SHORT COMMUNICATION

Learning experience of undergraduate medical students during 'model preparation' of physiological concepts

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Purpose: Learning physiological concepts and their practical applications in the appropriate contexts remains a great challenge for undergraduate medical students. Hence the present study aimed to analyze the learning experience of undergraduate medical students during an active learning process of 'preparation of models' depicting physiological concepts.
Methods: A total of 13 groups, involving 55 undergraduate medical students with three to five individuals in each group, were involved in model preparation. A total of 13 models were exhibited by the students. The students shared their learning experiences as responses to an open-ended questionnaire. The students' responses were analyzed and generalized comments were generated.
Results: Analysis of the results showed that the act of 'model preparation' improved concept understanding, retention of knowledge, analytical skills, and referral habits. Further, the process of 'model preparation' could satisfy all types of sensory modality learners.
Conclusion: This novel active method of learning could be highly significant in students' understanding and learning physiology concepts. This approach could be incorporated in the traditional instructor-centered undergraduate medical curriculum as a way to innovate it.

Key Words: Learning, Education, Physiology

Introduction

As medical students progress through their courses, they demonstrate a decline in basic science knowledge [1]. Retention of basic science knowledge plays a crucial role in clinical application [2] and is also necessary for students to be successful in the "National Eligibility Entrance Test-Post Graduate" for admission into the postgraduate medical courses in India. The Medical Council of India recommends adoption of active learning strategies with emphasis on self-directed learning and competency-based learning in its directives of undergraduate medical education [3]. In addition, the present scenario demands alternatives to animal experiments in the process of medical education in India [4].

An active learning strategy, apart from enhancing recall knowledge, should also aim to improve the analytical and critical thinking skills of medical students [5]. Bonwell and Eison [6] define active learning as "learning that involves students doing things and thinking about the things they are doing." Understanding

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physiological concepts and their concrete applications in clinical scenarios remains a challenging task for undergraduate medical students. Teaching with ready-made models might be an easy and effective method for medical school teachers to deliver content. However, learning with self-constructed models demands greater motivation, creativity, interest, referral habits, and higher-order thinking, as here the students become active learners. They are the ones exploring the content and developing a holistic view of the concept.

Hence, the present study aimed to analyze the learning experience of undergraduate medical students during their preparation of models depicting physiological concepts.

Methods

1. Setting

An intra-college physiology model preparation competition, 'ravishing replicas,' was planned to be organized as a part of the decennial year celebration of the institution. The program was designed with objectives of enhancing concept-based learning, promoting teamwork, improving communication skills, and avoidance of use of experimental animals in the process of learning physiology.

2. Methodology

A total of 13 groups, involving 55 medical students between 18 and 23 years of age from different semesters, enrolled to participate in the competition. Each group comprised three to five individuals. There were 30 females and 25 males among the study participants. Each group was allotted a physiology faculty member for guidance. The enrolled students were given freedom to select their own areas of interest in physiology. Students were required to give a write up for their model preparation to ensure the models were relevant to physiology. They were instructed to construct their models using cost-effective materials. They were also asked to donate the models to the department of physiology after the competition.

On the day of the competition, students were allotted suitable places to exhibit their models. Each group was given 15 to 20 minutes to present their models to the evaluators. The donated models were later displayed in the physiology department and were made accessible to other medical students. The models would also be used as resource materials during small group teaching sessions in physiology for subsequent batches.

Three judges were allotted for evaluation of the models, one was a physiology faculty who was there to provide an expert review of the content of the model constructs and other two judges were from preclinical departments (anatomy and biochemistry faculty to assess the other aspects of the models). A scoring system, ranging from 0 to 5, was established based on the following criteria: (1) creativity and uniqueness, (2) working model/non-working model, (3) response to queries during evaluation, (4) representativeness of the actual physiological concept chosen, and (5) quality of materials used (cost effective, recyclable, etc). Based on the consensus scores obtained from the three judges, the creators of the best three models were given awards and certificates. Participation certificates were given to all the participants.

The participants were asked to share their learning experiences and provide feedback about this program through an open-ended questionnaire. The students responded to the following questions: (1) What did you learn from preparing the model? (2) How did it help you in your studies? (3) Write your experience with working

as group. (4) What were the positives and negatives of model preparation?

Because feedback was obtained as a part of the event, a waiver of consent was permitted by the Institutional Ethics Committee.

3. Data analysis

The manual content analysis was done for the responses obtained from the students for the open-ended questions, and the core comments were tabulated in the results section.

Results

Table 1 represents the various physiological concepts chosen by the students for the preparation of the models. Totally 13 models were made by the students involving major systems, such as the central nervous system, cardiovascular system, excretory system, special senses, hematology, and nerve muscle physiology. Table 2 represents the general comments from the analysis of the students' feedback. Table 3 represents the possible characteristics acquired by the students under three domains of learning based on their feedback.

Table 1. Topics Chosen by the Students for "Model Construction"

System	Topics
Central nervous system	Sensory tracts
	Motor system
	Cross-section of spinal cord
	Reflexes
Cardiovascular system	Pulmonary and systemic circulation
	Cardiac cycle
	Fetal circulation
Renal system	Formation of urine
	Counter current mechanism
Special senses	Visual pathway
	Image focusing mechanisms
Hematology	Coagulation
Nerve muscle physiology	Neuromuscular junction

Table 2. Generalized Comments from Students' Responses

Questions	Responses	No. of responses[a)]
Learning experience & its effects	Enhanced deeper understanding of the topic and its basic concepts	27
	Enhanced problem-solving capability	4
	Enhanced referral of books	9
	Increased creativity	8
	Enhanced long-term memory	5
	Increased practical application, and also application of knowledge in exams	5
	Improved visual learning	1
	Helped students understand terminologies	3
	Increased concentration and zeal of research	2
	A new way of learning	9
Experience working within group	Improved understanding/relationship of team members	30
	Increased communication skills	20
	Learned to adjust to team members' mind sets/acceptance of each other	5
	Understood individual responsibility	5
	Sharing of ideas/knowledge	18
	Time management	12
	Learned to obtain guidance	2
	Learned to guide	1
	Learned organizing a work and segregation of work in a group	4
	Fun-filled learning	15

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Table 2. (Continued)

Questions	Responses	No. of responses[a]
Benefits of model preparation	Vague/difficult concepts can be made interesting/easy	6
	Identified hidden talents	2
	Improved memory	5
	Learned team work	35
	Increased creativity	8
	Learned to enjoy reading	15
	Increased referral habits	9
	Increased technical skills	3
	Time management	12
Drawbacks of model preparation	Time consuming	8
	Resources for model preparation were not easily available	2
	Practically not applicable for all concepts	1
	Lack of cooperation from other team members	2
	Could not concentrate on routinely conducted internal assessments	3
	Forced to face multiple failures during preparation	1
	Difficult to use imagination	1
	Required extensive planning/ground work	5

[a]Numbers represent the number of responses obtained from the students in each category.

Table 3. Skills Gained by the Students during the Learning Process

Cognitive domain	Affective domain	Psychomotor domain
1. Enhanced recall	1. Motivation	1. Active use of senses for model preparation
2. Understanding of basic concepts	2. Active participation	2. Obtaining guidance
3. Problem-solving capability	3. Willingness to participate in future events	3. Repeated trials before the final outcome
4. Referral habits	4. Teamwork: listening, cooperation, understanding responsibility	4. Able to adopt the concept suitable for model preparation
5. Framing answers	5. Communication skills	
6. Practical/clinical application of facts learned	6. Time management	
7. Ability to guide others	7. Sharing of ideas	

Discussion

The medical undergraduates actively participated in the event and made good models that clearly depicted physiological concepts.

In this study, all the models were constructed by students themselves. Many of the students enjoyed the learning process during model preparation. This method of active learning can actively reduce the stress among students. Model preparation would not have been possible without understanding of the basic concepts of the chosen topic. This learning process facilitated their referral habits and motivated them to study other related topics to obtain a holistic view of the concerned topic. Preparation for answering the questions from the judges facilitated the students' problem-solving and analytical skills. Thus, this active learning process can help students achieve higher levels in the cognitive domain of the revised Bloom's taxonomy.

Construction of the models by the students themselves greatly enhanced their motivation, enthusiasm, and creativity. As evidenced in their responses, many of the students exhibited interest in participating in future events. They learned time management, organization, delegation, sharing, cooperation, and listening in

addition to understanding their individual responsibilities. Learning time management is essential as literature shows that good time management is positively correlated with academic achievement [7]. Students also worked to improve their communication skills, not only for presenting their models to the judges, but also for accurate expression of the ideas with their team members and the teachers during the process of model preparation. Thus, activities, such as model preparation, also enhance the soft skills of the medical students in addition to their theoretical knowledge.

It is evident that this learning process enhanced their psychomotor skills, as the students 'learned by doing,' actively using all their senses. All the models were handmade, which boosted their self-confidence and concept understanding. The students were able to adapt the topics in a way that was suitable for presenting models.

Model preparation and presentation by students is a preferred learning methodology because it satisfies all types of sensory modality learners [8]. Visual learners benefited since they were able to visualize the concepts. Auditory learners learned better through discussions with their team members and teachers about the model concepts. Read/write learners learned while representing the theoretical background of their models. Finally, the kinesthetic learners benefited by doing, touching and experiencing.

The results obtained from the students' feedback were consistent with other reports [8,9]. However, these studies reported that usage of models proved to be an effective teaching tool in comparison to the traditional student-centered approaches. However, in our project, we did not attempt to compare this with the traditional approaches. Our study is distinctive because the students examined various physiological concepts. Thus, it effectively addressed the usage of model construction and presentation as an effective physiology learning methodology.

In passive learning, students serve as mere listeners, as they are merely exposed to a prepared course of content. However, even lectures could be made more effective by integrating active learning strategies [10]. However, the process of model preparation has its limitations. It was time consuming and may not be applicable for all concepts. An alternative approach is to prepare models integrating various medical disciplines and to construct them during leisure hours without compromising curricular activities. However, the success of this alternative is dependent on students' commitment and interest.

Our study has certain limitations. This study is a preliminary step undertaken to analyze the learning experience of students during model preparation. We did not attempt to compare this method with the traditional learning strategies. This study was only a cross-sectional evaluation and longitudinal study that needed to be implemented with well-planned modules on different concepts in order to evaluate the learning outcomes.

Preparation of models and presentation by students can serve as a better learning methodology satisfying all types of sensory modality learners. This novel active method of learning can be highly effective in helping students understand and learn physiology concepts. This approach can be incorporated in the traditional instructor-centered undergraduate medical curriculum to innovate it.

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