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Original Article

# Multisensory Approach in Teaching and Learning Among Undergraduate Medical Students

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## ABSTRACT

**Introduction**: Over the past decade, self-directed problem-based learning curricula and adaptations to accommodate different learning styles have gained popularity. According to research, effective learning will occur only when the students actively participate in the learning process. This implies that the lecture format might become a more effective teaching tool if combined with activities that engage student learning.

**Aim /Objective:** To determine whether clay modeling along with lecture, improves student learning and retention. To find whether a difference in learning and retention exists between lecture supplemented with clay modeling versus lecture supplemented with video.

**Materials & Methods:** This study included 54 out of 60 phase I MBBS students who had scored below average marks in the Physiology theory examination. Participants were randomly divided into two groups: Group A and Group B, with 27 students in each group. Both groups were administered a pre-test consisting of multiple-choice questions (MCQs) on the topic of the Visual Pathway and its Lesions. Group A received a 10-minute educational video on the topic, followed by a lecture. In contrast, Group B attended a lecture first and then engaged in clay modelling as an active learning strategy to reinforce the concept. After the interventions, both groups were given a post-test MCQ assessment on the same topic. Retention test was conducted for both groups after 60 days. Data was analysed using SPSS version 26. A paired t-test was used to compare pre- and post-test scores within each group. An independent t-test was used to compare the long-term retention scores between the two groups.

**Results**: There was a statistically significant increase in the scores of short term and long-term retention tests of group B compared to group A. Within-group comparisons also showed statistically significant improvement between pre and post-test scores in both groups.

**Conclusion**: Improvement in short term and long-term retention scores among students who participated in active learning i.e., by auditory, visual & kinesthetic means, shows a better conceptual understanding of the topic than the students who learned through auditory & visual means. It also imparts knowledge and confidence in solving problem-based learning among students. Both immediate and long-term learning gains are impacted by multimodal teaching methods.

***Keywords****: Lecture, clay modeling, video, learning, retention.*

## INTRODUCTION

Exposing students to a lot of knowledge in a short amount of time is already a challenge in pre-clinical medical education. In undergraduate classes, instructors frequently employ the lecture format with the assumption that students would pick up topics by going over their lecture notes and textbook. Research indicates that this teaching approach is ineffective and detrimental to many students' learning experiences when it is employed solely[(1)]. Active learning produces meaningful

learning, improves attitudes toward learning, and increases knowledge and retention, but is still not entirely institutionalized in the undergraduate sciences. Combined passive and active learning methods is more beneficial to the students than only the passive teaching method[2]. Individual variations in cognitive processing cause learning processes to differ from person to person[3].

Vodcasts (video podcasts) are gaining popularity in medical education. Videos meet the needs of the current digital generation of students, offering advantages such as convenience, ubiquity of access, ability to self-pace, and ability to repeat content[4]. In the study done by Street et al. they convert the traditional classroom to a flipped classroom by substituting lectures with brief videos. But feedback given by the students indicated a preference for lecture over the flipped classroom[5]. This shows that lecture cannot be replaced but can be added with short videos to enhance learning

Deep learning is difficult to achieve despite the availability of diverse audiovisual aids (blackboard, PowerPoint presentations, ready-made models, or CD-ROMs). Therefore, we developed an active learning component to teach about the visual pathway and its lesions based on the Chinese proverb "When I hear, I forget; when I see, I remember; and when I do, I understand"[2].

The recent developments in educational programs and methods show that one of the most effective methods to achieve success in education is multisensory learning. In this method the student simultaneously uses more than one sense when a piece of information is given to him or her. Learning becomes long-lasting, meaningful, and more comprehensive when multiple senses are simultaneously activated for a common learning objective during the learning process. When various sensory characteristics of the individual are activated, learning will be more effective, fun full and permanent[6].

This study aims to determine whether clay modeling along with lecture, improves student learning and retention. Also, to find whether a difference in learning and retention exists between lecture supplemented with clay modeling versus lecture supplemented with video.

**MATERIALS & METHODS:**

This cross-sectional study was conducted among 60 phase I MBBS students in a medical college in Kanniyakumari district, South Tamilnadu, who had scored below average marks in Physiology second sessional theory examination. Students who were unwilling to provide consent or absent on the day of post tests were excluded and the remaining 54 students were enrolled in the study. Participants were randomly divided into two groups: Group A and Group B, with 27 students in each group. Both groups were administered a pre-test consisting of multiple-choice questions (MCQs) on the topic of the Visual Pathway and its Lesions. Group A received a 10-minute educational video on the topic, followed by a lecture. In contrast, Group B attended a lecture first and then engaged in clay modelling individually as an active learning strategy to reinforce the concept. The lecture was given by drawing the Visual Pathway & it's lesions on the white board and explained it accordingly. After the interventions, short term retention of both groups was assessed by conducting a post-test with the same MCQ on the same topic. A long-term retention test was conducted for both groups after 60 days.

Data was analysed using SPSS version 26. A paired t-test was used to compare pre- and post-test scores within each group. An independent t-test was used to compare the short-term retention & long-term retention scores between the two groups. P value <0.05 was considered significant.

**RESULTS**:

Out of the 60 students under study 54 completed the pre-test & post-test. They were equally divided into group A & group B with 27 students each. The mean age of study population was 18.81 +/- 1.03 years. There was no difference in age between the two groups. 51.9% of the students were males and 48.9% were females.

The pre-test and post-test scores of group A were 3.15 + 1.2 & 6.29 + 1.5, whereas group B was 3.56 + 1.3 & 7.22 + 1.4, respectively. Comparison of mean pre- and post-test scores of Group A & Group B is given in Table 1.

Within-group comparisons showed very high statistical significance between pre and post-test scores (short-term retention) in both groups($p<0.001$). Short-term retention score of group B showed very high statistical significance compared to group A ($p<0.001$).

**Table 1: Comparison of Mean pre & post test Scores of Group A & Group B**

| Medium of Teaching | Pre-test score (Mean &SD) | Post-test score (Mean &SD) | P value | t value |
|---|---|---|---|---|
| Lecture + Video (Group A) | 3.15 $\pm$ 1.2 | 6.29 $\pm$ 1.5 | <0.001* | 10.8 |
| Lecture + Clay modeling (Group B) | 3.56 $\pm$ 1.3 | 7.22 $\pm$1.4 | <0.001* | 12.6 |

*P value<0.001- very high statistical significance (paired t test)

The long-term retention score of group A was 5.74+/- 2.3, and group B was 6.63+/-1.6. It was observed that, compared to group A, the long-term retention score of group B was statistically significant ($p<0.05$). Comparison of retention scores across time intervals is given in Table 2. Comparison of Short-term & Long-term Retention scores for lecture with Video vs. lecture with Clay Modeling is shown in Figure 1.

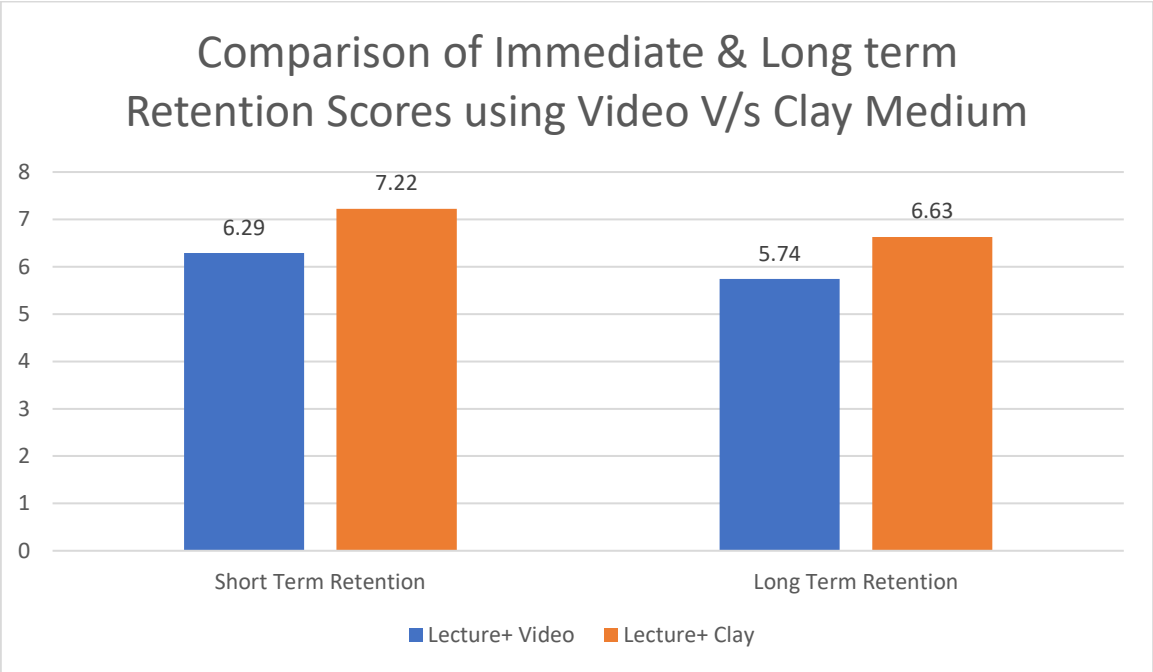


**Figure1: Comparison of Short term & Long-term Retention scores using Video V/s Clay Medium**

**Table 2: Comparison of retention scores across time interval:**

| Time interval | Group A | Group B | P value | t value |
|---|---|---|---|---|
| Short term | 6.29 ± 1.5 | 7.22 ±1.4 | <0.001 | 10.8 |
| Long term | 5.74 ± 2.3 | 6.63 ± 1.6 | 0.034 | 2.23 |

*P value<0.05- statisticaly significant (Independent T test)

On comparing the short term & long term scores of males and females in Group A and Group B, there was no statistically significant difference noted in either groups. Gender Differences in scores of Group A & Group B is shown in table 3.

**Table 3: Gender Differences in scores of Group A & Group B**

| Group | Males | Females | P value |
|---|---|---|---|
| Group A (Lecture + Video) | | | |
| Short term scores | 5.85 | 6.29 | 0.455 |
| Long term scores | 5.92 | 5.57 | 0.696 |
| Group B (lecture + Clay modeling) | | | |
| Short term scores | 7.07 | 7.33 | 0.688 |
| Long term scores | 6.20 | 7.17 | 0.114 |

**DISCUSSION:**

The results demonstrate that lectures, along with activities that engage students' learning, such as clay modeling, improve their performance on short- and long-term retention tests compared to those exposed to lectures and videos alone. This indicates that the clay modeling group has a better conceptual understanding of the topic than the other group.

There were no statistically significant gender differences in scores of short-term as well as long-term retention test of Group A & Group B. Several studies have shown that the cognitive attributes are different in males and females. Generally, females tend to excel in verbal fluency, perceptual speed, accuracy, and fine motor skills, whereas males often excel in their performance in spatial tasks, working memory, and mathematical reasoning[7]. However, we found no significant differences in learning or understanding between males and females of similar age groups who participated in video visualization or clay modeling along with lectures.

Many of the models in medical education are rooted in theories of learning styles, and a widely used one is Fleming's VARK model. In this, learners are categorized based on their preferred sensory modalities as visual (V), aural (A), read/write (R), and kinesthetic (K) (8,9,10,11). Students' learning styles have received increasing attention in higher

education. Each learning style requires different educational materials. Aligning learning framework with students' preferred learning styles has been linked to enhanced test performance, while a discrepancy between those preferences and the curriculum has been associated with diminished academic achievement[3].This indicates that multiple intervention modalities will enhance student learning among students of different learning styles[12]. By applying this concept, this study provides multiple sensory modalities for the learner to grasp a concept.

Podcasts are now being used in healthcare disciplines such as dentistry and nursing, and increasingly in undergraduate medical education. One of the emerging technologies in higher education is a combination of an audio recording of a lecture with video images of an accompanying Microsoft PowerPoint slideshow, referred to as a video podcast, computer-based learning, or audio/visual rich media presentation. Mayer, in his multimedia learning theory, suggested that successful learning using multimedia depends on recognising three features of learning such as dual channels, limited capacity and active processing. His assumption is that learners process visual and auditory information separately and that learning is enhanced when both are stimulated[13].

Street et al., in their study, converted the traditional classroom to a flipped classroom by substituting lectures with brief videos that only focused on the basic concepts of medical physiology and reserving the application and integration of this material for in-class, interactive sessions. But students' feedback indicated a preference for the lecture over the flipped classroom, citing a desire to miss the theatre of the lecture. They also commented that they missed the ability to ask the teacher questions in real time during the modules[5]. This shows that lecture cannot be replaced but can be added with short videos to enhance learning. Taking this into consideration, we provide a lecture along with a video for half of our students under study. This group also showed a significant improvement in short-term retention which was assessed by giving post-test with same MCQs as given for pre-test. It shows audiovisual aids have greater impact on learning than didactic lecture alone.

Back et al. found that medical students had higher knowledge gains with vodcasts compared to textbooks while Edmond et al. showed that medical students had equivalent learning gains with vodcasts and written handouts [4].

Whether for undergraduates, medical students, or residents, clay modelling serves as a hands-on, haptic tool that boosts student engagement and helps master anatomical structures from the cellular to the gross level (Krontiris-Litowitz).Studies done by Myers et al., Krontiris-Litowitz, Oh et al. Herur et al. showed improvement in examination scores among students using clay modelling[12].In all these studies, the students were selected randomly. In our study, we selected students who scored below average in their Physiology sessional theory exam, as they need extra help to overcome their learning and retention difficulties. As the multisensory learning model increases students' motivation and active participation in the lesson, especially those who are reluctant to engage, this teaching approach may benefit them and enable them to be involved in the educational process not only mentally but also behaviourally and emotionally.

Multisensory learning can be designed in different ways depending on the characteristics of the lesson, topic, and learning environment. Studies performed by researchers concluded that the advantages of multisensory learning include increasing creativity in teaching processes, facilitating learning processes, establishing multidimensional evaluation, and increasing active participation of the students. Rau et al. noted that it reduced distractions for individuals, resulting in higher efficiency with less effort for both students and teachers[6].

On the other hand, the listening skills and positive attitude toward listening have been shown to be enhanced by a multisensory learning approach. In the research conducted by Gazioğlu and Karakuş, it was concluded that tale-telling based on the multisensory learning method has a positive impact on the attitudes of fifth-grade students towards tale listening. Similarly, Yıldırım, in his research, concluded that learning through multiple stimuli improves students' attitudes toward reading and writing, boosts their self-efficacy in these areas, and ensures that acquired knowledge is more permanent. According to Shams and Seitz, the advantages of multisensory learning include a more organized learning environment, enhanced cognitive development, increased student motivation, and a more efficient overall learning process[6]. A study done by Satapathy and Singh revealed that kinesthetic learning, or "learning by doing," was the most popular unimodal style, preferred by 34% of participants. They concluded that the preference for kinesthetic learning reflects the practical, hands-on nature of medical training, where students benefit from activities such as laboratory work, clinical rotations, and skill-based workshops[10].

Research shows that using hands-on tools in classrooms strengthens students' problem-solving and critical-thinking abilities. Manipulative activities are also great for engaging students who have very little background knowledge of the subject. A well-structured activity scaffolds a concept from its basic foundation to its most advanced levels, ensuring students master the entire topic**.** Just like other active learning methods, these tactile activities address a spectrum of learning styles, appealing to the visual, auditory, and kinaesthetic learners alike. It also contains undefined components, forcing the student to "fill in the gaps" or improvise, thereby providing an opportunity for learning through discovery. Ultimately, these activities lead students to build a conceptual or qualitative model that helps them grasp, remember, and use their newly acquired knowledge[1].

A study done by Isidora et al showed that the drawing group's scores significantly improved by 11% from pre- to posttest. Scores in the clay and control groups did not significantly improved[16]. Kurien et al. in their study in fourth year medical students who received PODcast, VODcast and 10-minute expert demonstration of the technical skills on a human cadaver and spent half an hour practicing these techniques on cadaver simulators with expert guidance showed statistically significant improvement between the pre- and post-laboratory Confidence Level Questionnaires (CLQ) scores and also between pre- and post-laboratory Objective Structured Assessment of Technical Skills (OSATS) scores. Thus, the study concludes that it provides further evidence that a multisensory teaching intervention effectively imparts the necessary knowledge, skill, and confidence in fourth year medical students to manage epistaxis[8].

Studies on multisensory learning prove that engaging multiple senses helps students succeed and remember information longer (1,4,6,9). In the study done by Bareither et al., undergraduate medical students showed that clay and written module interventions, both of which involve active learning and group work, were similarly effective in producing great improvement in learning as compared to the control group, which received no intervention. The intervention groups appear to show greater retention than the control group, but the difference is not statistically significant [4]. Herur et al. in their study, the control group received PowerPoint presentations and CD-ROMs (passive learning), and the study group made models using dough, showed that the mean total score in the study group was greater compared with the control group when scores were evaluated immediately after the class, after 15 days, and even after 30 days. The study demonstrated that kinesthetic modes of learning will improve short- and long-term learning[6]. Our study is also consistent with these studies, as the retention scores (after 60 days)of the lecture with clay modeling group was significantly higher than those of students who received video and lecture. This shows engaging multiple senses while learning helps students strengthen their long-term memory.

Krontiris-Litowitz, in his study, showed improvement in examination scores among students using clay modelling. According to him, the activities also appeared to encourage students to challenge their understanding of the topic. Observations revealed that interaction with peers and the instructor is important; without it, the manipulatives might have been less effective[11]. Research by Correia, Baatjes, and Meyer suggests that including hands-on clay modeling in undergraduate clinical anatomy is a valuable learning tool. In their study, the students felt that it enhanced their anatomical knowledge and improved collaborative learning[17].

In our study, as the clay modeling was given individually, it provided an opportunity to analyze how the student understood the concept, & inaccuracies in the model indicated gaps in his understanding. This helps the instructor identify and teach that student to better understand the weak areas. This also increased confidence, student-instructor interaction & bonding. So this will allow the student to ask doubts and clear them confidently in the future too. This may not happen in group activities, although peer interaction is also important in learning. Thus, the role of the teacher is redefined from a "sage on the stage" to a "guide by the side”**.** Each of our students will have their own individual constraints, experiences, and preferences. It is an educator's responsibility to foster an optimal environment and provide the necessary resources for every student to reach their full potential. The learner’s role is not only to receive knowledge but also to search, challenge, construct knowledge, and change their own perception, views, and beliefs [17].

**Limitation:**

This study involved a relatively small sample size. The qualitative content of the educational video lacked standardization. The allotted lecture duration may not be sufficient & not all topics in Physiology may be suitable for a multisensory teaching approach. The sample was from a single institution and may be biased.

## CONCLUSION:

From an attempt to help the below-average students to come out of their difficulties in the learning process, this study was conducted & it showed a positive impact on learning as well as retention. Learning becomes more accessible to students with learning differences when multisensory learning tools are involved in the learning process. Therefore, it is clear that multisensory learning is a model that can be used to fulfil the existing objective in the learning process when considering its advantages in the learning process for both teacher and student. Students’ learning and retention can be enhanced by combining activities that engage student learning with the lecture. This information is very useful for improving the quality of teaching and may impact how educators deliver information to students in the future.

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