International Journal of Research in Medical Sciences
Kartikeyan S et al. Int J Res Med Sci. 2016 Jan;4(1):272-277
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20160042

Research Article

Retention of case-based learning on infectious diseases by third-year medical students

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Received: 24 November 2015
Accepted: 18 December 2015

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ABSTRACT

Background: Undergraduate medical students infrequently see a variety of cases of infectious diseases during their batch-wise rotatory clinical postings. Traditional didactic teaching resulted in lack of learner-centred teaching, lack of in-depth knowledge and less retention of learning. The main aim and objective of this complete-enumeration, before-and-after study (without controls) is to employ case-based learning (CBL) as an adjunct to traditional didactic lectures (TDL) for teaching infectious diseases to third-year undergraduate medical students to study the retention of knowledge by comparing the cognitive domain scores in pre- and post-tests.
Methods: After obtaining ethical permissions and written informed consent, TDLs were delivered to give a preview on ten topics (selected by lottery system from topics in syllabus) and a pre-test was conducted after TDL. After pre-test, CBL sessions were conducted jointly by two facilitators (using identical CBL modules) in two randomly-assigned sub-groups (n=28) to enable discussion. After CBL, two post-tests (identical to pre-test) were conducted at intervals of one and six months to determine the levels of retention of learning.
Results: The differences in the student-wise and question-wise scores in the pre-test and one-month post-test and that between the pre-test and six-month post-test were highly significant. However, the difference between the mean scores in one-month and six-month post-test were not statistically significant.
Conclusions: CBL modules using case scenarios were found to enable learning. The marginal differences between the scores in the one-month and six-month post-tests indicate that a single post-test administered six months after the educational intervention (CBL) would be adequate.

Keywords: Case-based learning, Retention of learning, Cognitive domain

INTRODUCTION

The principles of adult learning need to be applied while teaching medical students. Adults readily learn details that have immediate relevance and pragmatic applicability in work-related situations.[1] Case-based learning (CBL) is a discussion-based small-group learning technique that employs a guided inquiry method and provides more structure during small-group sessions. CBL enhances comprehension and acquisition of cognitive skills since learning is positioned within its context. CBL has been compared with the traditional didactic lecture (TDL) format by various authors.[2-5]

An American study has reported that learners and faculty overwhelmingly preferred CBL (guided inquiry) over problem-based learning that involves open inquiry.[6] CBL has been found to be a feasible and an effective way to conduct inter-professional multidisciplinary health science education. [7] Students exposed to CBL were found to be more interactive during class; however they opined that the lecture method was more helpful in preparing for

a written exam. [5] CBL is case-specific and is best carried out in a multidisciplinary context.[8] Since the packed medical curriculum necessitates efficient use of student and faculty time, the student-centered case-based learning (CBL) format offers an alternative learning model.[6]

This study, using CBL as an adjunct to TDL for teaching infectious diseases to undergraduate medical students, was conducted because it was observed that undergraduate medical students infrequently see a variety of cases of infectious diseases during their batch-wise rotatory clinical postings due to seasonal occurrence of infections and transfers of infectious cases to a specialized infectious disease hospital, soon after diagnosis. The observed consequences of paucity of cases of infectious diseases were in lack of learner-centred teaching, lack of in-depth knowledge and less retention of learning imparted through TDL. The objectives of this study were to evaluate the cognitive skills acquired by the participating students after attending TDL (using a pre-test) and to study the retention of cognitive skills after using CBL as the educational intervention (using identical post-tests at one-month and six-month intervals).

METHODS

The complete-enumeration, before-and-after type of study (without controls) was conducted in 2015 in a municipal medical college in Kalwa, Thane, located about 30 kilometers from Mumbai city in the state of Maharashtra in Western India. After obtaining permissions from the Institutional Ethics Committee (IEC) and institutional authorities for conducting the study, the purpose of the study was explained to third year medical students enrolled for the Bachelor of Medicine, Bachelor of Surgery (MBBS) course. Written informed consent was taken from students (n=56) who were willing to participate in the study.

From a list of topics on infectious diseases in the MBBS syllabus, simple random sampling (lottery method) was used to choose ten topics (enteric fever, pin worm infestation, giardiasis, measles, influenza, malaria, dengue, round worm infestation, tuberculosis, and brucellosis). TDLs were delivered to give a preview of the topic. Pre-test, conducted after the TDLs, comprised ten questions (ten marks per question) pertaining to these ten topics. The total marks obtainable were 100.

For CBL, participating students were randomly assigned to two sub-groups (n=28) to enable small-group discussion. Each sub-group was identically exposed to case-based learning modules using case scenarios for student learning. The same facilitators (SK and AAM) jointly guided the discussion and encouraged participation of all students in each sub-group. Two post-tests were conducted one month and six months after case-based teaching to determine the levels of retention of learning. Post-test questionnaires were identical to that of the pre-test. The scores from students in the two sub-groups were amalgamated for analysing results of the pre and post-tests.

The outcome studied was the difference in cognitive domain scores after attending TDL (by a pre-test) and CBL (by post-test after one month). An additional identical post-test was administered after six months to study the level of retention of learning. The pre-test and post-test scores were tabulated and statistically analysed using open source software for epidemiologic statistics - OpenEpi Version 3.03a.[9] Confidence interval (CI) was stated in the range of [Mean – (2 x Standard Error)] to [Mean + (2 x Standard Error)].

RESULTS

Since all the 56 students were jointly exposed to the same set of facilitators (two subject experts) for CBL and took identical pre-and post-tests, the probable effects of confounding variables would be nullified.

Student-wise scores

The mean scores obtained by the students in the pre- and post-tests are depicted in Table-1. Highly significant differences ($p<0.0000001$) were observed between the mean scores obtained are as follows; [a] the pre-test and one-month post-test and [b] the pre-test and six-month post-test. However, the difference between the mean scores in one-month and six-month post-test were not statistically significant (Table 1). This suggests that a single post-test, administered after six months is adequate to evaluate the effect of the educational intervention (CBL). Such a post-test may be flexibly timed as per convenience of the teacher and the taught.

50% of the students scored between 39 (median) and 29 (minimum) in the pre-test. However, all the parameters (minimum, first quartile, median, third quartile and maximum) increased in the post-test, with insignificant differences between the one-month and six-month evaluations (Figure 1). This indicates good retention of learning after six months.

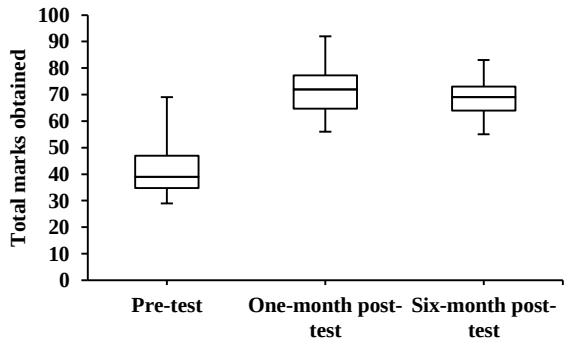

Figure 1: Student-wise scores in pre-test and post-tests.

Question-wise scores

The question-wise mean scores obtained by students along with standard deviation and standard error of difference between means is depicted in Table 2. Highly significant differences ($p<0.0000001$) were observed between the mean scores obtained during pre-test and one-month post-test and that between the pre-test and six-month post-test. However, the differences between the one-month and six-month post-test scores were statistically significant only for question No 3 and 7 (Table 2).

Boxplots for pre-test scores

The lower whiskers are not seen in the box plots for question No. 1 and 8 since the value of the first quartile and that of the minimum score are identical (3 and 2, respectively), implying that more than 25% of the students had the lowest score in these questions during the pre-test. The median is not seen in box plot for question No. 3 because the values of the median score and the third quartile are identical (viz. 5). Since the value of the first quartile is the same as that of the median score (viz. 4), the median is not seen in the box plot for question No. 10 (Figure 2).

Table-1: Statistical significance of student-wise scores.

Parameter	Pre-test	One-month post-test	One-month post-test	Six-month post-test	Pre-test	Six-month post-test
N	56	56	56	56	56	56
Mean	41.446	71.839	71.839	68.893	41.446	68.893
SD	8.999	7.903	7.903	6.254	8.999	6.254
CI	39.04 – 43.85	69.73 – 73.95	69.73 – 73.95	67.22 – 70.56	39.04 – 43.85	67.22 – 70.56
Z value	18.990		2.188		18.742	
p value	<0.0000001 Highly significant		0.4854 Not significant		<0.0000001 Highly significant	

SD = Standard deviation; Z = Relative deviate; n = No. of students; CI = Confidence Interval.

Table 2: Statistical significance of question-wise scores.

Parameter		Question Numbers									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Pre-test	Mean	4.29	3.82	4.34	4.41	3.95	4.29	4.02	3.71	4.23	4.39
	SD	1.107	1.441	1.180	1.108	1.623	1.091	0.963	1.461	1.414	1.139
OMPT	Mean	7.14	7.25	7.09	7.13	7.00	7.13	7.30	7.00	7.50	7.30
	SD	1.086	1.083	1.066	1.113	1.095	1.207	1.205	1.095	1.236	1.174
SEDM	Z	13.79	14.23	12.94	12.90	11.70	13.10	15.90	13.50	13.00	13.30
	CI	6.85 – 7.43	6.96 – 7.54	6.81 – 7.37	6.83 – 7.43	6.71 – 7.29	6.81 – 7.45	6.98 – 7.62	6.71 – 7.29	7.17 – 7.83	6.99 – 7.61
	p value	< 0.0000001 **									
OMPT	Mean	7.14	7.25	7.09	7.13	7.00	7.13	7.30	7.00	7.50	7.30
	SD	1.086	1.083	1.066	1.113	1.095	1.207	1.205	1.095	1.236	1.174
SMPT	Mean	6.93	6.86	6.70	6.88	6.73	6.77	6.84	6.82	7.18	7.20
	SD	1.024	1.069	1.008	1.113	0.842	1.128	1.023	1.064	1.064	1.119
SEDM	Z	1.074	1.932	2.004	1.189	1.451	1.618	2.198	0.875	1.475	0.494
	CI	6.66 – 7.20	6.57 – 7.15	6.43 – 6.97	6.58 – 7.18	6.50 – 6.96	6.47 – 7.07	6.57 – 7.11	6.54 – 7.10	6.90 – 7.46	6.90 – 7.50
	P value	0.285	0.054	0.046*	0.234	0.147	0.105	0.028*	0.379	0.667	0.624
Pre-test	Mean	4.29	3.82	4.34	4.41	3.95	4.29	4.02	3.71	4.23	4.39
	SD	1.107	1.441	1.180	1.108	1.623	1.091	0.963	1.461	1.414	1.139
SMPT	Mean	6.93	6.86	6.70	6.88	6.73	6.77	6.84	6.82	7.18	7.20
	SD	1.024	1.069	1.008	1.113	0.842	1.128	1.023	1.064	1.064	1.119
SEDM	Z	13.11	12.66	11.37	11.70	11.40	11.80	15.00	12.90	12.50	13.10
	CI	6.66 – 7.20	6.57 – 7.15	6.43 – 6.97	6.58 – 7.18	6.50 – 6.96	6.47 – 7.07	6.57 – 7.11	6.54 – 7.10	6.90 – 7.46	6.90 – 7.50
	p value	< 0.0000001 **									

* Statistically significant; ** Highly significant,SD = Standard deviation; SEDM = Standard error of difference between two means; Z = Relative deviate; OMPT = One-month Post-test; SMPT = Six-month Post-test; CI = Confidence Interval.

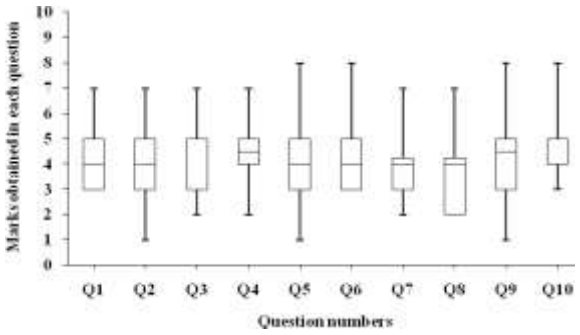

Figure 2: Question-wise scores in pre-test.

Boxplots for one-month post-test scores

The median is not seen in box plot for question No. 2 since the values of the median and the third quartile are identical (viz. 8), implying considerable improvement over the pre-test score in the same question. Lower whisker is not seen in box plot for question No. 8 because the value of the first quartile coincides with that of the median suggesting that there was not much difference as compared to the pre-test scores in this question. The median values are not seen in the box plots for question No. 9 and 10 since the median has merged with the third quartile indicating considerable improvement over the pre-test scores (Figure 3).

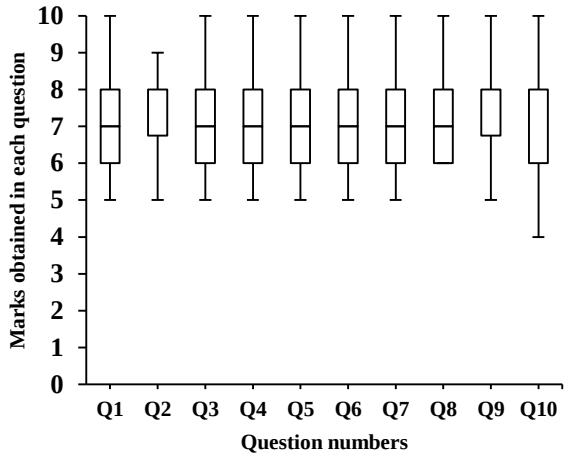

Figure3: Question-wise scores in one-month post-test.

Boxplots for six-month post-test scores

The medians are not seen in box plots for question Nos. 3, 5 and 6 since the values of the medians and the third quartiles are the same (viz. 7), indicating that the scores of 25% of the students had decreased as compared to their one-month post-test in these questions. But the median is the same or the difference is insignificant suggesting that the distribution approximates a normal distribution (Figure 4). This finding emphasizes the importance of periodic re-training and the need for continuing the CBL format as a regular method of teaching.

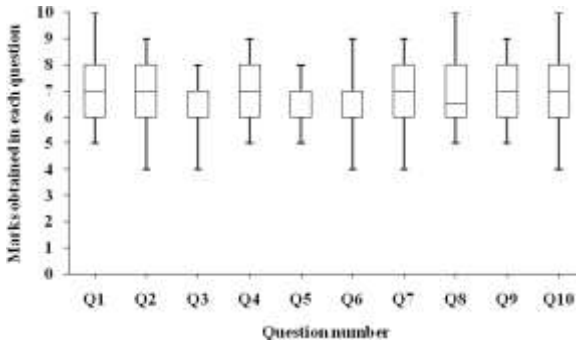

Figure 4: Question-wise scores in six-month post-test.

Mean question-wise scores

The line graph (Figure 5) reveals considerable improvement in average scores in all questions between the pre and post-tests.

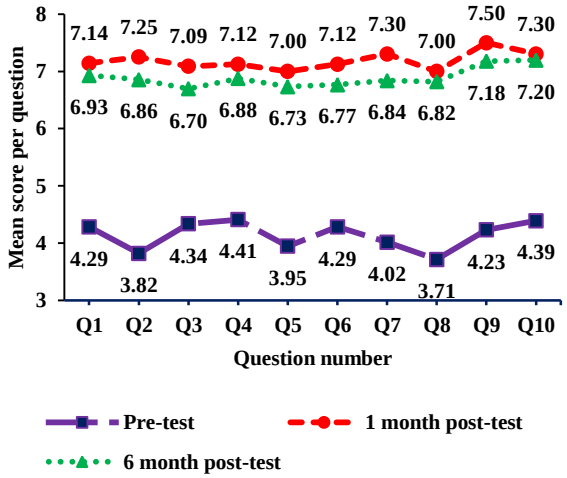

Figure 5: Mean question-wise scores in pre-test, one-month and six-month post-tests.

DISCUSSION

Learning retention is the ability to maintain the availability of acquired knowledge so that it may be accessed for use at a later time.[10] The long-term retention of knowledge and skills is dependent on multiple factors, such as complexity of the task, time limits, stress, individual aptitude, and amount of original learning.[11] For retrieval, it has been suggested that the training sessions should employ several contexts and situations for creating retrieval "hooks." Knowledge situated in individual experience that is meaningful to the learner is more apt to be retained providing the requisite "hooks" for retrieval.[10]

CBL has been found to allow students to delve into real or virtual situations and during analysis and discussion of alternative solutions, they understand complicated issues and analyse them more effectively.[12] In the present study, the marginal differences between the scores at the one-month and six-month post-tests indicate that a single post-test administered after the educational intervention (CBL) is adequate. Conversely, the post-tests conducted immediately after a training session also seem justified in the light of this finding. CBL has been reported to produce a significant improvement in medical student learning and retention as compared to the TDL format.[2,3,5] A study using interactive medical software revealed that long-term improvement from baseline knowledge was greater in the experimental group, when compared to the control group.[2]

In the present study, both facilitators were experienced subject experts. According to Garvey et al, since students assume responsibility for their own learning in the CBL format, the facilitator should not provide information but ought to initiate discussion and encourage student participation.[13] Hay, Katsikitis have reported that the mean score was found to be higher in student examination results when facilitated by subject-expert tutors, in comparison to that when facilitated by non-experts, however, tutors who were not subject-experts but trained in facilitation skills were found to be able to provide greater student-tutor flexibility as compared to their subject-expert counterparts.[14]

TDL imparts theoretical knowledge that is restricted to the cognitive domain. The purpose of education is to achieve transfer of learning (application of knowledge across a variety of situations, domains, and contexts). Positive transfer requires the activation of the learner's prior knowledge.[15] Discussions during CBL sessions result in reflection and self-learning that enables transfer of previously learned experiences and prior knowledge. When a satisfactory "depth" of knowledge is acquired, learners are able to generalize their knowledge to a broad range of contexts and to apply it in practical settings.[16] Furthermore, during CBL; students discuss and give valid justifications for various probable diagnoses and investigations. Since these discussions help them realise the implications of ordering unnecessary and expensive investigations in resource-poor settings, their application of knowledge would also reach out to the affective domain.

Literature search for studies on cost-effectiveness of CBL for medical students were not successful. Bransford et al have reported that intensive hands-on practical training for US Air Force technicians has been reported to be more cost-effective and time-saving, as compared to on-the-job experience.[15] Limitations of the present study were that it was conducted on one batch of 56 third-year medical students and only ten randomly selected case scenarios were included for CBL.

CONCLUSION

CBL modules using case scenarios were found to enable learning. The marginal differences between the scores at the one-month and six-month post-tests imply that a single post-test after CBL is adequate and that learning was retained even after six months.

Part of Project Work for Fellowship in Medical Education (2014-2015) conducted by GSMC-MCI Faculty Development Centre at Seth G. S. Medical College, Mumbai - 400 012, India

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Kartikeyan S, Malgaonkar AA. Retention of case-based learning on infectious diseases by third-year medical students. Int J Res Med Sci 2016;4:272-7.