Original Article

Assessing the Effectiveness of Student-generated Scenario-based Questions as a Tool for Active Learning

Abstract

Background: Active learning is not new as an educational philosophy and its benefits over passive learning modes are well known. In a competency-based framework, active learning is one of the key thrust areas. However, across the globe studies have shown that its implementation is wrought with challenges and limitations. The present study explored the implementation and effectiveness of an innovative technique of active learning where students in small groups of 5–6 construct structured scenario-based questions (SBQs) and learn in the process of making questions. **Objectives:** The study was done with the objective of assessing the effectiveness and feedback of student-generated SBQs as a method of active learning among medical students. **Materials and Methods:** Sensitization about the project was done followed by deciding the topics which could be covered with this method. The method was implemented in Physiology for Phase 1 MBBS students. During implementation, two small groups (25 students each) were randomly assigned into a "study group" and two into a "control group." The students were given trigger topics, learning resources and then asked to make SBQs in sub-groups of 5–6. The questions were then opened to discussion, comments and answering by the peers. Knowledge obtained was compared by a pre-post analysis within-group using paired *t*-test. Between-group analysis was done using independent sample *t*-test. Feedback was collected both from faculty and students on a Likert Scale. **Results:** The study group recorded a statistically significant higher score (11.92 ± 2.2) after the activity as compared to control group (8.04 ± 2.24). Feedback received from participants and faculty was positive with a mean score of more than 4 on a 5-point Likert Scale for all items, except feasibility in which the faculty feedback score was 3.67. Out of 49 participating students, 31 students commented on qualitative feedback that it was engaging. More than half (26) students mentioned they "want more such sessions." **Conclusion:** The present study showed that this activity can be implemented in small group teaching hours of the timetable. It retains the benefits of active learning both in terms of learning outcomes and experientially. It can also be used as a means to implement problem-based learning and early clinical exposure.

Keywords: *Active learning, competency-based medical education, problem-based learning, scenario-based questions*

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Introduction

Active learning is not new as an educational philosophy. Bonwell and Eison defined active learning as "*instructional activities involving students in doing things and thinking about what they are doing*."[1] In context of medical education, active learning is an umbrella term that comprises a variety of teaching-learning methods such as case-based learning, experiential learning, peer problem-solving, and project-based learning.[2,3] In active learning, students are not just passive recipients of the learning process but involved as participants of the process. This promotes not only factual recall but also higher levels of cognition. It is therefore a method rooted in constructivist learning theory and "schema modification."[4] Its advantages in terms of learning outcomes, student engagement as well as peer collaboration are well documented.[5-7] Active learning decreases cognitive load and improves retention in long-term memory.[8] Scientists have also reported a sound neuroscientific basis of active learning with the help of functional magnetic resonance imaging-based studies.[9,10]

Active learning is one of the key elements in the broader trajectory of learning reforms envisaged in a competency-based curriculum which has been adopted in medical schools across the globe including India. However, in spite of that, its implementation in medical schools has

How to cite this article: Dhar DK, Saiyad S, Mahajan N. Assessing the effectiveness of student-generated scenario-based questions as a tool for active learning. Int J App Basic Med Res 2024;14:278-83.

Submitted: 10-Jul-2024
Revised: 11-Aug-2024
Accepted: 17-Sep-2024
Published: 01-Nov-2024

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Access this article online

Website: https://journals.lww.com/IJAB

DOI: 10.4103/ijabmr.ijabmr_320_24

Quick Response Code:

not been promising and most of the educational content is delivered through traditional lectures.[11,12] Some of the reasons behind this were the need of meticulous planning and preparation which demands time, lack of faculty familiarity and training of different approaches to active learning, and paucity of available curricular material for active learning.[13,14] Studies have also revealed attitudinal and perceptional barriers. Many faculties believe that they need to cover all available material pertinent to a topic and hence are hesitant to use active learning techniques in the limited time frame. As far as student perceptions are concerned, some authors have observed that when active learning sessions are not properly designed and executed, the effects were negative both in terms of perceptions and learning, resulting in reluctance among the students.[15,16]

It is consequential that in the face of all these barriers, implementation of active learning is wrought with challenges and pitfalls. Therefore in the present study, we aimed to explore the effectiveness of a novel method of active learning and also gain a firsthand experience of how well these sessions be implemented. In the present study, the students in groups of 5–6 themselves constructed subjective-type, structured scenario-based questions (SBQs) under the moderation of a faculty facilitator. SBQs are unique assessment tools because they test the critical thinking and clinical reasoning of a student as they solve the scenario. In order to make a SBQ themselves, learners require information gathering, construct clarity, ability to organize the content, decide what to ask and also have a fair idea of the correct answer as well as the distracters. This is where SBQs can also be used as a learning tool because the learner goes through a detailed metacognitive process. It also gives the students a snippet of their future role as doctors. In addition, National Medical Commission (erstwhile Medical Council of India) in their assessment module explicitly suggests to use scenarios in long essay type questions instead of one-liners.[17] This exercise will therefore eventually help the students in preparing better for the examinations. Constructing structured SBQs by students and learning in the process has not been used so far in medical schools. Therefore, the exploring the effectiveness, acceptability and ease of implementation of this novel teaching–learning method becomes important.

Materials and Methods

The study was carried out in the Department of Physiology, Himalayan Institute of Medical Sciences as a part of the advanced course in medical education under Nodal Centre, NHL MMC. It was duly approved by the Institutional Ethics Committee (vide letter no. HIMS/RC/2023/249 dated October 19, 2023) and completed within 3 months. The study was done on Phase 1 MBBS students. Informed consent was taken from all the participants before the study. It was an educational intervention where a new teaching–learning method was proposed. It was conducted with a sample size of 100 students which had a study group (who underwent the proposed method) and a control group (who learnt through the routine methods such as discussion of "difficult to understand" topics, questions in previous assessments, drawing of flowcharts and diagrams, and picture triggers). There are 150 Phase 1 students at our institute which are divided into six small groups (A to F) of 25 students each for tutorial and small group teaching activities. Since the intervention was planned during the small group teaching hours of the curriculum, four out of six small groups (25 students each) were randomly chosen to cover 100 students (Groups A, D, E, and F). Two groups out of them were randomly assigned as "study" group (Groups E and F) and two groups as "control" group (Groups A and D). Therefore, there were 50 students each in "study" and "control" group. A sensitization session was held about the nature and purpose of the study for the students and other faculty members of the department where the outline of the project was discussed. Students were also given an idea about group dynamics. Students who were absent during the sensitization session or were unwilling to participate in the study were excluded. The intervention was carried out in two phases-planning and implementation as shown in Figure 1. Within the study duration, two such sessions were conducted pertaining to two units: nerve muscle physiology and endocrine physiology.

Planning

Competencies which could be taken up using this method and "trigger" topics were decided at departmental level by discussion with all faculties [Table 1]. The "trigger" topics were common diseases and clinical aspects pertaining to the competency. Learning material and resources were collected and organized as per the topics. These were given to the students during the sessions.

Implementation

First hour

All the participants were given a pretest using a prevalidated multiple choice question (MCQ) questionnaire on the competencies selected. The study group was further subdivided into subgroups of 4–5 students and each subgroup was given a trigger topic on which they had to construct a SBQ along with an answer key. The students were allowed to use their textbooks, reference books and mobile phones for exploring on the topic. Two standard study materials were also given to each group by the facilitator. During this hour, the group members discussed among themselves. Few of them read the materials, explored online and highlighted the important points. One of them acted as the "scribe" and one of them periodically kept track of time. The facilitator ensured all of these happened smoothly and all members contributed to the group activity.

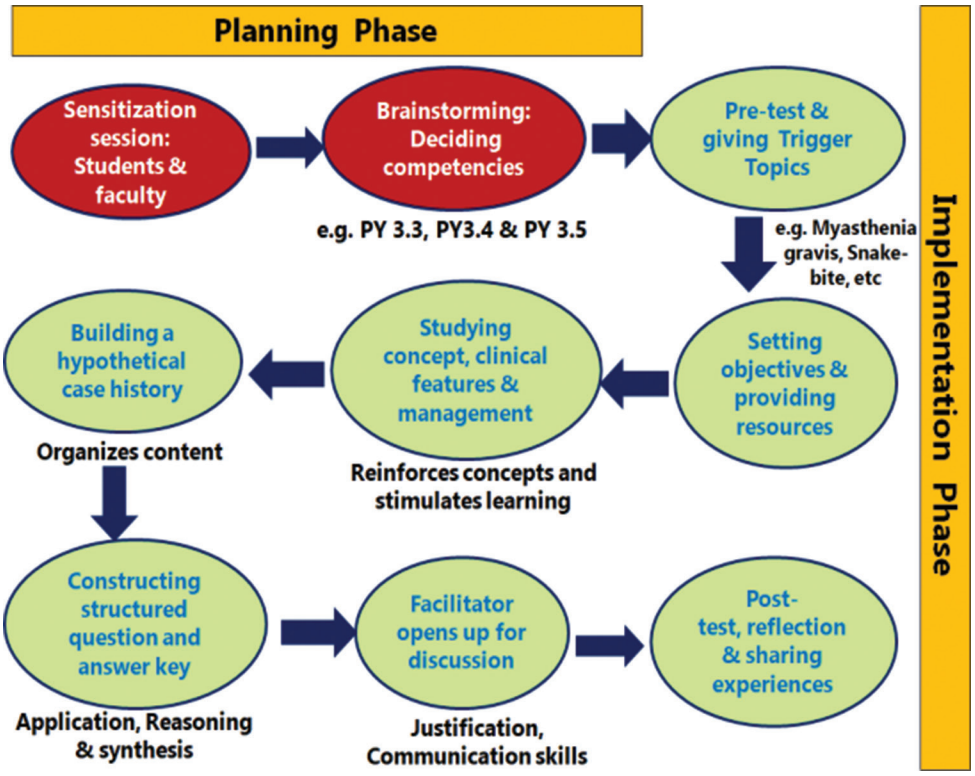

Figure 1: Steps of planning and implementation of the activity

Table 1: Competency-wise list of trigger topics

Competency number	Competency title	"Trigger" topics
PY 3.3	Describe the degeneration and regeneration in peripheral nerves	Carpal tunnel syndrome
PY 3.4	Discuss the action of neuromuscular blocking agents	Snake Bite, Organophosphorus Poisoning
PY 3.6	Describe the pathophysiology of myasthenia gravis	Myasthenia gravis, Lambert Eaton Syndrome
PY 3.13	Describe muscular dystrophy; myopathies	Duchenne's Muscular Dystrophy
PY 8.2	Describe the synthesis, secretion, transport, physiological actions, regulation and effect of altered (hypo and hyper) secretion of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas and hypothalamus	Gigantism, Dwarfism
PY 8.5		Graves' Disease, Goiter
		Hypocalcemia
	Describe function tests: Thyroid gland, adrenal cortex, adrenal medulla, and pancreas	Addison' s Disease, Cushing's Disease
		Diabetes Mellitus, Diabetic Ketoacidosis, Pheochromocytoma

Second hour

Over the next hour, one member from each group read out the question prepared by them. Each group got 10–12 min for their presentation. The facilitator opened up each question for discussion and answering, comments and questions by other such peer groups. After the activity, posttest questionnaire was shared with the students.

Feedback

From both the faculty and the study group, structured feedback was collected on a 5-point Likert Scale. The student feedback had 5 items and faculty feedback had four items. Each of the items had to be scored on a scale of 1–5 where 1 meant "strongly disagree" and 5 meant "strongly agree." One column was left open-ended for the participants seeking their general thoughts, remarks and suggestions for further improvement.

Statistical methods

The data were analyzed using Statistical Package for Social Sciences, SPSS (Manufactured by SPSS Inc., Chicago, USA) version 17. The quantitative variables were expressed as mean and standard deviation. Within each group, pre–post score comparison was done using paired *t*-test and scores of study and control groups were compared using independent sample *t*-test. A $P < 0.05$ was considered statistically significant.

Results

The study and control groups were comparable as there was no significant difference in the pretest scores. The posttest

scores were significantly higher in the study group as compared to the control group. Within group analysis also revealed that the improvement in scores was statistically significant in the study group as shown in Table 2. The feedback from students and faculty who participated in the activity are shown in Tables 3 and 4, respectively. Some of the common responses obtained from the 49 participating students in the last column seeking their comments were "engaging" (31) "felt involved in process"(24), "develop clinical thinking" (24), "opportunity to apply their knowledge to real-world scenarios" (12), "teamwork" (6), and "communication skills" (6). Twenty-six students mentioned they "want more such sessions." One participant mentioned that all students were not contributing adequately to the group effort and this was a disadvantage of this method. The numbers in parentheses represent the number of respondents.

Table 2: Comparison of performance between groups and within groups

Scores	Study group (*n*=49)	Control group (*n*=45)	Independent sample *t*-test (*P*)
Pretest	9.10±2.81	8.30±2.60	0.09
Posttest	11.92±2.2	8.04±2.24	<0.001
Paired *t*-test (*P*)	<0.001	0.75	*P*<0.05 statistically significant

Table 3: Feedback of study group (*n*=49) on a scale of 1–5

Feedback parameters	Mean score
Enhancing knowledge about topic	4.44±0.73
Engagement and motivation	4.40±0.81
Group work and communication	4.36±0.83
Effectiveness of the method for clinical and applied topics	4.42±0.72
Effectiveness of the method for small group sessions	4.53±0.69

Table 4: Faculty feedback (*n*=6) on a scale of 1–5

Feedback parameters	Mean score
Innovativeness	4.00±0.89
Enhancing reasoning and problem-solving skills	4.33±0.52
Feasibility (resources, session conduct, faculty motivation)	3.67±0.52
Ease of timetable placement	4.67±0.52

Discussion

Making SBQs requires, construct clarity, organizing the content and having a fair idea of the correct answer as well as the distracters. The findings of the present study show that this exercise brought about a significant improvement in learning. Reaction level analysis from student feedback also showed a positive effect with a mean score above 4 out of 5 in all the feedback items. Faculty feedback was also positive with a score of above 4 out of 5 in most items.

The activity of constructing structured SBQs followed by peer-discussion has not been explored much in medical schools. Student-authored MCQs have been used as a learning method in some studies and they reveal better academic scores and learning outcomes like the present study.[18-20] A systematic review published in 2022 on the effect of creating MCQs concluded similar findings, especially critical thinking and higher cognition.[21] In a study conducted among nursing students, higher scores were seen in the study group compared to the control group.[22] Research using similar approach done among school, college and university students of various other disciplines also report good outcomes. Hardy *et al*. in their study in three universities in Britain found that students' grades increased when question generation, answering questions and commenting on peers' questions were combined which was similar to our findings.[23] Contrary to our study, Aflalao reported in her study that no significant effect of this exercise was seen on overall grades. However, a significant effect was seen when only higher order thinking questions were accounted.[24] Yu and Pan in their study on middle school students found better academic performance with this activity.[25] In similar studies on school students, researchers reported that problem writing and student-generated questions enhances comprehension of learned content, motivates learning and higher order thinking and even results in better academic achievements.[26] We gauged the acceptability of the method from the feedback and remarks received from the participating students. A mean score of more than 4 out of 5 for all the items shows that most of the students received the method well and their experience in the activity was affirmative. The feedback items comprised of engagement and motivation, enhancing knowledge, group work and communication, effectiveness for applied topics and for conducting tutorials and small group teaching. These points covered their views on both the cognitive aspects of the activity and their perspective on conduct and implementation of such sessions. It shows good acceptability. Unlike the present study, some authors had reported that the task of forming or creating MCQs was perceived as "burdensome" and an "unpopular strategy."[20,22] The only perceived drawback mentioned by one participant was that some students were not actively participating. This can be addressed by the role of the facilitator.

Limitations

Although the study brought forth some interesting findings and insights into a new teaching–learning method, there are a few limitations. Only two sessions were done, among only Phase 1 MBBS students, in one subject, across one batch and one institute. In the limited study duration, the exercise also could be evaluated only up to reaction and learning level analysis as per Kirkpatrick's model of evaluation. Whether or not it brings

an effect on the learning behavior and academic performance in summative and formative exams can be evaluated best only after this method is done regularly. Prima facie this method seems to be an acceptable and effective method, but a holistic inference can be drawn only when it is tried across different phases of MBBS, across different subjects and across different institutes and across different batches of MBBS students over few years. This will also increase the sample size and provide more robustness of the findings. A complete thematic analysis of open-ended feedback was not done presently. This can also provide valuable insights if included when the ambit of the study is expanded.

Challenges

The activity is effort-intensive and needs meticulous planning and faculty motivation during the planning phase. Also because it is a new method, a good sensitization session especially for the students is a must. This will also improve the quality of the questions prepared. The faculty should also have good facilitation skills and a pro-active approach for best results.

Conclusion

The study reveals a glimpse into the benefit of SBQs as a learning tool. This exercise retains all the benefits of active learning both in terms of learning outcomes and experientially. Our experience shows that it can be implemented easily with some amount of planning. It is acceptable to the students and is an effective method.

Future recommendations

It can be easily placed in the timetable in 2 h-formats, in small group teaching hours. Given the positive feedback, this method can also be used to implement active learning in various formats such as for problem-based learning, early clinical exposure, and self-directed learning. It can also serve as a model of peer-assisted learning. In addition, this method not only promotes critical thinking, but also a spirit of lifelong learning. However, the sessions should be spaced evenly throughout the academic calendar and not crowded in one particular month or block. It should also be aligned with the subject matter already delivered in theory. The authors intend to explore the effectiveness further in subsequent batches of students.

Acknowledgments

Dr. Abha Shrivastava, Professor and Head and Dr. Ramkumar S, Assistant Professor, Department of Physiology, Himalayan Institute of Medical Sciences for their kind support and help.

Ethical statement

The study was approved by the Institutional Ethics Committee of Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Jolly Grant, Dehradun, Uttarakhand, India (Approval No. HIMS/RC/2023/249).

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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