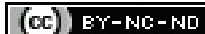


# Effectiveness of Active Learning Methods as a Supplementary Measure to Routine Didactic Amphibian Experiments in Physiology

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## ABSTRACT

**Introduction:** Animal experiments are banned but it is still a part of first year MBBS curriculum and is well assessed in the examination. Most of medical teachers use the traditional chalk and board method for teaching these experiments where students are passive learners and face difficulty in knowledge gain and recall. In this context, Active Learning Methods (ALM) can be a helpful student-centric approach.

**Aim:** To assess the effect of ALM in addition to the traditional chalk and board method on the performance of students and also to assess their perception regarding ALM.

**Materials and Methods:** This cross-sectional analytical study was conducted in Department of Physiology, Pravara Institute of Medical Sciences (DU), Rural Medical College, Loni (BK) Maharashtra state on first year medical students of batch 2013-14 from August 2013 to December 2013. Total of 64 students were included and divided into two batches A and B with 32 students each. Initially, for four Skeletal Muscle (SKM) sessions, ALM was introduced to batch B as revision in the second hour of practical class, following teaching by chalk and board method

in the first hour, while batch A had routine tutorial. Thereafter, crossover of batches was done. Student's performance was assessed by Multiple Choice Questionnaire (MCQ) tests at the end of each section of experiments and also the perception for ALM was recorded by Likert's scale. Unpaired t-test was used to compare between groups.

**Results:** In batch A, there were 14 females and 18 males with mean age  $18.06 \pm 0.56$  years and in batch B, 10 females and 22 males with mean age  $18.06 \pm 0.24$  years. Batch B students with implementation of ALM scored significantly higher ( $7.62 \pm 1.26$ ) compared to batch A ( $6.41 \pm 1.99$ ) without ALM, for SKM section, with p-value of 0.004. After crossover of batches, score of batch A with ALM ( $8.31 \pm 1.17$ ) was significantly higher compared to batch B ( $5.84 \pm 1.56$ ) without ALM with p-value of  $< 0.001$  for cardiac muscle experiments. Total of 96.87% of the students strongly agreed that ALM created a safe learning environment as well as they learned with fun.

**Conclusion:** The ALM supplementing with the traditional chalk and board method in small groups should be incorporated to improve understanding of amphibian experimental physiology.

**Keywords:** Amphibian practical, Chalk and board method, Finger signal method, Pen grabbing method

## INTRODUCTION

First year medical students find physiology a tough subject to learn and face difficulties in knowledge gain and recall of information. Along with theory, experiments or practical are also a very important part of academics as it improves understanding and skills of an individual. The same is applicable to amphibian experiments for undergraduate medical students. But, laboratory use of animals had faced great criticism on ethical issues as raised by animal activists [1].

Studies show a downward trend in the use of animals for teaching and learning basic sciences [2,3]. It is acceptable that animals should not be unnecessarily sacrificed just to acquire skills and techniques of experimentation. The Medical Council of India (MCI) recommended the use of Computer-Assisted Learning (CAL) modules for teaching animal experimental physiology in the undergraduate curriculum [4]. Also, it has imposed a ban on animal dissection in undergraduate medical courses in 2014 [4]. Being basic science topics, as most of the properties of skeletal muscle and cardiac muscle are simulated to human beings and can be understood well; amphibian experiments are there in the curriculum and well assessed in the first year physiology professional examination. Studies reported CAL as effective alternative and better replacement of animal experimentation [5,6]. The only drawback is rapid advancement in the software packages which makes older version non operational because of ever-evolving technology [1,7].

Moreover, teachers are still using traditional chalk and board method which is followed by doubt solving tutorial to explain animal experiments where students are passive learners and face difficulties in understanding and remembering those concepts.

Though the doubts of students are being solved after teaching, many students are afraid of asking questions or doubts to teachers. Therefore, there is a need of involving students in learning process and facilitating them to interact by using student-centric teaching-learning methods. Active learning is a way of engaging students in an activity that forces them to reflect upon learned concepts [8].

Study conducted with implementation of ALM on respiratory physiology where peer instruction, models, role-playing, interactive games, and debates were used by Rao SP and DiCarlo SE 2001, found improved score in the test conducted for students [9]. Similarly, Thaman RG et al., conducted a study on respiratory physiology classes and found improved test scores and students gave positive feedback for implementation of ALM. Pause procedure, minute papers, think-pair-share, models, seminars, role play and mannequins were used by them as ALM [10]. Minhas PS et al., 2012, conducted a study in animal physiology course and used lectures by instructors and seminars presentation by students at two halves of a year and found significantly higher score in the examination [11].

The feedback taken for these methods, found 68.8% of students preferred both methods. This suggested that the integration of active and passive learning may have greater benefit in terms of student preference and performance than either method alone. But all these methods were time consuming [9-11] and scores were tested between two different year batches with and without implementation of ALM [10].

Therefore, the present study was carried out to assess the effect of the use of less time consuming ALM like 'pen grabbing' and

'finger signal' methods [12] as a supplemental measure along with chalk and board method, compared to routine class for amphibian experiments in physiology with relation to knowledge gain and perception of students.

## MATERIALS AND METHODS

This cross-sectional analytical study was conducted from August 2013 to December 2013 at Pravara Institute of Medical Sciences (DU), Rural Medical College, Loni (BK) Maharashtra state, India. Permission from the Institutional Ethics Committee (Letter No. PMT/PIMS/RC/2013 dated 02.08.2013) was taken. Written informed consent was taken from all participating students before starting of study.

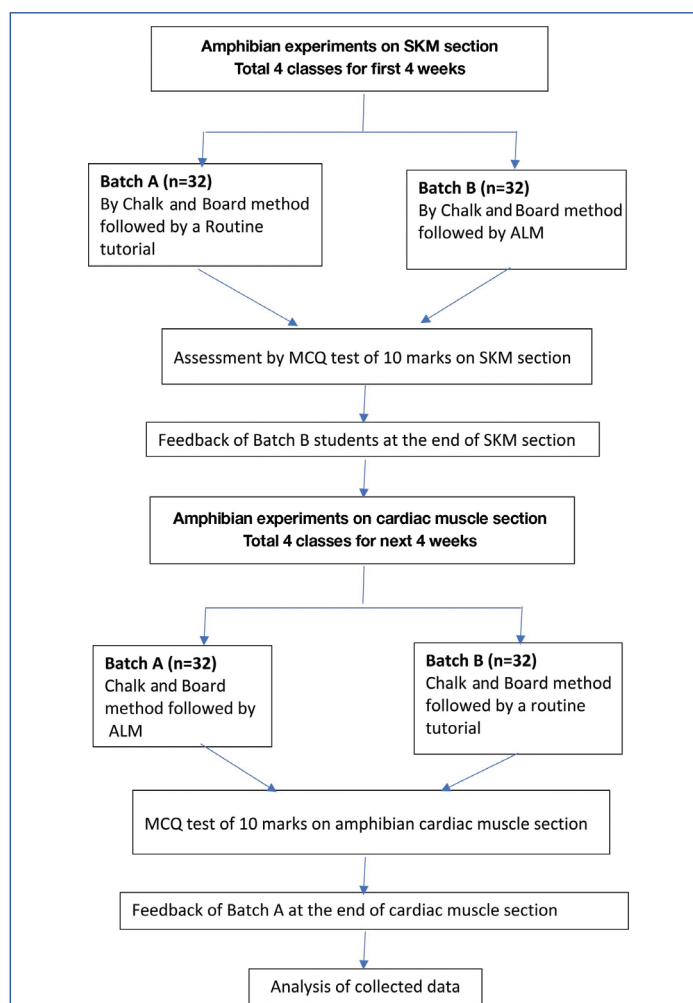
**Inclusion criteria:** All the first year medical (2013-14 batch) students, who were willing to participate after explaining the nature of study were included.

**Exclusion criteria:** Those who remained absent twice or more times for practical classes were excluded.

**Sample size calculation:** There were total 125 students in the first year medical 2013-14 batch. They were attending physiology practical in four batches (A, B, C and D). Two batches posted to amphibian laboratory at the time of conduction of study were enrolled i.e. Batch A (n=32) and Batch B (n=32).

Two batches A and B visited the amphibian experimental laboratory once a week for two hours on two separate days. The intervention was implemented for two months (eight weeks) which included SKM section with one session every week (for four weeks) followed by a cardiac muscle or Cardiovascular System (CVS) section with one session every week (for four weeks).

As shown in [Table/Fig-1] initially for SKM, experiment students of batch A were taught for one hour by traditional chalk and board



[Table/Fig-1]: Flowchart of methodology.

method and it was followed by routine doubts solving tutorial for next one hour. Same topic was taught to batch B students by chalk and board method in first hour and intervention of two ALMs ('Pen grabbing' method and 'Finger signal' method) was implemented in next hour. Same was continued for four weeks. After completion of four such sessions for both batches A and B, assessment on SKM was done by using MCQs of 10 marks (each MCQ having 1-mark). MCQ test questions were devised and validated on consultation with teaching staff of the department. Batch B student's perception for ALM was taken using '5 point Likert scale' as described below [5].

In next month, cross-over of batches was done for CVS experiment section. Here intervention of two ALMs was implemented for batch A students. After completion of four weeks, assessment was done using MCQs of 10 marks on covered experiments. Batch A student's perception for ALM was taken using '5 point Likert scale'.

## Active Learning Methods

- 1. Pen grabbing method:** 32 students batch was divided into four groups having 8 students in each group. A pen was kept at the centre of each group. Every student was asked to write one question on a small piece of paper from the topic in which he/she had difficulty. All pieces of paper were kept in the centre and mixed, one student read the questions. A student who could answer the question grabbed the pen first and answered it to others under the supervision of a teacher.
- 2. Finger signal method:** The teacher asked questions and instructed students to signal their answers by holding up fingers immediately in front of their torso [12]. The questions were of Yes/No and True/False type and students were instructed to show 1 for Yes/True and 2 for No/False. After the finger signal method, correct answers to the questions were discussed.
- 3. Perception of students to ALM:** Feedback form was devised on consultation with staff of the department after reviewing the previous study [5]. There were six statements/questions to assess the perception of the students regarding ALM. The validity and reliability of feedback form was checked by using it on a small group of 15 teaching staff members.

Five point 'Likert type' response scale with minimum score of 1 and maximum score of 5;

- 1 Strongly disagree
- 2 Disagree
- 3 Uncertain
- 4 Agree, and
- 5 Strongly agree

was used [5]. Interpretation of the questionnaire was based on percentage of students responding positively to each question. A response of 4 and 5 was considered positive in favour of use of ALM and score less than 3 was considered negative.

## STATISTICAL ANALYSIS

Statistical analysis was done by Microsoft Office Excel 2007 and Epi Info 7 software. Mean and standard deviation were calculated for the MCQ score. Unpaired t-test was used as a test of significance for MCQ score. A p-value of <0.05 was considered as significant. Perception of students was calculated as percentage of positive responses for respective questions.

## RESULTS

Batch A (n=32) had 14 females and 18 males with mean age  $18.06 \pm 0.56$  years. Batch B (n=32) had 10 females and 22 males with mean age  $18.06 \pm 0.24$  years. There was no significant difference between two batches regarding age of the students (p-value=0.8) [Table/Fig-2].

In SKM practical, MCQ test score for batch B was significantly higher ( $7.62 \pm 1.26$ ) compared to batch A ( $6.41 \pm 1.99$ ). After crossover of

batches, in cardiac muscle experiments, the MCQ test score was significantly higher for batch A ( $8.31 \pm 1.17$ ) compared to batch B ( $5.84 \pm 1.56$ ) [Table/Fig-3].

Parameters	Batch A (n=32)	Batch B (n=32)
Age (years)	18.06±0.56 yrs	18.06±0.24 yrs
<b>Gender</b>		
Male	18	22
Female	14	10

[Table/Fig-2]: Age difference between batch A and batch B students.

SKM test score (out of 10)		CVS test score (out of 10)	
Batch B with ALM	Batch A without ALM	Batch A with ALM	Batch B without ALM
7.62±1.26	6.41±1.99	8.31±1.17	5.84±1.56
p-value <0.005*		p-value <0.001*	

[Table/Fig-3]: MCQ test score of batch A and batch B students.

Unpaired t-test was used to determine p-value; n=32 for each group; p-value of <0.05 was considered as significant

The MCQ test score of batches A and B was compared for assessing the effect of ALM on same batch of students but with different topics. For batch A student's mean score was significantly higher ( $8.31 \pm 1.17$ ) with ALM compared to without ALM ( $6.41 \pm 1.99$ ). Similarly, batch B students mean score was also significantly higher with ALM ( $7.62 \pm 1.26$ ) compared to without ALM ( $5.84 \pm 1.56$ ) [Table/Fig-4].

Batch A		Batch B	
SKM without ALM	CVS with ALM	SKM with ALM	CVS without ALM
6.41±1.99	8.31±1.17	7.62±1.26	5.84±1.56
p-value <0.001**		p-value <0.001**	

[Table/Fig-4]: Score of Batch A and Batch B with and without ALM.

Paired t-test was used to determine p-value; n=32 for each group; p-value is considered

Perception of batch A and B students (n=64) for both ALM implemented was assessed with the help of 5 points Likert scale for questions asked. Among them, 38 (59.37%) students strongly agreed and 26 (40.62%) agreed that Pen grabbing method helped them to clear the doubts about the topic. Most of the students strongly agreed 54 (84.37%) that pen grabbing method helps to remember the facts, 48 (75%) of them strongly agreed that the finger signal method helped them to remember the facts. Total of 62 (96.87%) strongly agreed that ALM creates a safe learning environment as well as learning with fun. All students (100%) strongly agreed that sessions helped them in learning as compared to routine classes (traditional) as shown in [Table/Fig-5].

Questions	No. of students Rank 5 (Strongly agree)	No. of students Rank 4 (Agree)	No. of students Rank 3 (Uncertain)	No. of students Rank 2 (Disagree)	No. of students Rank 1 (Strongly disagree)	Total number of students (Batch A and Batch B)
Pen grabbing method helps to clear the doubts about the topic.	38 (59.37%)	26 (40.62%)	0	0	0	64
Pen grabbing method helps to remember the facts.	54 (84.37%)	10 (18.75%)	0	0	0	64
Finger signal method helps to remember the facts.	48 (75%)	16 (25%)	0	0	0	64
The session provides a safe learning environment.	62 (96.87%)	2 (3.12%)	0	0	0	64
Session help in learning with fun.	62 (96.87%)	2 (3.12%)	0	0	0	64
Session as a overall helps in learning as compared to routine class.	64 (100%)	0	0	0	0	64

[Table/Fig-5]: Student's perception for ALM on 5 point Likert scale.

ALM: Active learning method

## DISCUSSION

In the first set of study, the mean score of batch B students in the MCQ test on implementation of ALM was greater ( $7.62 \pm 1.26$ ) and highly significant as compared to batch A students ( $6.41 \pm 1.99$ ). This indicates more knowledge gain by them with supplemental ALM. However, the reason behind the greater score can also be

that either the student in batch B may be more intelligent than batch A students, or students found the topic taught to them very easy. So, to eliminate this possibility, a different topic (Cardiac muscle practical) was taught with cross-over of batches for the next one month with the implementation of ALM on batch A which was previously taught by traditional chalk and board method. The mean score of batch A students was greater and highly significant ( $8.31 \pm 1.17$ ) as compared to batch B ( $5.84 \pm 1.56$ ).

Thus, the change in the topic has eliminated the bias that can occur due to variable level of intelligence of students. The reproducibility of the greater score by the students on the implementation of ALM with different topics indicates its effectiveness. When analysis was done for individual batch separately, MCQ test score was higher with ALM compared to without ALM. This indicates that the intervention of ALM in supplement with traditional chalk and board learning is more effective for knowledge gain. Our finding of improved score in examination indicating an increase in knowledge gain and reinforcement, is similar to reports by Rao SP and DiCarlo SE, 2001, [9] Thaman RG et al., 2013, [10] Goel P et al., 2020, [13] Faadiel ME and Beselaar L, 2022, [14] and Mukharjee S et al., 2018 [6] as depicted in [Table/Fig-6].

Moreover, in present study all students strongly agreed that sessions with ALM helped them in learning as compared to routine classes. Both the ALM created a safe learning environment and students enjoyed all the sessions. Therefore, student's responses are found to be positive for both the ALM (Pen grabbing and Finger signal method) which were incorporated in supplementation with traditional teaching. Similar findings are reported by Minhas PS et al., 2012, who reported that 68.8% students liked the use of both traditional (lectures) and ALM (student-led seminars) combination [11]. Goel P et al., 2020 and Faadiel ME and Beselaar L 2022 also reported that students have a strong positive response to adoption of ALM [13,14]. As per Mukharjee S et al., 2018, simulation-based teaching is a student-friendly and better alternative of traditional lecture-demonstration for nerve-muscle amphibian experiments [6] as shown in [Table/Fig-6].

Active learning makes intentional engagement and improves knowledge gain as well as recall abilities [15]. It also leads to lasting meaningful learning [16]. The present study emphasises that supplementing ALM to traditional method is useful to students for improving reinforcement of knowledge and learning with fun. It suggests that active learning when especially done within small group with peers encourages students to ask questions, generates more interest, improves understanding, and communication skills as well.

Studies regarding amphibian experiments with CAL (simulation) has been reported to be an effective alternative [5] and better method in learning compared to traditional learning [6]. However, present study report that the use of ALM in small groups in addition to traditional teaching (passive learning) is also a useful strategy of learning in amphibian physiology experiments.



Name of the study	Place of the study	ALM used	Scores in test	Feedback/Conclusion on feedback
Rao SP and DiCarlo SE, 2001 [9]	USA	Peer instruction, models, role-playing, interactive games, and debates in respiratory physiology classes.	<ul style="list-style-type: none"> <li>• ALM=61±2.2</li> <li>• Traditional=86±1.0</li> </ul>	--
Minhas PS et al., 2012 [11]	USA	Lectures and student-led seminars in animal physiology course	<ul style="list-style-type: none"> <li>• ALM=85.77±5.22</li> <li>• Traditional lecture=73.91%±13.18</li> </ul>	68.8% students preferred use of both methods.
Thaman RG et al., 2013 [10]	India	Pause procedure, minute papers, think-pair-share, models, role play, seminar and mannequins in respiratory physiology classes.	<ul style="list-style-type: none"> <li>• ALM=29.42±8.67</li> <li>• Traditional teaching method=26.01±9.70</li> </ul>	Better understanding of respiratory physiology topics as 94.1% students agreed it.
Goel P et al., 2020 [13]	India	Student-teacher interaction, blended learning, jigsaw technique, peer discussion and pause procedure, discussion of MCQs, seminars, role plays and models for renal physiology.	<ul style="list-style-type: none"> <li>• ALM=31.41±9.10</li> <li>• Traditional=25.62±8.23</li> </ul>	Better understanding of the subject along with enhancement of teacher-student interaction.
Faadiel ME and Beselaar L, 2022 [14]	South Africa	'In-class collaborative group work' (cardiovascular physiology for B Sc life science course)	<ul style="list-style-type: none"> <li>• ALM=68±15.1</li> <li>• Traditional previous 3 years=57.5±19.4%</li> </ul>	Strong positive response to the adoption of those ALM.
Mukharjee S et al., 2018 [6]	India	Simulation-based teaching for nerve-muscle physiology practical	<ul style="list-style-type: none"> <li>• Post-test score with CAL=26±1.9</li> <li>• Traditional Lecture cum demonstration=22.77±2.23</li> </ul>	Simulation-based teaching are student-friendly and better alternative of Traditional Lecture-Demonstration.
Present study	India	Pen grabbing method and finger signal method	<ul style="list-style-type: none"> <li>• Batch B with ALM=7.62±1.26 and</li> <li>• Batch A without ALM=6.41±1.99.</li> <li>After crossover</li> <li>• Batch A with ALM=8.31±1.17 and</li> <li>• Batch B without ALM=5.84±1.56</li> </ul>	ALM in supplementation with traditional method for amphibian practical help students in knowledge gain and learning with fun.

[Table/Fig-6]: Scores and feedback of studies involving other ALM in physiology [6,9-11,13,14].

### Limitation(s)

Sample size considered was small as it was done under a project required to complete advanced course of Health Profession Education Certificate, within a limited time period.

### CONCLUSION(S)

The ALM like pen grabbing and finger signal helps students in knowledge gain and learning with fun, when supplemented with traditional method while teaching amphibian experiments. Higher score in tests of both batches with the implementation of ALM is suggestive of its usefulness to acquire knowledge. Students were positive towards these ALM incorporated along with traditional teaching method. Therefore, ALM in small groups should be incorporated as a supplement in addition to passive learning to improve understanding of amphibian experiments in physiology. Studies involving large number of students are recommended.

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