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DOI: 10.4103/jehp.jehp_1046_23

Effectiveness of selected small group teaching methods for undergraduate medical students on basic concepts of epidemiology: A quasi-experimental study

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Abstract:

BACKGROUND: Teaching epidemiology to young medical students using traditional teaching techniques is fraught with myriad challenges. Incorporating innovative small group teaching (SGT) approaches that promote active learning, practical application, and critical thinking can help in overcoming these challenges.

AIM/OBJECTIVE: To identify the most effective SGT method from selected three approaches [tutorial technique (TT), problem-based learning (PBL), and fishbowl technique (FBT)] to teach the basic concepts of epidemiology to the third-year undergraduate medical students of a private medical college in Puducherry, Southern India.

MATERIALS AND METHODS: A quasi-experimental study was conducted among third-year undergraduate medical students for 6 months. The sample size was calculated to be 60 using the nMaster 2.0 sample size software. Three groups were formed with 20 students each. A pre-test, which included fifty multiple-choice questions covering topic one, was conducted for students in all three groups. An SGT session on topic one (dynamics of disease transmission) was held on the same day by different facilitators for three groups A, B, and C using the TT, PBL, and FBT, respectively. After 6 weeks of the SGT session for topic one, a post-test using the same questions was organized for all three groups to identify the effectiveness of each SGT method. The above sequence of events was followed for topic two (study designs) and topic three (investigation of disease outbreak) among all groups in the subsequent months. A written informed consent was sought from all students. The collected data was entered in MS Excel 2010 and analyzed using SPSS 21. The pre- and post-tests for all topics in all three groups were compared using a paired *t*-test, and an ANOVA test was used to find any difference between the groups.

RESULTS: The mean post-test score in each of the three groups for all topics had improved when compared with the mean pre-test score, which was significantly different between the three groups. Further, the mean score of group B (PBL group) was found to be higher than group C (FBT) but not significantly higher compared to group A (TT). The mean score of the feedback where the participants were asked to rate the overall session was found to be high in group B (PBL) followed by group A (TT).

CONCLUSION: PBL and TT were found to be an equally effective way of small group methods for teaching-learning epidemiology in medical school.

Keywords:

Fishbowl technique, medical education, problem-based learning, quasi-experimental study, tutorials

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Received: 17-07-2023
Accepted: 04-10-2023
Published: 29-04-2024

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How to cite this article: Vasudevan J, Chellamuthu L, Anandaraj L, Chalil AK. Effectiveness of selected small group teaching methods for undergraduate medical students on basic concepts of epidemiology: A quasi-experimental study. J Edu Health Promot 2024;13:143.

Introduction

Medical education has evolved and faced continuous changes to meet the demands of medical practice in the twenty-first century.^[1] The current Indian medical curriculum focuses on competency-based education, which encourages active, skill-based, and practice-oriented learning. This era's medical education requires student engagement and interaction through small group teaching (SGT) methods rather than formal didactic lectures.^[2] An SGT has been described as a team-based approach to learning. The group size can range from 3 to 20 students.^[3] SGT modalities promote student-centric learning when compared with the conventional teacher-centric model.^[4] A well-planned SGT session offers a structured approach for both facilitators and learners.^[5] The SGT methods enable learners to be more independent and self-reliant by helping them in retaining the subject concepts for a longer period of time. Additionally, it enables the learner to assess their own capacity for learning.^[3] The SGT strategy makes a medical student to be more applied and practically sound and communicates better with patients, peers, paramedical staff, and community organizations.^[6] Many SGT techniques have been employed earlier like tutorials, seminars, group discussions, and workshops. Recently, many other newer modalities of SGT have been introduced in medical education such as buzz session, fishbowl technique (FBT), jigsaw group technique, reflective writing, problem-based learning (PBL), and case-based learning.^[7] Teaching medical students epidemiology is essential to equip them with a broader understanding of disease patterns, prevention strategies, bio-medical research methodologies, and population health considerations. It empowers them to make informed decisions, contribute to clinical research and public health, provide high-quality patient care based on evidence, and have a comprehensive understanding of health and diseases.^[8] Teaching epidemiology to young medical students using traditional teaching techniques is fraught with myriad challenges, namely, passive learning, limited practical application skills, failure to grasp complex statistical concepts, failure to keep abreast of rapid evolutions in the field, time constraints, limited interactivity, and feedback from the students. Further, the passive approach fostered by conventional teaching methods, namely, didactic lectures and textbook-based learning, may not always emphasize the practical relevance of epidemiology. Moreover, it might even result in reduced attention and retention of complex epidemiological concepts.^[9] It thus becomes pertinent to explore newer and more engaging SGT techniques to capture and engage the interest of the millennial student population characterized by their short attention spans and exploratory natures. Incorporating innovative SGT approaches that promote active learning, practical

application, and critical thinking can help in overcoming these challenges. Many studies earlier had researched the effectiveness of any one particular SGT method or compared a single SGT technique with conventional didactic lectures for teaching-learning undergraduate medical students in India,^[10-15] whereas the present study selected some of the newer and innovative SGT methods, namely, the tutorial technique (TT), PBL, and FBT, to identify the most effective one for teaching-learning the basic concepts of epidemiology for the third-year undergraduate medical students of a private medical college in Puducherry, Southern India.

Materials and Methods

Study design and setting: A quasi-experimental study was conducted among the third-year undergraduate medical students of a private medical college in Puducherry, Southern India, for a period of 6 months between November 2022 and April 2023.

Study participants, sampling technique, and sample size: Undergraduate medical students from the sixth semester who consented to participate were included in the study. The sample size was calculated using the nMaster 2.0 sample size software (formula for comparison of two proportions: Paired—Before/After),^[16] where α was considered to be 0.05 and β value or power of the study was set at 80%. The value of π_A was taken as 10% (students' baseline level of knowledge), and π_B was assumed to be 60% (improvement in students' knowledge after the SGT). The minimum required number of students per group was calculated as 16 students. The students who consented to participate were ranked based on their second-year marks into high, average, and under-performers. These students were assigned to one of the three groups, namely, A, B, and C, so that the proportion of high, average, and under-performers was distributed equally in each group to ensure comparability. Thus, three groups were formed with 20 students each, which led to a final sample size of 60 students.

Data collection tool and technique: The three SGT techniques chosen for comparison were TT, PBL, and FBT. The tutorial intervention was a class in which the facilitator or tutor first provided a lecture for 30 minutes on the selected epidemiological topic to a small group of 20 students, followed by an essentially interactive discussion between the tutor and students. The lecture did not involve any audio-visual aids by the tutor. The discussion lasted about 1 hour and 30 minutes, with a significant proportion of the interaction coming from the learners. The discussion also included clarification of doubts and exploring different styles of learning.

The PBL intervention was providing a design of a real-world problem scenario to the small group of 20 students based on the epidemiological topic. The study material covering the theoretical aspects and concepts of the selected epidemiological topic was distributed to the students before the PBL session. Around five real-time problems or scenarios were provided to the students, and discussion on those scenarios was carried out during the PBL session. Each problem or scenario discussion lasted for 20 minutes. The given problem or scenario acted as a trigger for self-directed and collaborative learning for the students.

The FBT intervention was a combination of 30 minutes of interactive lecture followed by discussion using FBT. The fishbowl activity was conducted for 1 hour and 30 minutes among 20 students. Those 20 students were divided into inner and outer circles (i.e., 10 in each circle) by assigning them respective numbers as one and two; all the students numbered one formed the inner circle, and all two formed the outer circle. The inner circle was given an epidemiological topic for discussion based on the lecture. They were instructed to hold a discussion with the representative members of their group for about 20 minutes. The outer circle was asked to observe the inner circle, and they were called the fish watchers. Fish-watchers were instructed to listen carefully to their fish and take notes on their fish's contribution to the discussion. Later, the places of the inner and outer circles were reversed, and the same topic was given for discussion for 20 minutes. The discussion was guided by the facilitator and followed by a plenary presentation for 10 minutes. One student from each circle was asked to report on the active participation of the other circle in the discussion.

A pre-test, which included 50 multiple-choice questions covering topic one (dynamics of disease transmission), was conducted for students in all three groups. An SGT session on topic one was held on the same day by different facilitators for three groups A, B, and C using TT, PBL, and FBT, respectively. The SGT sessions for each group lasted for 2 hours. After 6 weeks of the SGT session for topic one, a post-test using the same questions was organized for all three groups to identify the effectiveness of each SGT method. In addition, a feedback form consisting of ten questions was employed to collect perceptions about the SGT sessions from the students in all three groups [Table 1]. The facilitators who handled the SGT sessions had completed the Revised Basic Course Workshop as mandated by the National Medical Council, India. The three facilitators carried out the sessions for the same groups on three topics. The above sequence of events was followed for topic two (study designs) and topic three (investigation of disease outbreak) among all groups in the subsequent months. Figure 1 depicts the

Table 1: Feedback form: Students' perception of the SLT methods for the three topics

Feedback questions	1	2	3	4	5
q1 Specific learning objectives of the session largely achieved					
q2 Integration of topics covered with other epidemiological topics					
q3 Usefulness of learning resources and material					
q4 Gaining applied knowledge of the topic					
q5 Facilitation of self-directed learning					
q6 Gaining robust retrievable/reproducible knowledge					
q7 Deep learning with clear concepts					
q8 Interactive communications					
q9 Elicited active participation of the students					
q10 Overall effectiveness of the session					

1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree

flow of events in the study and gives an overview of the study methodology.

Data analysis: The collected data was entered in MS Excel 2010 and analyzed using Statistical Package for the Social Sciences (SPSS) 21. The data has been presented in the form of numbers and percentages for qualitative variables and mean and SD/median and IQR for quantitative variables. Suitable statistical tests (according to the nature and distribution of the data, e.g., Chi-square test) were applied to assess the significance of the study findings. The pre- and post-tests for all topics in all three groups were compared using a paired *t*-test, and an Analysis of Variance (ANOVA) test was used to find any difference between the groups. Statistical significance was set at a *P* value <0.05.

Ethical consideration: A written informed consent was sought from all students. The scientific and ethical committee approval was obtained from Indira Gandhi National Open University (IGNOU), New Delhi, India (Ref no. SOE/PGDHE/Project-15), since this study was done as a part of the Postgraduate Diploma in Higher Education by the first author.

Results

The age, gender, and second-year marks of the students in each of the three groups were compared before the pre-tests. There was no difference in the gender and age composition among the groups based on the Chi-square test performed. Also, the ANOVA test showed there was no significant difference between the three groups in their second-year marks. Table 2 reflects the effectiveness of different interventions in three groups for all topics. The mean post-test score in each of the three groups for all topics has improved when compared with the mean pre-test score and was found to be statistically significant (*P* value <0.05). A comparison of the three groups based on mean post-test scores in all topics has

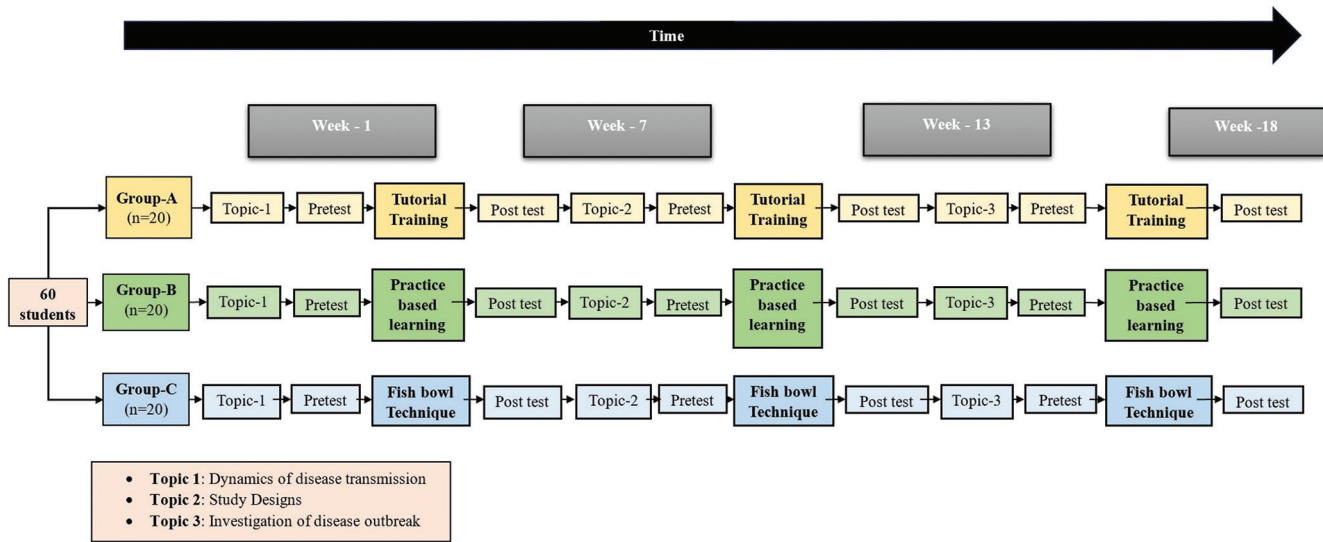


Figure 1: Flow of events in the study

Table 2: Effectiveness of different interventions in three groups for all topics

Topic	Test	A	B	C	F ratio	P
One	Pre-test	11.35+3.72	11.65+3.88	11.3+3.76	0.05	0.951
	Post-test	17.95+4.44*	20.45+3.41*	16.25+3.64*	6.003	0.004
Two	Pre-test	14.65+5.04	14.2+4.26	13.8+4.23	0.177	0.839
	Post-test	19.8+2.67*	21.65+3.53*	17.75+2.97*	8.042	<0.001
Three	Pre-test	14.9+3.58	12.9+3.82	13.5+4.32	1.37	0.262
	Post-test	21.2+4.3*	22.95+3.66*	17.45+3.09*	8.042	<0.001

*P<0.05 significantly differs from the corresponding pre-test in all three groups

Table 3: Comparison of three groups based on post-test marks in all topics

Groups	Topic one		Topic two		Topic three	
	Mean difference	P	Mean difference	P	Mean difference	P
A						
B	-2.5	0.111	-1.85	0.148	-1.489	0.304
C	1.7	0.351	2.05	0.097	3.191	0.006
B						
C	4.2	0.003	3.9	<0.001	4.680	<0.001

*P<0.05 considered to be statistically significant

been provided in Table 3. The mean post-test scores of the three groups showed that there was a significant difference between the groups. Further, the mean score of group B (PBL group) was found to be higher than group C (FBT) but not significantly higher compared to group A (TT). Table 4 describes the comparison of the three groups, interventions, and topics by MANOVA test. There was a significant difference between the three groups as well as between the mean pre- and post-test scores in each group. Further, it showed that the interaction between the groups as well as mean pre- and post-test scores was significantly differing, which implied that the mean score of group B (PBL) was significantly higher compared to group C (FBT). Figure 2 illustrates the mean scores of the questions

in the feedback form filled out by the students at the end of each session for all topics. The mean score of the feedback where the participants were asked to rate the overall session was found to be high in group B (PBL), followed by group A (TT), and the least score was given by group C (FBT).

Discussion

The medical education has been going through various adaptable changes in the method of delivering knowledge and skills to the learners.^[17] Due to a shorter attention span, the vastness of the subject, and the ever-updating nature of medicine, newer SGT methods such as flipped classrooms, case-based learning, tutorials, and FBTs have gained attention and popularity among teachers and learners.^[18,19] In this study, the aim was to identify the most effective SGT method for teaching-learning the basic concepts of epidemiology to the third-year undergraduate medical students of a private medical college in Puducherry, Southern India.

In the current study, the age, gender, and second-year marks of the students in each of the three groups were compared before the pre-tests. A study by Bihari et al. from Azamgarh, Uttar Pradesh, India, on the

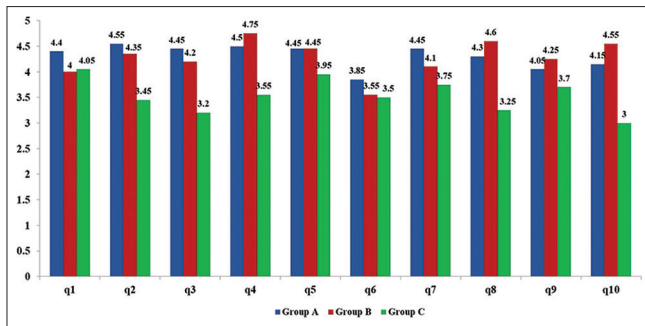


Figure 2: Mean value of feedback scores received in all three groups

effectiveness of PBL for biostatistics among medical students also ensured the similarity of the groups based on gender and age before the intervention.^[15]

In the present study, the mean post-test score in each of the three groups for all topics has improved when compared with the pre-test mean mark and was found to be statistically significant (P value <0.05). Similar findings have been reported by other researchers in medical education. A study by Bobby *et al.*, Puducherry, India, had conducted a pre-test consisting of multiple-choice questions (MCQs) in the Biochemistry subject for first-year medical students. Later, a set of incorrect statements related to the topic was given to the students, and they were asked to identify the mistakes and correct them in a small group discussion. The effectiveness of “identification of mistakes and their correction by small group discussion” on students was evaluated by a post-test with the same set of MCQs. The mean post-test marks were significantly higher among all three groups compared to the pre-test marks.^[20] A research work by Saleh from Erbil, Iraq, had conducted a problem-solving interactive class in a medical school for 31 students. The small interactive session was assessed by the pre- and post-test scores of the students, and it was found that the difference in the two mean scores was statistically significant.^[21]

The mean post-test scores of the three groups showed that there was a significant difference between the groups. Further, the mean score of group B (PBL) was found to be higher than group C (FBT) but not significantly higher compared to group A (TT). In a few studies, problem- or case-based learning was found to be a more effective method for increasing medical students’ engagement in the class, improving their performance, and enhancing their clinical skills.^[22,23] In another study, the present student population has been cited as Generation Z, who has been documented as the most open-minded, inclusive, and technologically savvy. An ideal, evidence-based option to fill the skill gaps regarding critical thinking and perseverance and accentuate the strengths of Generation Z was identified

Table 4: Comparison of the groups, interventions, and topics by MANOVA test

Cases	df	Approx. F	Trace Pillai	Num df	Den df	P
(Intercept)	1	1622.191	0.978	3	112	<0.001
Group	2	3.206	0.157	6	226	0.005
Time	1	63.204	0.629	3	112	<0.001
Group * Time	2	2.598	0.129	6	226	0.019
Residuals	114					

as PBL, according to the authors.^[24] A study by Begum *et al.* showed that interactive teaching–learning like case-based learning was found to be satisfactory, and the authors had recommended the introduction of interactive teaching–learning methods in regular classes of undergraduate medical education curriculum.^[25]

The mean score of the feedback where the participants were asked to rate the overall session was found to be high in group B (PBL), followed by group A (TT), and the least score was given by group C (FBT). Similar findings were documented by Bihari *et al.*, where the mean score of overall satisfaction level for teaching–learning statistics in medical school was more for PBL groups in comparison to traditional teaching techniques.^[15]

The major strength of this research was the study design. It was a quasi-experiment that was carried out after ensuring comparability based on age, gender, and second-year marks among three groups of students. In addition, feedback was received from learners for all sessions. However, there were a few limitations in this study.

Limitations and recommendations

The study was limited to only third-year undergraduate medical students. Due to its feasibility, we had to restrict our study population. The long-term effect of the SGT methods was not performed, which could have compared the retention capacity of each of the teaching methods. Moreover, the same facilitators were not involved in SGT among all three groups to cover a single topic. Further, future studies can be carried out on the long-term effectiveness of PBL and tutorials for teaching epidemiology to all medical and para-medical students in India. Also, a mixed-method study design can be suggested in the future to capture the learner’s perspective and insight on the same.

Conclusion

In the present study, three different SGT techniques, namely, TT, PBL, and FBT, were compared among three groups of students. The mean post-test score in each of the three groups for all topics has improved when compared with the mean pre-test score. The

mean post-test scores of the three groups showed that there was a significant difference between the three groups. Further, the mean score of group B (PBL group) was found to be higher than group C (FBT) but not significantly higher compared to group A (TT). The mean score of the feedback where the participants were asked to rate the overall session was found to be high in group B (PBL), followed by group A (TT). Thus, PBL and TT were found to be equally effective way of small group methods to be employed for teaching-learning epidemiology in medical school.

Acknowledgement

The study was part of the first author's project submitted toward a Postgraduate Diploma in Higher Education from the Indira Gandhi National Open University, New Delhi, India. The administrative support provided by the institute, guidance from the faculty, and co-operation from the student participants in carrying out this study are gratefully acknowledged.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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