Research

Traditional Versus a Modified Problem-based Learning Activity: Is There a Difference in Student Knowledge Retention?

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Abstract

Objective: This comparative study of a modified problem based learning activity examined the knowledge retention immediately after instruction and at six weeks post-instruction in two groups of students who were presented patient information either through a teacher-led lecture or student-directed patient interaction.

Methods: Eighty-four students were randomly divided into two groups; active participation versus didactic. Students were provided information on a patient with neurological signs and symptoms. This was done either through a teacher-led verbal and written presentation of the case or a collaborative student directed thorough history taking and examination using a standardized patient.

Results: The majority in both groups reported that they would retain information if they were actively involved in the learning process (91% and 94%, respectively). Overall, the group that was able to interact with a patient during a clinical simulation scored statistically significantly higher on both Test 1 (CI, 0.2-1.9) and Test 2 (CI, 0.3-1.7).

Discussion: Problem based learning activities include varying aspects of student participation. Students report higher satisfaction with activities in which they actively participate. There is a paucity of research demonstrating that factual knowledge retention increases when students are actively involved.

Conclusion: Overall, this study suggested that there may be differences in knowledge retention when instruction is provided actively versus didactically.

Introduction

Problem-based learning (PBL) has been used in medical education for over 40 years.[1] It was initially developed at McMaster University as a way to address the problems with teacher-centered and discipline-based learning which failed to prepare students to solve clinical problems or to develop life-long learning skills.[1] In general, PBL is a student centered instructional strategy which encourages student understanding of underlying concepts and principles by identifying issues raised while solving specific problems.[2] PBL requires students to integrate critical thinking skills into all areas of learning.[3] Problem-based learning is student-centered as opposed to faculty-centered[4] and consists of small groups of students discussing a problem with a tutor or faculty facilitator who acts as a guide.[4-6] Seven classical steps of PBL described by Wood in 2003 include: 1) identification and clarification of unfamiliar terms, 2) definition of the problem or problems, 3) discussion of problem with suggestions of possible explanations based on prior knowledge, 4) arrangement of explanations into tentative solutions, 5) formulation of learning objectives (decision on what information is needed), 6) information gathering, and 7) application of the information (group shares the results). [7]

In chiropractic education, Shreve describes a hybrid curriculum that integrates traditional lecture-based methods and problem-based learning.[8] He notes the importance of chiropractic colleges producing doctors not only with technical and scientific knowledge but also the ability to critically think, communicate effectively and to eventually become lifelong learners.[8] Hawk et al. describes implementation of problem-based learning activities consisting of small group discussions, self-study assignments and group projects in addition to traditional lecture-based teaching into a course on wellness at a chiropractic college. The authors stated the positive benefits of this experiential learning.[9] In 1996, National University of Health Sciences (NUHS) implemented a PBL curriculum in which basic and clinical sciences were integrated. This program used a mix of lectures, small group interactions, large group discussions and self-directed learning. Researchers demonstrated that with the implementation of the PBL curriculum students increased their overall performance on the National Board of Chiropractic Examiners Part I exam as well as on the individual basic science disciplines.[10]

Traina et al. in 1994 discussed the use of standardized patients in chiropractic education. They noted that chiropractic education had traditionally followed the lecture/lab format for instruction and it was important to incorporate problem-based teaching methods early in the educational process. They described how to design a case, train standardized patients and assess the student encounter. They noted the opportunities that standardized patients add to the curriculum in large and small group settings as well as in one-on-one situations.[11] Wood also noted that modified PBL techniques may be introduced using standardized patients as the stimulus for learning in clinical medical education[7].

In 2003, Herzig et al. addressed the question as to whether problem based learning affected long term factual retention. A small group problem based learning activity was implemented into a traditional, large lecture based curriculum. A written test was given to the participants immediately after the activity, and after 18 months as a mandatory summative exam and at 27 months as a non-scheduled formative exam. The researchers concluded that in their small scale trial (n=90), there was no difference in the factual knowledge among the PBL group and the lecture based learning group.[12] Koh et al. completed a systematic review on the effects of problem-based learning on physician competencies after graduation and concluded that positive effects are demonstrated in the area of social and cognitive dimensions.[13]

Given the continual push for student centered learning in medical education, the purpose of our research was to assess the impact of a modified problem based learning activity on factual knowledge retention in a clinical science course traditionally taught by an instructor in a large class lecture format.

Methods

This comparative study examined the knowledge retention immediately after instruction and at six weeks post-instruction in two groups of students who were presented patient information either through a traditional teacher-led lecture or student-directed patient interaction. The specific aims were to, 1) compare students' performance on a written examination, measuring understanding of content immediately after a traditional lecture with a power point presentation of a patient with a clinical problem versus an activity using information obtained from a standardized patient during a clinical encounter, 2) compare the students' retention of the material six weeks later using the same written examination as described in the previous aim; and 3) compare the students' opinion about the two presentation methods by means of a survey after the conclusion of the activities.

Study Participants

All students in the Clinical Neurology course were provided the opportunity to participate in the activity. General information regarding headaches and more detailed information regarding temporal arteritis was presented. The Clinical Neurology course is currently taught in the sixth trimester (final trimester, second year) as a requirement for the Doctor of Chiropractic degree. The information was presented as either a student-centered clinical activity or traditional didactic lecture. Participation was voluntary; if a student chose to opt out, he or she was to be provided with the same material in written format. The participants were randomly assigned to either the clinical or didactic group. The Institutional Review Board approved the project. Students and standardized patients gave their informed consent to participate in the activity.

Activity

During the sixth week of the trimester, all students present (n=84) were offered participation in the activity. All of the students present chose to participate and received a 1-hour introductory lecture on headaches (types, signs, symptoms, differential diagnosis) by their regular Clinical Neurology instructor. The instructor presented the material in the same manner as all new material was presented including an introduction to general concepts, headache classification, demographics and pathological diagnosis rates and public health ramifications. Next, differentiating headaches and the

neuropathological basis of the various types was discussed. During the lecture, each type was discussed emphasizing recognition by means of history (including social, family, past medical history, identification of risk and comorbid factors, and onset of present complaint), physical diagnosis, and advanced diagnostic procedures. The lecture concluded with a discussion of management strategies.

Following the lecture, students were randomly divided into two groups; an active participation group in the clinical skills center or a traditional learning group in the lecture classroom. The students participated in a 35 minute activity in their respective group. Both groups were presented a case of a 72 year old patient presenting with temporal arteritis. The instructional objectives were the same for both groups. These objective included 1) differentiate headache of temporal arteritis origin based on physical findings (signs), 2) differentiate headache of temporal arteritis origin based on presenting history (symptoms), 3) identify proper management strategies including appropriate diagnostic studies and therapeutic intervention.

The active learning group was further divided into smaller units (6 or fewer students) interacting with a standardized patient within a clinical examination room. The standardized patient was trained to simulate a patient with temporal arteritis, including partial vision loss in the right eye, unitemporal and occasionally bitemporal headaches for several weeks in duration and pain and stiffness in the neck, shoulders and hips. The group interacting with a standardized patient was able to ask questions of the patient in a history-taking format. The patient answered questions regarding history of present illness, past medical history, social history and family medical history. The patient also simulated the physical examination findings. The students were allowed to perform a brief physical examination including palpating and auscultating the temporal arteries, assessing ranges of motion and performing an eye examination. A facilitator interacted with the groups in order to assist them with questioning and examining the patient. Students were also encouraged to collaborate with their peers during the activity.

The group participating in the traditional didactic learning group was presented with a 35 minute PowerPoint lecture of the material regarding the case (presenting situation, history of present illness, past medical history, social history, family medical history and physical exam findings). Participants in this group were permitted to ask questions of the instructor during the presentation in order to clarify information. Immediately after the two groups completed their activity—interaction with the standardized patient or lecture—the students were given a written, multiple choice test assessing their understanding of the material. Students also completed a survey assessing their opinions about the activity. Six weeks after the activity the same multiple choice test was administered to the students.

Data Collection and Analysis

All students registered for the course were included. Data were collected to address the specific aims of the study as follows:
1) Comparison of student performance on a written examination immediately after the activity, by group. A 10-item quiz which was created by the instructor for the course was administered. It addressed the content presented in the activity. Its reliability and validity have not been established, but it is used as a part of the usual coursework. The proportion of each group with a correct answer to each of the 10 questions was compared. The 10 questions are shown, in abbreviated form, in **Table 1**. Questions were also categorized by the investigators in two ways: as requiring a single or multiple response; and information covered by the question was visually, factually, or experiential (performed

exam, etc.) presented.
2) Comparison of the student retention of the material six weeks later. The same procedure was followed as described above.
3) Comparison of the student opinion about the two presentation methods using a survey after the conclusion of the activities. A 6-item survey was designed by the investigators to address the issues of interest. Its reliability and validity have not been established, as it was exploratory and the questions had obvious face validity. This project was the first time the survey was used. Responses were given using a Likert scale of 1 ("strongly disagree") to 5 ("strongly agree"), with 3 being "no opinion." The survey questions are shown, in abbreviated form, in Table 2.

Data were entered into an SPSS (v. 21) database. They were de-identified, with only a code number associated with each record. For the opinion questionnaire, the Likert scale categories were collapsed from 5 to 3 ("strongly agree" and "agree" were combined and "strongly disagree" and "disagree" were combined). Descriptive statistics were computed. For categorical data, a Pearson Chi square test was used for assessing statistical significance of the difference between groups, and for continuous data, a t-test of either paired samples (for Test 1 and Test 2 within-groups comparisons) or of independent samples (for Test 1 and Test 2 between-groups comparisons). The significance level was alpha< .05; 95% confidence intervals were also included. The investigator doing the data analysis (CH) was not involved in teaching the course and was blinded to group assignment.

Table 1. Item analysis, showing percent of correct answers for Test 1 (immediately post-learning activity) compared to Test 2 (6 weeks post-learning activity).

Question	Question Type[1]	Method of presenting information[2]	Test 1 Immediate post-learning activity		Test 2 6 weeks post-learning activity	
			Active (%; n=44)	Lecture (%; n=40)	Active (%; n=44)	Lecture (%; n=40)
In terms of the typical age of onset for this type of headache which is most accurate?	S	V	98*	78	86	73
Another associated symptom this patient is likely to report would include….	S	E	96*	43	41*	5
A potential serious complication of allowing this condition to progress untreated is…	S	F	93	98	77	80
A 72 year old female patient presents with a history of transient monocular blindness and bilateral headaches? Which headache type is	S	F	89	90	80	78

highest on your list of differentials?						
If the laboratory examinations are negative, proper management of the patient would dictate what?	S	F	75	63	43	33
The visual difficulties experienced by this patient are most likely of what nature?	S	F	66	63	43	33
Your initial diagnostic work-up should include which of the following?	M	F	43	53	16*	3
In this condition the temporal artery typically palpates as_____.	M	E	43*	23	9	3
What other features of the pain presentation would you expect the patient to report?	M	F	34	20	11	5
Concomitant conditions to be expected in this patient include which of the following?	M	F	21	28	0	0

[1] S= single response required; M=multiple responses required.
[2] V=visually presented; F=factual; E=experiential (performed exam, etc.)
* Indicates comparison between active and lecture group was statistically significant (p=.05).

Table 2. Attitudes toward learning activity, active learning (n=46) compared to lecture (n=36) (total n=82).*

	Agree (%)		No opinion (%)		Disagree (%)	
	Active	Lecture	Active	Lecture	Active	Lecture
I believe the method of instruction was optimal in helping me to understand the clinical presentation and subsequent management for a patient with temporal arteritis.	96%	83%	2%	14%	2%	3%
This activity increased my confidence in being able to assess and manage a patient presenting with a significant medical concern.	94	83	4	8	2	8
I prefer learning experiences in which I am an active participant in obtaining the information.	91	94	7	3	2	3
I retain information better when I am actively involved in a learning experience.	91	94	7	6	2	0
I prefer learning experiences in which an instructor presents information on a case to the class.	61	72	15	17	24	11
I retain information better when I am presented the information through an instructor.	39	39	24	42	37	19

*Comparisons of the proportion who agreed, by item, were not statistically significant between Active and Lecture groups, at the p=.05 level.

Results

Attitudes

Eighty-two of 84 students completed the survey on attitudes (four students failed to complete the survey). As shown in Table 1, a minority of students (39% in both the active and lecture groups), after completing the opinion questionnaire following the activity, agreed that they retain information better when presented by an instructor. In contrast, a majority of students in both the active and lecture groups (91% and 94%, respectively) agreed that they retain information better when actively involved in the learning experience and equally prefer activities in which they are actively involved.

Knowledge scores

All 84 students completed both Test 1 and Test 2. For the students actively participating, out of a maximum score of 10, the mean total score for Test 1 was 6.6 and for the lecture group it was 5.6, which was a statistically significant difference (CI, 0.2-1.9). For test 2, the same group of active participants was 4.1 and for the lecture group it was 3.1, which was also statistically significant (CI, 0.3-1.7). For the total sample, the mean total score was 6.1 (median 6.0; minimum 1, maximum 10) for Test 1 and 3.6 (median 3.5; minimum 0, maximum 7) for Test 2. The difference between Test 1 and Test 2 mean scores was statistically significant (p=.00; CI, 2.0-2.9). Both groups had a 2.5 decrease in the total score from Test 1 to Test 2. Table 2 shows the differences between group scores for each of the 10 questions. Table 2 shows the percentage of correct answers, and also denotes the method of presenting the question. Those questions with a visual or experiential component demonstrated a greater difference in scores among the two groups. Questions requiring multiple responses were less frequently correctly answered, with Test 2 scores appearing to drop more sharply in the lecture group than in the active group.

Discussion

The activities in which the students participated both involved case-based teaching, whether as part of a problem-based learning activity or a traditional lecture. The difference between the presentations dealt with the involvement of the student in the actual case; whether as an active participant or passive learner. Presentation of clinical material intended to stimulate learning helps students to bridge understanding between scientific knowledge and knowledge necessary for clinical practice.[7] Case-based teaching may occur in a variety of ways. It may occur as part of a lecture, in a formal grand rounds presentation where multiple learners are involved or more informally where discussions occur between a facilitator and learners.[14] Our activity was presented as a case to the students either in a lecture classroom to a large group, or in clinical examination rooms where students collaborated in a small group with a standardized patient and faculty facilitator. While this activity doesn't have all the components of PBL activity as defined earlier in the introduction, it does fit the definition of a modified problem based learning activity as defined by Wood who recognized that "real" patients (standardized patients) are used in clinical education as a stimulus for learning[7].

Research has confirmed that student satisfaction is higher during active learning or experiential group activities[15-17] but there is a scarcity of evidence showing that students retain information to a greater extent after being an active versus passive participant[17]. Our results demonstrated that the students believed (Table 1) that they would retain information over time to a greater extent if they were allowed to be actively involved in obtaining that information. While six weeks after the initial presentation of the material the students all scored lower then on the initial test, those actively involved in the learning did score higher (retain the information longer) than the students in the traditional group.

Brown et al. asked the question, "Are lectures as effective as other methods of teaching?" and found that with respect to presentation of information and explanations, lectures are as effective.[1] Contrary to this, given the information we obtained in this research, students in the modified problem based learning activity were able to immediately recall the information to a greater extent when they were allowed experiential interaction with the standardized patient in comparison to students who were presented the clinical information as part of a lecture.

Interestingly, questions which had a visual or experiential component were recalled by a greater percentage of students in the active group both immediately post activity and six weeks later. Table 2 illustrates the three questions on the test that showed the greatest difference in scores, with the active learning group scoring higher. These were questions that the patient was able to visibly demonstrate (age, physical symptoms; denoted as a V) or information that was gathered by the student performing an exam on the patient (denoted as an E). For the questions that could be considered factual information typically presented in written form, the difference in scores between the two groups was less apparent.

Future Research

While it was not the intent of this study to compare students' ability to think critically after an active versus passive learning activity, we did find that both groups of students struggled with questions that required multiple answers. These types of questions require a level of critical thinking often not required of single answer factual questions. Future research might include examining differences in those critical thinking skills among students within different learning environments.

In a study by Alghasham, the importance of acknowledging a student's learning style when deciding on classroom activities was emphasized. The study also demonstrated that students with different learning styles performed differently in PBL sessions.[18] Therefore, it cannot be assumed that all students will perform better, be more satisfied and retain information to a greater extent just because the student is an active participant. Future research into activities based on individual student learning styles might further address the question of whether retention is greater in an active versus passive environment.

Limitations

This study was limited by the study size (n=84) and by being conducted in only one class, thereby preventing us from generalizing across the curriculum. Another limitation is that the exam questionnaires did not have established reliability and validity. Further studies using similar groupings will be required across multiple classrooms, using standardized questionnaires, in order to explore if our findings are reproducible in other settings. Lack of a longer-term follow up was also a limitation to this study.

Conclusion

Overall, our research suggested that there may be differences in knowledge retention when instruction is provided with students actively participating versus a teacher-led didactic lecture.

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