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Original Research Article

Effectiveness of crossword puzzle as an adjunct tool for active learning and critical thinking in Pharmacology

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ABSTRACT

Background: Modern pedagogic methodologies are being introduced in Medical education and there is a growing evidence of crossword puzzle as an educational tool for active learning, problem solving and critical thinking. The aim of the study was to study the effectiveness of crossword puzzle as an adjunct to the conventional lecture for active learning and critical thinking in Pharmacology. This was a parallel group; pre and post assessment, educational intervention study conducted among second year undergraduate medical students.

Methods: Second year medical students were randomly selected and assigned to two groups A (Cross word puzzle) and B (control), after an hour conventional lecture on "Drugs for Hypertension" In both the groups, pre- and post-intervention knowledge was assessed using the MCQ test. A self-designed crossword puzzle on the lecture topic was used as an intervention and students were allowed to read textbooks with a crossword puzzle in intervention group A, whereas control group B were allowed to read textbook only. After 45 minutes, the post-intervention assessment was done in both groups with the same set of MCQ and students' feedback on crossword usefulness was obtained.

Results: The average MCQ test score in Group A improved significantly from 6.65±3.4 pre-intervention to 11.26±2.5 post-intervention ($p < 0.05$) with absolute learning gain 30.73 % and relative learning gain 69.32 %. The average test score in Group B also improved significantly from 5.7±2.9 pre-intervention to 9.59±2.5 post-intervention ($p < 0.05$) with absolute learning gain 25.93 % and relative learning gain 68.23%. There was a significant improvement in the MCQ scores in both the groups after intervention. But the post-intervention MCQ scores in group A (crossword puzzle) was higher and statistically significant ($P < 0.05$) in comparison to group B.

Conclusions: Cross-word puzzle promotes active self-learning and develops critical thinking among medical students. It could be used as supplementary educational tool in pharmacology to enhance problem-solving skills along with the information provided through traditional teaching lectures or could be used as a micro task.

Keywords: Crossword puzzles, Education, Medical, Problem solving, Pharmacology/education, Teaching/methods

INTRODUCTION

Incorporating active learning strategies improves understanding and learning.[1-3] Medical education is challenged to adopt and develop modern pedagogic methodologies that can enhance and supplement the conventional lecture teaching in order to promote active learning, problem solving and critical thinking among medical students.[4-6]

Crossword puzzle as an education tool, stimulates the mind, promote active learning, increase vocabulary as well develop healthy scepticism and critical thinking skills.[7-9] Crossword puzzles are useful as structured educational tools for facilitating active learning, critical thinking and reinforcing the material acquired during the lecture.[3,10]

Crossword puzzles have been used as educational tools for active learning in medicine, pharmacy and nursing students.[3,11-23] Studies conducted in limited subjects in medicine have documented promising results and substantiate the usability of this technique as a modern pedagogic tool.[3,12,19,22-24] Pharmacology is an important subject to develop rationale behind therapeutics in disease management. However, it is perceived to be dry and volatile by students due to extensive core content, information overload, difficult to remember drug names and recall the same as well the concepts in the subject.[11,12,20]

There is inadequate literature on the effectiveness of this educational technique in Pharmacology subject among second year medical students. Therefore, the present study was conducted with the aim to study the effectiveness of the educational crossword puzzle as an adjunct to the conventional lecture for promoting active learning and critical thinking in Pharmacology.

METHODS

This was a pilot, parallel group, pre/post assessment, educational intervention study conducted in the month of January 2016 among students of second year MBBS course. Minimum samples of 70 students were targeted based upon earlier study.[12] A total of 78 second year MBBS students participated in this study.

Research instruments

Multiple choice questionnaires (MCQ)

The MCQ test questionnaire comprised of 15 multiple choice questions on antihypertensive drugs. The same set of MCQ questions were used for the pre/ post-test assessment. Each correct answer was awarded one mark / score (maximum score was 15).

Educational crossword puzzle

A self-designed crossword puzzle on "drugs used in hypertension" was used for assessment. This topic is from the 'Must know' portion of the pharmacology syllabus and is taught by traditional teaching. Based upon the content of this topic, a self-learning crossword puzzle with drug terms was prepared. The crossword puzzle clues (Across and Down) were verified from the standard textbooks of pharmacology. Before introducing the crossword puzzles to students, two senior faculties from the Pharmacology department verified the content of the crossword puzzle.

Perception / feedback questionnaire

Students perception on crossword usefulness was taken on a 10 item questions adapted from previous studies.[3,12] Students' responses to questions 1 to 8 were recorded on a 5-point Likert scale and were expressed as percentages. Students' response to item 9 in the questionnaire (05-point scale for usefulness) was categorized as follows: not useful, slightly useful, moderately useful, useful and very useful. A comment in response to question 10 was evaluated separately.

After the conventional lecture on "drugs used in hypertension" was finished, second MBBS students studying in 3rd semester was approached in the class. They were briefed about the purpose and the procedure of the study. A total of 78 undergraduate students volunteered for participation and consent was obtained. They were randomly assigned to two groups (A and B) based upon odd and even roll numbers. In both the groups, a pre intervention MCQ was administered to students for 15 minutes to solve and collected back. Then based upon the groups, the educational intervention was applied (Figure 1).

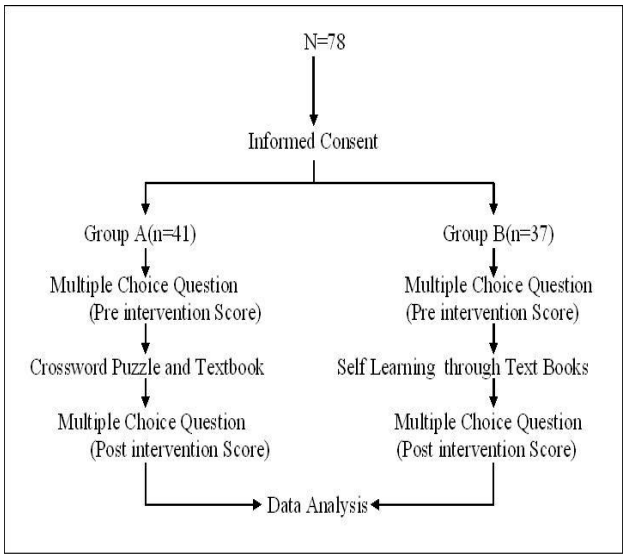

Figure 1: Flow chart of the study.

Group A (n = 41): Crossword puzzle Interventional group in which standard pharmacology textbook plus crossword puzzle intervention was given.

Group B (n = 37): Control group in which only standard textbook was given.

Group A (Crossword puzzle) were administered printed papers of the crossword puzzle. Students solved the crossword puzzle individually for 45 minutes. They were encouraged to self-learn the topic by referring to standard pharmacology textbooks while solving the puzzle.

Group B (Non-Crossword puzzle / Control) underwent the self-learning module without the crossword puzzles and were encouraged to self-learn the topic from standard text books for 45 minutes.

After 45 minutes of the educational intervention, both the groups were again re-administered MCQ for 15 minutes

as post intervention assessment. Student's perception on crossword usefulness was obtained by administering perception/feedback questionnaire in group A. Respective pre and post intervention MCQ scores were calculated.

Data analysis

1. Following parameters were assessed in both the groups.
2. Pre and Post intervention MCQ test scores were calculated
3. Learning effectiveness index: absolute learning gain (% Posttest score- % Pretest score) and relative learning gain (% Posttest score- % Pretest/ % Pretest score).
4. Intervention effectiveness: Effectiveness of intervention evaluated by class-average normalized gain (g) [g = (% Post-test score - % Pre-test score) - (100 - % Pre-test score)]. A class-average normalized gain (g) of 0.3, i.e. 30 % was considered significant A class-average normalized gain of 0.1- 0.29 signified low gain, 0.3-0.69 signified medium gain and 0.7-1.0 signified high gain.[25,26]

Statistical analysis

Data was entered in Microsoft Excel 2007 and statistically analyzed. Data was expressed in descriptive statistics i.e. actual number, mean with standard deviation and percentage. Comparison of the mean score between the two groups was done using independent t-test and within the group (pre and post) assessment using paired t test. Probability (P) value ≤0.05 was considered statistically significant.

RESULTS

In this study, both the groups completed the pre and post intervention MCQ test. The mean pre-intervention (baseline) MCQ scores in Group A and Group B were 6.65±3.4 and 5.7±2.9 respectively. The difference in the mean pre-intervention MCQ scores between the two groups were not statistically significant (t= 1.31, p= 0.192) (Table 1).

After the educational intervention, we found that the mean post-intervention MCQ scores in Group A and Group B were 11.26±2.5 and 59.59±2.5 respectively. The mean post-intervention MCQ score in group A increased from 6.65 to 11.26 and this change in the score was statistically significant (t= -11.18, p <0.001), signifying an improvement in the Group A scores after the intervention.

Table 1: Pre and post intervention MCQ scores with learning gain and class-average normalized gain.

Groups	Pre-intervention MCQ Score mean ±SD (%)	Post-intervention MCQ Score mean ±SD (%)	Absolute learning gain (%)	Relative learning gain (%)	Effectiveness of intervention OR class-average normalized gain (%)
Group A Crossword puzzle (n=41)	6.65 ± 3.4† (44.3%)	11.26± 2.5*‡ (75.06%)	30.73%	69.32%	0.55 or 55%
Group B Non crossword puzzle (n=37)	5.7 ± 2.9† (38.0%)	9.59 ± 2.5 * (63.93%)	25.93%	68.23%	0.41 or 41%

***** p<0.05 - Significant using paired t-test (pre intervention versus post intervention score in same group)
† p>0.05 - Not significant using independent t-test (Group A pre intervention score versus Group B pre- intervention score)
‡ p<0.05 - Significant using independent t-test (Group A post intervention score versus Group B post intervention score)

The mean post-intervention score in group B also increased after the intervention from 6.65 to 11.26 and this change in the score was statistically significant (t= -6.61, p <0.001) signifying an improvement in group B. However on comparing the mean posttest scores between group A and B, we found that there was statistical significant (t= 3.03, p=0.003) difference in the mean post-intervention scores between the two groups. Group A had comparative higher scores than group B (Table 1).

The absolute learning gain in Group A was 30.73% whereas the relative learning gain was 69.32%. Intervention effectiveness or a class-average normalized gain (g) was 0.55 which was significant and suggested moderate gain. The absolute learning gain in Group B was 25.93% whereas the relative learning gain was 68.23%. Intervention effectiveness or a class-average normalized gain (g) was 0.41 (Table 1).

There was a significant improvement in the MCQ scores in both the groups after intervention. But the post-intervention MCQ scores were higher and statistical significant in group A (crossword) in comparison to group B.

Student's perception towards the crossword puzzle was that, 77.78% found it as enjoyable experience, 74.06% agreed that crossword puzzles enhanced their knowledge

of antihypertensive drugs, 70.31% student found that the exercise was helpful for remembering the drug names, 70.36% found it challenging, 81.47 % student opined that it was a good self-learning, recreational activity and 74.06% students noted that it promoted active learning whereas 70.35% found that it emphasized on core area of the topic (Table 2).

Table 2: Feedback/perception of medical students regarding crossword puzzles as a self-learning educational tool.

Questions	Responses %				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Enjoyable experience to solve crossword puzzle	0	2.4	7.3	9.8	80.5
2. Enhanced knowledge of antihypertensive drugs	0	7.3	12.2	4.9	75.6
3. Helped to remember drug names	0	2.4	9.8	17.1	70.7
4. Challenging and problem solving	0	0	4.9	21.9	73.2
5. Enhances learning through recreation	0	0	12.2	14.6	73.2
6. Promotes active learning	0	2.4	14.6	7.3	75.6
7. Emphasizes core area of topic	0	7.3	9.8	14.6	68.3
8. Incorporation in pharmacology curriculum as self-learning tool/small group discussion	2.4	4.9	7.3	19.5	65.9
9. How much do you find it useful *	0	4.9	12.2	7.3	75.6

* Grading based on usefulness

DISCUSSION

The key findings of the present study suggest that, educational crossword puzzles are effective and beneficial for active learning and critical thinking in Pharmacology among medical students.

Pharmacology is often perceived as difficult and volatile due to extensive core content, information overload, difficulty in remembering drug names, recalling the same as well understanding the pharmacokinetic and pharmacodynamics concepts.[11,12,20] Therefore the current study assessed the effectiveness of crossword puzzle as adjunct to conventional lecture for reinforcement of the contents taught.

In this study, the mean MCQ test score in both the group improved significantly from pre-intervention (baseline) to post-intervention. There was a significant improvement in the MCQ scores in both the groups after intervention. But the post-intervention MCQ scores in crossword puzzle group was higher and statistically significant ($P<0.05$) in comparison to control group. Our findings are comparable to the observations of Gaikwad et al, conducted among medicals students and Thomas et al, among nursing students using pre/post-test assessment model documenting higher post test scores in the crossword puzzle group in comparison to control group with statistical significance.[10,12]

In a randomized, two arm interventions, pre/post-test assessment conducted by Gaikwad et al among medical students, documented that the intervention arm receiving self-learning crossword puzzle module on anti-epileptic and antihypertensive drugs had higher and significant post test scores than the control arm. The test scores improved when crossword puzzles were incorporated in the self-study modules of pharmacology training.[12]

Similarly a study conducted by Thomas et al, pre/post-test assessment among nursing students found that that the implementation of cross word puzzle to the experimental group was significantly effective than control group. They concluded that the crossword puzzle teaching learning method stimulated the learners to think critically, resolve the problem and enhanced their retention of knowledge, facts or concepts.[10]

The class-average normalized gain offers a comparative measure for course effectiveness over diverse student populations with widely varying average pre-test scores. It diminishes the confounding effect of pre-course knowledge.[25,26] In this study, the class-average normalized gain was 0.55 (55%) in the crossword puzzle group in comparison to 0.41 (41%) in the control group which signified that the crossword puzzle group had an average gain of 55% of the maximum possible average gain. Thus, the crossword puzzle intervention was moderately effective adjunct tool for self-learning in pharmacology. Our findings are similar to observations of Gaikwad et al, in which the class-average normalized gain was 0.48 (48%) in the intervention group as compared to 0.26 (26%) in control group, documenting moderate effectiveness of crossword puzzle intervention in pharmacology among medical students.[12]

Effectiveness of the crossword puzzle as a self-learning tool is supportable due to the positive feedback received from the medical students. Feedback indicated that they enjoyed crossword puzzle activity. More than 70% medical students strongly agreed that crossword puzzle enhanced their knowledge of antihypertensive drugs and was helpful for remembering / recalling the names, 73% students found it challenging / good problem solving activity and 75% students strongly agreed it promoted self-learning. Overall, crossword puzzle activity was enjoyable experience for the medical students. Students perceived crossword puzzles as a challenging, problem solving, useful and recreational tool for learning. Hence, it can be argued that the retention was more and post test scores were better in the crossword puzzle group in compared to control group. As far as students' perceptions and acceptability are concerned, the results were consistent with other studies.[3,10,12,22-24]

The crossword puzzle involves participation of the students to read through the clues, recall and review the material, and engage into the educational material.[3] Crossword puzzle have successfully been utilized to reinforce the intricacies of science during, in-between, or after a didactic discourse to break the monotony of the learning process.[20,21] This leads to a better comprehension, retention and contributes towards the positive learning experience perceived by the students.

Crossword puzzle can be utilized in undergraduate medical education to reinforce learning in interactive environment for pharmacology subject. They can be used as adjunct educational tool to traditional lectures /group task for self-learning and critical thinking in pharmacology. However the logistics and cost of the printed materials for crossword puzzle intervention needs to be weighed.

Limitation

The study involved single lecture topic and the study sample size was moderate. The study was designed for a single day delivery and short-term acquisition of knowledge was assessed while long-term knowledge and retention was not assessed. Academic performance based grouping of the participants was not done.

CONCLUSION

The study concludes that crossword puzzles are beneficial and moderately effective adjunct to the conventional lectures for active learning and critical thinking in pharmacology. It can be utilized in undergraduate medical education and curriculum to reinforce learning in an interactive environment or to enhance problem-solving skills along with the information provided through traditional teaching lectures or can be used as a group/micro task.

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