

Original Research Article

Effectiveness of scenario-based learning for teaching epidemiological concepts amongst undergraduate medical students: a quasi-experimental study

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ABSTRACT

Background: Epidemiological concepts underpin community medicine and require application in real-life public health contexts. Traditional lectures often limit active engagement. Scenario-based learning (SBL), a learner-centred approach, may improve understanding, critical thinking, and application. This study evaluated the effectiveness of SBL versus conventional lectures for selected epidemiological concepts among MBBS students.

Methods: A quasi-experimental crossover study was conducted among Phase III MBBS students. Study designs and incidence and prevalence were taught using SBL and lecture-based methods. Pre-test and post-test assessments were used to measure learning gains, and student perceptions were assessed using a structured questionnaire.

Results: Both teaching methods significantly improved post-test scores ($p < 0.001$). However, SBL resulted in higher learning gains than lectures. The overall mean gain score was significantly greater in the SBL group (2.85 ± 2.16) compared with the lecture group (1.49 ± 2.90 ; $p < 0.001$). Students demonstrated favourable perceptions towards SBL, with 88.3% reporting that group discussions clarified concepts, 86.7% expressing overall satisfaction, and 85.0% reporting improved confidence in solving epidemiological problems.

Conclusions: Scenario-based learning was more effective than traditional lectures in improving understanding of selected epidemiological concepts and was well accepted by students. SBL can be considered a useful adjunct to conventional teaching in undergraduate community medicine.

Keywords: Active learning, Community medicine, Epidemiology, Medical education, Scenario-based learning, Students

INTRODUCTION

Epidemiology is a core component of community medicine that requires students not only to understand definitions and formulas but also to apply epidemiological concepts to real-world public health situations. However, students often find concepts such as incidence, prevalence, and study designs difficult to contextualize when they are taught predominantly through conventional lectures.

Traditional lecture-based teaching mainly involves passive transfer of knowledge and provides limited opportunities for active participation, critical thinking, and application of concepts. Consequently, students may acquire factual knowledge but often struggle to interpret and apply epidemiological principles in practical situations. Research has shown that active learning approaches can improve knowledge retention, learner engagement, and application of concepts compared with traditional didactic teaching.¹

Scenario-based learning (SBL) is a learner-centred instructional strategy that uses realistic scenarios to encourage students to analyse problems, discuss possible solutions, and apply theoretical knowledge in authentic contexts. Through collaborative learning and guided facilitation, SBL promotes active participation, critical thinking, clinical reasoning, and decision-making skills, making learning more meaningful and relevant to future professional practice.

Evidence from medical and allied health education demonstrates that scenario- and case-based learning approaches improve conceptual understanding, self-directed learning, learner engagement, confidence, and application of knowledge compared with conventional teaching methods.²⁻⁶ Baek et al further demonstrated that scenario-based learning significantly improved learner engagement, problem-solving ability, and confidence by situating learning within realistic and contextual frameworks.⁷ Despite these educational advantages, evidence regarding the effectiveness of scenario-based learning for teaching epidemiological concepts in undergraduate community medicine remains limited. Therefore, the present study was undertaken to evaluate the effectiveness of scenario-based learning compared with traditional lecture-based teaching among MBBS students.

METHODS

Study design and setting

A quasi-experimental crossover educational intervention study was conducted from March to July 2026 in the department of community medicine of a tertiary care teaching institute located in south Gujarat to compare scenario-based learning (SBL) with conventional lecture-based teaching for selected epidemiological concepts among phase III MBBS students. The batch comprised 150 students.

Participants, sampling and sample size

Students enrolled in phase III MBBS and attending the scheduled teaching and assessment sessions were eligible. Students who missed either the pre-test or post-test or did not complete the intervention were excluded.

Assuming an expected proportion of 50%, 95% confidence level and 10% allowable error, the calculated sample size was 96. To account for possible non-participation, 104 students were included in the study. Students were selected from the batch using systematic sampling. SBL was conducted in smaller groups to facilitate active participation and discussion; therefore, 30 students participated in SBL sessions, while 74 students received conventional lecture-based teaching. The unequal group sizes reflected the practical requirements of the two teaching formats.

Educational intervention and data collection

Two topics were selected: incidence and prevalence and epidemiological study designs (cross-sectional, case-control and cohort studies). Students underwent a 10-item scenario-based MCQ pre-test, followed by either a structured lecture or facilitator-guided SBL session, and subsequently completed a 10-item post-test. The study followed a crossover approach, with students receiving exposure to both teaching methods across the two sessions. SBL involved structured epidemiological scenarios, group discussion, application of concepts and facilitator feedback. A Likert scale-based questionnaire was administered to assess students' perceptions of SBL. The assessment tools and SBL activities were developed according to the learning objectives and reviewed by six faculty members/subject experts from community medicine department. Content validity was assessed through expert review, and modifications were made accordingly. The scale-level content validity index (S-CVI) was 0.91.

Outcome measures

The primary outcome was improvement in knowledge, assessed by the change in pre-test and post-test scores. Gain score was calculated as post-test score minus pre-test score. Students' perceptions of SBL constituted the secondary outcome.

Statistical analysis

Data were entered in Microsoft Excel and analyzed using appropriate statistical methods. Continuous variables were expressed as mean±standard deviation (SD), while categorical variables were summarized as frequencies and percentages. Pre- and post-test scores within each teaching method were compared using the paired t-test. The mean gain scores between the lecture and SBL groups were compared using the independent-samples t-test. The assumptions of normality and independence required for parametric testing were assessed before analysis. Effect estimates were reported along with 95% confidence intervals where applicable. Perception responses were summarized using frequencies and percentages. A p value <0.05 was considered statistically significant.

The study was approved by the institutional ethics and review committee of teaching institute. Written informed consent was obtained from all participants, and participation was voluntary.

RESULTS

The impact of scenario-based learning (SBL) and traditional lecture-based teaching on students' understanding of epidemiological concepts was assessed using pre-test and post-test scores. Both teaching methods resulted in significant improvement in knowledge scores

following the intervention. However, students exposed to scenario-based learning demonstrated greater learning

gains compared to those taught through traditional lectures.

Table 1: Comparison of pre-test and post-test scores following traditional lecture and scenario-based learning.

Topic	Teaching method	Pre-test Mean±SD	Post-test Mean±SD	Mean difference	t-value (df)	P value
Topic 1 (study designs)	Traditional lecture	5.3±2.7	6.7±2.4	1.4	3.9 (73)	<0.001*
	Scenario-based learning	4.5±2.1	7.7±1.4	3.2	9.8 (29)	<0.001*
Topic 2 (incidence and prevalence)	Traditional lecture	7.0±2.3	8.5±1.5	1.5	5.1 (73)	<0.001*
	Scenario-based learning	6.7±2.5	9.3±1.0	2.6	5.6 (29)	<0.001*

*Statistically significant at $p < 0.05$.

Table 2: Topic-wise comparison of gain scores between traditional lecture and scenario-based learning.

Topic	Teaching method	N	Mean gain score ±SD	t-value	P value
Topic 1 (study designs)	Traditional lecture	74	1.29±3.04	-3.85	<0.001*
	Scenario-based learning	30	3.13±1.76		
Topic 2 (incidence and prevalence)	Traditional lecture	74	1.53±2.57	-1.91	0.062
	Scenario-based learning	30	2.57±2.50		

*Statistically significant at $p < 0.05$.

Table 3: Overall comparison of gain scores between traditional lecture and scenario-based learning.

Teaching method	N	Mean gain score ±SD	t-value	P value
Traditional lecture	148	1.49±2.90	-3.74	<0.001*
Scenario-based learning	60	2.85±2.16		

*Statistically significant at $p < 0.05$.

Table 4: Students' perception towards scenario-based learning (n=60).

Questions	Agree* (%)	Neutral* (%)	Disagree* (%)
SBL improved my understanding of epidemiology concepts	81.7	15.0	3.3
Scenarios helped me apply theoretical concepts to real-life situations	80.0	15.0	5.0
Scenario-based learning made the class more interesting	70.0	26.7	3.3
I felt actively involved during the learning session	80.0	13.3	6.7
The activity improved my critical thinking ability	80.0	16.7	3.3
SBL improved my confidence in solving epidemiology problems	85.0	13.3	1.3
Group discussion helped clarify concepts	88.3	6.7	5.0
This method should be used more frequently in community medicine teaching	73.3	20.0	6.7
Overall, I am satisfied with this learning method	86.7	8.3	5.0

*Agree = strongly agree + agree, neutral = neutral, disagree = strongly disagree + disagree.

Table 1 presents the comparison of pre-test and post-test scores following traditional lecture and scenario-based learning for the topics of study design and incidence and prevalence. A statistically significant improvement in post-test scores was observed following both teaching methods across all topics ($p < 0.001$). For the study design topic, students taught through traditional lecture demonstrated an increase in mean score from 5.3 ± 2.7 to 6.7 ± 2.4 (mean difference = 1.4, $t = 3.9$, $p < 0.001$), whereas those taught through scenario-based learning showed a greater improvement from 4.5 ± 2.1 to 7.7 ± 1.4 (mean difference = 3.2, $t = 9.8$, $p < 0.001$). Similarly, for the

incidence and prevalence topic, mean scores increased from 7.0 ± 2.3 to 8.5 ± 1.5 following traditional lecture (mean difference = 1.5, $t = 5.1$, $p < 0.001$) and from 6.7 ± 2.5 to 9.3 ± 1.0 following scenario-based learning (mean difference = 2.6, $t = 5.6$, $p < 0.001$). Overall, scenario-based learning demonstrated greater improvement in scores compared with traditional lecture for both topics.

Table 2 shows the topic-wise comparison of gain scores between traditional lecture and scenario-based learning (SBL). For the topic of study design, the mean gain score was significantly higher among students taught through SBL (3.13 ± 1.76) compared to those taught through

traditional lecture (1.29 ± 3.04) ($t = -3.85$, $p < 0.001$). For the topic of incidence and prevalence, students in the SBL group demonstrated a higher mean gain score (2.57 ± 2.50) than those in the lecture group (1.53 ± 2.57). However, this difference was not statistically significant ($t = -1.91$, $p = 0.062$). Overall, scenario-based learning was associated with greater learning gains than traditional lecture-based teaching, with a statistically significant advantage observed for the cross-sectional study topic.

Table 3 presents the overall comparison of gain scores between students taught through traditional lecture and scenario-based learning (SBL). The mean gain score was higher in the SBL group (2.85 ± 2.16) compared to the traditional lecture group (1.49 ± 2.90). Independent samples t-test revealed that this difference was statistically significant ($t = -3.74$, $p < 0.001$). These findings indicate that scenario-based learning resulted in significantly greater improvement in students' knowledge scores than traditional lecture-based teaching.

Table 4 depicts students' perceptions regarding scenario-based learning after participation in the teaching sessions. Responses were grouped into three categories: agree (strongly agree + agree), neutral, and disagree (strongly disagree + disagree). Students demonstrated highly favourable perceptions towards scenario-based learning. The highest agreement was observed for group discussions helping to clarify concepts (88.3%), followed by overall satisfaction with the learning method (86.7%) and improved confidence in solving epidemiological problems (85.0%). Additionally, 81.7% of students reported better understanding of epidemiological concepts, while 80.0% agreed that SBL facilitated application of theory to real-life situations, promoted active participation, and enhanced critical thinking skills. Furthermore, 73.3% recommended greater use of SBL in community medicine teaching.

DISCUSSION

The present study evaluated the effectiveness of scenario-based learning (SBL) compared with traditional lecture-based teaching for selected epidemiological concepts among MBBS students. Both teaching methods resulted in significant ($p < 0.001$) improvement in post-test scores; however, students exposed to SBL demonstrated consistently higher learning gains. For the topic of study design, the mean score increased by 3.2 points following SBL (1.4 in lectures), while for incidence and prevalence topic, the corresponding improvements were 2.6 and 1.5 points, respectively. Furthermore, the overall gain score was significantly higher in the SBL group than in the lecture group (2.85 ± 2.16 versus 1.49 ± 2.90 ; $p < 0.001$), indicating the educational advantage of active participation, discussion, reflection, and application of theoretical concepts to realistic situations.

Prince et al reported that active learning strategies consistently improve student engagement and academic

performance compared with passive instructional methods.⁴ Similarly, McLean et al and Thistlethwaite et al emphasized that context-based approaches enhance knowledge integration, clinical reasoning, and application of concepts through authentic learning experiences.^{3,5} These characteristics are closely aligned with the principles of scenario-based learning and may explain the higher learning gains observed in the present study.

Topic-wise analysis revealed that the difference between SBL and lecture-based teaching was statistically significant for study design (mean gain score: 3.2 versus 1.4; $p < 0.001$) but not for Incidence and Prevalence (mean gain score: 2.6 versus 1.5; $p = 0.062$). Study design concepts require interpretation, analytical reasoning, and decision-making, whereas incidence and prevalence involve relatively straightforward calculations and definitions. Similar observations have been reported by Gade et al who found that application-oriented learning approach was particularly effective in improving students' ability to apply physiological concepts to clinical situations, and by Ilgüy et al, who demonstrated greater gains in higher-order cognitive skills among students exposed to case-based instruction.^{9,12} Williams et al in a review of case-based learning, also noted that this approach is especially valuable for promoting analysis, synthesis, and problem-solving rather than simple recall of factual information.¹³ Ilgüy et al demonstrated that students taught through application-based learning performed significantly better in higher-order thinking domains than those receiving lecture-based instruction.⁹ Likewise, Srinivasan et al reported that both students and faculty preferred context-based approaches because they facilitated application of knowledge and achievement of learning objectives.¹¹

Students' perceptions towards SBL were highly favourable. Most students agreed that group discussions clarified concepts (88.3%), were satisfied with the method (86.7%), and felt more confident in solving epidemiological problems (85.0%). Over 80% also reported improved understanding, better application of theory to practice, greater participation, and enhanced critical thinking. These findings are consistent with previous studies reporting high levels of learner satisfaction with case-based and scenario-based approaches. Nair et al found that 95% of medical students perceived context-based learning as more interesting and effective than traditional lectures, while Ilgüy et al reported significantly higher student satisfaction and engagement with interactive learning approach in dental education.^{8,9} Similarly, Goldman et al demonstrated that interactive learning improved learners' confidence and perceived ability to apply knowledge in clinical situations.¹⁰ McLean et al reported that 89% of students preferred case-based learning, while Srinivasan et al observed that both students (89%) and faculty (84%) favoured case-based instruction over alternative methods.^{5,11}

The positive perceptions observed in the present study are also supported by Baek et al, who reported significant improvements in team efficacy, systems thinking, and proactive problem-solving following scenario-based learning interventions (all $p < 0.001$).⁷ Similarly, Nair et al found that medical students perceived interactive learning as more interesting and more relevant to future professional practice than traditional teaching methods.⁸ Interactive case-based workshops conducted by Goldman et al also resulted in significant improvements in learner confidence and knowledge scores.¹⁰

Collectively, these findings suggest that scenario-based approaches not only improve knowledge acquisition but also foster critical thinking, confidence, collaboration, and problem-solving skills.

The successful implementation of SBL sessions within the routine teaching schedule and the favourable student feedback observed in the present study indicate that SBL is a feasible approach for teaching epidemiological concepts in undergraduate medical education.

This study was conducted at a single institution and evaluated only selected epidemiological concepts using immediate post-test scores. The smaller SBL group size and reliance on self-reported student perceptions may also have influenced the findings.

CONCLUSION

The present study demonstrated that both lecture-based teaching and scenario-based learning (SBL) significantly improved students' understanding of epidemiological concepts. However, students exposed to SBL achieved greater learning gains compared to those taught through traditional lectures.

The advantage of SBL was particularly evident in the topic of study designs (case control, cohort and cross sectional) where significantly higher gain scores were observed. Students also expressed highly favourable perceptions towards SBL, reporting improved understanding, active participation, critical thinking, confidence in problem-solving, and overall satisfaction with the learning experience. The findings also suggest that SBL can be feasibly integrated into routine community medicine teaching with appropriate planning and faculty support.

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