapping as a learning tool.

## Methods

### *Study design and setting*

To fulfil the study objectives, we carried out a quasi-experimental study on sixth-semester undergraduate medical students in the Department of Dermatology at Sri Manakula Vinayagar Medical College and Hospital (SMVMCH), tertiary care center in Puducherry, India. A total of 144 students were selected and categorized into two groups by simple random sampling, and the participants with odd roll numbers were allocated to Group 1 and even numbers to group 2. Group 1 (intervention group) and Group 2 (control group) comprised 72 students each. Both groups were taught about the morphology of skin lesions. The academic sessions on the selected topic for Group 1

students were run by mind mapping technique and for Group 2 students through a conventional lecture-based manner. The content reference for both modes of teaching was taken from standard Dermatology textbooks.

### *Group 1 – Intervention group*

We chose FreeMind written in Java as the mind mapping software in our study at the researcher's convenience. The mind map was designed by one of our faculty and internally assessed for its effectiveness by an expert team comprising three experienced faculty members. Before the commencement of clinical rotation, the students of the intervention group were oriented about mind mapping. None of the students was aware of mind mapping before the session. A two-hour session of mind mapping on the morphology of skin lesions was conducted using the predesigned mind map for 72 students.

The program allows the users to expand and collapse subtopics/categories in the map. Images of patients encountered in our dermatology department with different skin morphology are stored in our department image bank database. From that for each morphological lesion, two different clinical images were selected. For example, in the case of macules, hypopigmented macules and hyperpigmented macules were included. These images were embedded as a hyperlink in the FreeMind software, so that they were displayed by just clicking that corresponding node. Students were encouraged to take notes based on the Mind map structure showing relationships, hierarchies, and connections between individual subtopics.

### *Group 2 - Control group*

Students in the control group were oriented about the learning outcomes of the session. A 2-hour interactive lecture session on the morphology of skin lesions was carried out through the Microsoft Powerpoint™ software. It consisted of a total of 32 slides that included the basics and the definition of various primary and secondary lesions along with the clinical images. The students were involved in the linear note-taking by recording each topic, and writing down as simple sentences. A small 10-minute refreshment break was provided to break the monotony. At the end of the lecture, group discussion of that topic and students' doubts were addressed.

### *Computer-Assisted image-based assessment*

To assess the level of knowledge on the selected topic before the commencement of



academic sessions, was conducted a simple test. Students of both groups were allocated a separate desktop computer in the the digital library of our institution. Each computer was preloaded with a Microsoft Powerpoint™ presentation consisting of 20 clinical images which depicted different morphologies of skin lesions and the students were asked to identify them. It was programmed in such a way that each slide changed automatically every minute, and the total duration of examination was conducted for 20 minutes. The students were given examination answer sheets to write down their answers.

The test result scores were considered as the pre-test scores. Again, students of both groups were subjected to similar kinds of computer-based examinations after attending their respective mode of academic session, the results of which were considered as post-test marks. To increase the internal validity, we carried out a computer-assisted image-based assessment by a dermatology faculty who was not a part of this research team and was blinded to the intervention to nullify the investigator's bias on the students' performance. The answer sheets were evaluated separately by two faculties and the mean value was taken as the final mark.

#### Feedback collection

A feedback questionnaire that was prepared based on the literature review was administered to the intervention group to explore the students' perceptions regarding mind mapping as a learning tool (9). It consisted of a total of nine questions framed in a way to know the effectiveness of mind mapping as a teaching tool to learn the morphology of skin lesions. It also included questions to know the satisfactory levels of this teaching modality. Responses were recorded using a 5-point Likert scale, ranging from strongly disagree (score 1) to strongly agree (score 5). In the last part of the questionnaire, open-ended feedback regarding the usefulness of the session, suggestions to improve, and problems faced by them in mind mapping-based learning were obtained. The anonymity of the feedback was solicited.

#### Statistical analysis

The data were entered into MS Excel and analysed using the SPSS software (version 16) package. The students' scores in the pre-test and post-test of the intervention and control groups were presented as mean and standard deviation. The difference in the mean pre- and post-test scores was found using an independent sample t-test and a  $P < 0.05$  is considered significant.

The content of the open-ended responses was analysed manually by two dermatology faculties.

#### Ethical Consideration

Institutional Research and Ethics Committee approval was obtained. Ethical principles such as respect for the participants, beneficence, justice and ensuring confidentiality was adhered to all through the study. Informed written consent was obtained from all participants.

#### Results

A total of 144 students who were studying at the sixth semester participated in the study. Among them, 69 (48%) were male and 75 (52%) were female. The majority of them (122; 84.8%) were from an urban background and the remaining 22 (15.2%) belonged to rural background.

A comparison of the pre and post-test scores of the participants was done in both groups; each test included twenty questions. Pre and post-test score distributions were  $5.04 \pm 1.27$  and  $11.44 \pm 2.52$ , respectively, in the intervention group (95% CI: 5.876-6.929). In the control group, the pre and post-test score distributions were  $4.83 \pm 1.39$  and  $8.04 \pm 1.63$ , respectively (95% CI: 3.478-2.9381). The mean difference was statistically significant in both groups ( $P < 0.001$ ) (Tables 1 and 2). As shown in Table 3, it was found that the increase in mean score was more in the intervention group in comparison to the control group. The mean rank of the mind mapping group was higher (76.43) than the lecture group (67.5).

**Table 1:** Socio-demographic profile of the sixth semester students

Variable	N (%)
Total participants	144
Gender	
Male	69 (48%)
Female	75 (52%)
Background	
Urban	122 (84.8%)
Rural	22 (15.2%)
Religion	
Hindu	98 (72%)
Muslim	28 (15.5%)
Christian	18 (12.5%)

The overall response to mind mapping was positive and encouraging. The majority of the participants (93.1%) agreed to prefer mind mapping in the future, 97.2% agreed the fact that mind mapping enhanced their interest in learning, and 91.7% of the students were satisfied with mind mapping as the learning method. The noted open-end responses of students about the mind map are shown in Table 4.

**Table 2:** Pre- and post-test evaluation between mind mapping group and lecture-based teaching group

	Group 1	Group 2	Independent sampled t test (t) and P-value
Pre test (Mean±SD)	5.04±1.27	4.83±1.39	T=24.3; P<0.001
Post test (Mean±SD)	11.44±2.53	8.04±1.63	T=23.6; P<0.001
Percentage of change (%)	74.62%	52.37%	P≤0.001
P-value, within groups	<0.001	<0.001	

\*P-value≤0.05 is statistically significant using p independent sampled T-test, \*Improvement % or Change %=(Post-test mean - Pre-test mean) 100/(Pre-test mean). \*Only the scores of the students who participated in both the pre and post tests were included. Group 1=74.62%, Group 2=52.37 (change %).

**Table 3:** Five-point Likert scale response survey regarding the students' perceptions of mind mapping (1=Strongly Disagree to 5=Strongly Agree)

No.	Feedback	Mean	Percent Rating Agree+ Strongly Agree
1	Mind mapping covered the topic of subject effectively.	1.875	63 (87.5%)
2	Do you feel mind mapping enhances your observational skill?	1.722	52 (72.2%)
3	I prefer mind mapping as a teaching method in future.	1.930	67 (93.1%)
4	It enhances my interest of learning.	1.972	70 (97.2%)
5	I felt confident that I can adapt myself to mind mapping.	1.958	69 (95.8%)
6	I was satisfied with mind mapping as a learning method.	1.916	66 (91.7%)
7	It enhances your ability to describe the morphology of skin lesions.	1.944	68 (94.4%)
8	It illustrates important concepts and aids understanding.	1.819	59 (81.9%)
9	Are the concepts linked together and clearly describes the relationship?	1.972	70 (97.2%)

**Table 4:** Student's reflections on mind mapping learning technique

Titles
How does the mind mapping session facilitate your learning?
• We enjoyed learning the topic through this method.
• Easy understanding and correlation of concepts.
• The learning technique was not monotonous.
• This way of learning and notes taking was novel and kindled our interest.
• More involvement in the process of learning.
• Better interaction with the faculty.
• Unique learning experience.
• Non-linear notes are helpful in rapid revision of the topic.
What are the problems faced with this learning technique?
• Took more time than traditional method of learning.
• Found difficult to adopt this new teaching strategy.
• Images were lesser in number for few morphological lesions.
• Expansion and collapse feature of secondary topics led to distraction.
What are the suggestions to improve this learning technique?
• Same technique should be tried in didactic lectures for difficult topics.
• Prior sensitization workshop about mind mapping should be conducted.
• We want to make mind map on our own for easy understanding.
• The sessions should be made concise and finished off in short time.

## Discussion

Mind mapping is a technique that visually creates and connects ideas. Dermatology, as a visual science, provides ample opportunities for mind mapping. In this context, a pre- and post-interventional quasi-experimental study was conducted in a medical college in South India among 144 second-year undergraduate students. It is observed that in the post-tests, the performance of the students who had mind maps as a learning tool was significantly better than

those who had traditional lecture-based learning. In our study, feedback from the students in the intervention group favoured the utility of mind maps as a learning tool.

In medical education, lectures are the most commonly used method of teaching. Powerpoint™ lectures are usually convenient and have the advantage of being stuffed with the tiniest detail. However, the audience may fail to see the connections between the slides which can cause poor attention in class (9). Visual mapping

is a technique that displays complex information visually with graphical organization and presentation. A few examples of this technique are concept maps, mind maps, visual metaphors, and conceptual diagrams (10).

Mind mapping is a study technique in which information from different sources is converted into a diagrammatic representation of vital keywords related to the study topic (11). It allows the students to recognize the intra- and inter-relationships between various concepts, thereby reflecting the kind of real-world thinking principally in the clinical setting (12). Mind mapping can be used as a teaching resource to prepare and review the lectures, have a quick revision of notes, and update the new information. It can be used in situations such as problem-based learning, one-to-one context, small group teaching, as an assessment tool, and for individual revision (13). Although concept maps have similar characteristics, they differ from mind maps with their top-down structure, with linking keywords or phrases to depict the relationships between the concepts (5).

Farrand et al. (2002) were the first to study the effectiveness of mind mapping among undergraduate medical students. It was found to provide improved long-term factual recall of written information. However, the motivation to use this technique was lower when compared to the self-selected study technique. They stressed the importance of motivating the audience group before adopting it as a study learning technique (11).

Wickramasinghe et al. developed a method to score the mind maps prepared by the students based on the structure and content, but they described neither the method nor the data to support it. Based on their study findings, it was concluded that mind mapping, as a teaching tool, may not be effective in enhancing short-term information retention (14).

Choudhari et al. studied the effectiveness of visual mapping techniques, i.e. concept mapping and mind mapping as a learning tool in Community-based Medical Education (CBME) for the subject of community medicine among undergraduate medical students. One group of students was given the assignment to draw visual maps, while the other group had a Question-Answer session with built-in discussion. When a surprise written examination was conducted on the topics taught, the mean score of the students of visual mapping techniques was significantly higher than the other group (15).

Van Gog et al. propose that a learning strategy that combines verbal reports along with mind mapping aids the learners to make inferences

about categorizing or relate concepts together (16). D'Antoni et al., in their study on medical students, found that those who had learned through mind mapping retrieved information successfully in the short term. However, their critical thinking and information retrieval did not increase in the long term as compared to the standard note-taking group (12). A meta-analysis of designs used to teach scientific problem-solving found that those that built integrated frameworks of knowledge such as mind maps were the effective ones (17).

The application of mind mapping in teaching has been reported to improve the critical thinking of nursing students (18). Learning with understanding permits the consolidation of newer concepts with previously learned concepts, thereby contributing to the retention of information in long-term memory (5). The information obtained by integrating the concepts in mind maps helps the students to attain a metacognitive level (19). In medical education, the unique added colours and pictures of mind maps appeal to a wide range of students with visual- and linear-oriented learning styles (12). In our study, the faculty who took the mind mapping session observed that students were more attentive, showed good interest, and were more interactive while learning through it.

A majority of the undergraduate medical students who utilised mind maps in the pharmacology course wanted the lecturers to utilise it as an alternative to conventional teaching formats such as the PowerPoint (20). Mind maps have also been reported as a good online teaching and assessment method during the COVID-19 pandemic (21). A recent meta-analysis showed that mind mapping when combined with problem-based learning could improve self-learning and practical abilities of the students (22).

The major limitation of our study was that mind maps were designed by the faculty and students were encouraged to listen and take notes rather than asking them to make a mind map on their own. Smaller sample size and risk of contamination bias was another limitation in which students of the intervention group might have influenced the control group participants with their experience and notes.

## Conclusion

Critical thinking and active learning are integral parts of medical education. To kindle the interest and develop critical thinking skills in students, the faculty should continue to explore and evaluate the efficacy of various learning and teaching strategies. This study is one of the first

kinds, which have utilized mind mapping in dermatology and assessed its effectiveness against time-tested lecture-based learning. Based on our study, we suggest that mind mapping could be a novel and integral part of conventional teaching techniques in medical education as evidenced by our student's performances.

### Authors' Contribution

All authors contributed to the discussion, read, and approved the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Conflicts of Interest:** None Declared.

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