



Crossword Puzzles as an Active Learning Mode for Student Directed Learning in Anatomy Teaching: Medical Undergraduate Perceptions

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ABSTRACT

Introduction: An extensive research in the medical education has brought a paradigm shift from a routine traditional lecturing to new innovative methods of teaching which are more student-centered. Use of crossword puzzles provides a simple and creative way to incorporate active learning in human anatomy, a subject which introduces the students to core knowledge of human body with newer terms and concepts which are totally different from their pre-existing knowledge. **Aim:** The aim of the study is to evaluate the usefulness of crossword puzzles as a learning tool at the level of the undergraduate medical curriculum. **Objectives:** To evaluate the student's perceptions regarding the usefulness of crosswords as an effective mode to reinforce the essential concepts and vocabulary, and to design, and evaluate the use of crossword puzzles as an educational tool in anatomy teaching and learning. **Materials and methods:** The research study was carried out at Shadan Institute of Medical Sciences, Hyderabad, India. The study sample included 150 students of 1st-year MBBS of batch 2015-2016, which were divided into 25 groups. These groups were given an exercise of total 8 crossword puzzles, one each after the completion of all sessions in each region of the human anatomy. **Results:** Majority of the students agreed that the use of the crossword was an innovative method of learning, whereas few students suggested that more time should be allotted and these activities should be given individually rather than in small groups. **Conclusion:** Using crossword puzzles provides an opportunity for the students to develop approaches to critical learning for understanding human anatomy. Students perceive the crossword puzzles as an active learning exercise.

Keywords: Crossword puzzles, Questionnaire, Active learning, Human anatomy, Recreational learning

Abbreviations: MBBS: Bachelor of Medicine and Bachelor of Surgery; AD: Anno Domini; CIP: Comprehensive Integrative Puzzle; N: Number; p-value: Probability Value

INTRODUCTION

The present trends in undergraduate medical education are to make the learning process student-centered in which students can actively learn about a subject. To achieve this, many new innovative methods have been adopted by various universities. The goal is to employ these innovative techniques to make the process of learning interesting and interactive, thereby encouraging the students to take an active part in these innovations [1,2].

In spite of these innovations, the majority of the undergraduate teaching in most of the medical colleges in India and across the world is still delivered in the form of traditional lectures. Studies showed that students invariably find these lectures boring resulting in poor knowledge retention rates [3,4]. In contrast, active learning that involves discussion

with peers as in problem-based learning sessions or practicing by doing in disciplines like anatomy by performing the dissection, or teaching others as in small group discussions and seminars, results in a more effective learning addressing at higher levels of cognitive function [4]. In the present scenario, the educator faces a constant challenge to augment the traditional teaching methods with creative learning methods which can assist in active learning, problem-solving and encourages the student to work as an active member of a team [5].

According to research the incorporation of active learning strategies benefits the students by facilitating the development of critical thinking, improving communication skills and also promotes concept formation, attitudes, and values thereby providing a chance for identifying misconceptions and increasing motivation [6-8].

The history of crossword puzzles can be traced back to the word squares of Pompeii and 300 AD Egypt. It was Arthur Wynne who was credited to create the first “modern” crossword in December 21, 1913, and it appeared in Sunday “Fun” section of the New York World as a “Word Cross” [9]. In the contemporary era many disciplines in health sciences, psychology, biology, and sociology have used crossword puzzle as an effective learning tool. Various formats of games and puzzles have been used to supplement traditional teaching, for example, a Jeopardy-style game in obstetrics, card games for gastrointestinal physiology, frame game in psychiatry, panel board games in immunology and puzzles for gastrointestinal physiology [10-19]. These puzzles though may not completely replace the traditional way of obtaining theoretical knowledge but can be used as an adjunct to reinforce acquisition of content and enhance the problem-solving skills [20].

The first year medical students in Indian medical curricula are introduced to newer terms and concepts in preclinical subjects i.e., biochemistry, anatomy and physiology. It has been observed that students often find it difficult to remember and consolidate the amount of knowledge and especially the terminologies in these subjects.

In the present scenario, the fundamental concepts of anatomy are taught through didactic lectures where students found difficult to concentrate for more than 10-20 minutes. Based on the research, the attention cycle alternates between being engaged and no engaged throughout the lecture segment which may vary from 30 seconds lapse in attention after the class begins to more lapses about four-and-a-half minutes into the lecture [21]. This is the foremost reason for traditional lectures as a passive mode of learning with the lowest retention rates in comparison with student-centered learning methods. It has been observed that students are unable to exhibit the desired level of competency when they are assessed for comprehension of these fundamental aspects of anatomy. This situation tempted us to think about a recreational active learning tool which not only encourages the students in active learning but can help them to reinforce the key concepts, better retention of the new terminologies and assists in improving vocabulary.

The present study describes the utility of crosswords for reviewing and reinforcing concepts and vocabulary, student responses for evaluating their usefulness, and a review of relevant literature. The study was conducted to identify the student reactions regarding the use of crossword as an adjuvant to lectures.

Aim of the Study

The aim of the study was to evaluate the usefulness of crossword puzzles as a learning tool in the subject of anatomy at the level of undergraduate medical curriculum.

Objectives of the Study

To identify the perceptions of students about crossword puzzles as a learning tool, and to assess the acceptability and feasibility in terms of implementation of crossword puzzles in anatomy teaching

MATERIALS AND METHODS

The research study was carried out from September 2015 to August 2016. The study sample included 150 students of 1st-year MBBS studying at Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Hyderabad, Telangana, India. The study was conducted after obtaining approval from the ethical committee of the institute. The students were randomly divided into 25 groups, each group consisting of 6 students. The themes to be included in the crossword puzzles were the difficult topics as per the survey taken from the teaching faculty of anatomy and the students. An exercise of crossword puzzle consisting of 50 items across and down was given to each of the group of students after the completion of lectures and regional dissection of the cadaver.

A total of 8 sets of crossword puzzles were constructed using the eclipseword.com, crossword maker website. The content validity in these crossword puzzles was ensured keeping in mind with the intended learning outcomes and the clues with the answers were linked to those learning outcomes. The puzzle clues were constructed accurately around keywords signifying essential concepts, facts and terms that need memorizing and these clues were verified from the standard textbooks of human anatomy. The approximate time required to plan a content-valid crossword at a moderate level of difficulty was around 3 to 4 hours. In addition, the content and the format of this exercise were reviewed by 3 experts from the department of anatomy. The time to solve the crossword puzzle was decided after asking a few students and one of the faculty members to answer.

An informed consent of the students was taken after briefing and explaining them the objectives of the study. They were instructed as to the mode of solving the crossword puzzle and 45 minutes time was allotted. At the end of the session, correct answers to the crossword puzzle were discussed.

The present study used a simple crossword format involving both short and long words, unlike some of the common crossword puzzles in newspapers and professional competitions which uses anagrams or telescoped words, because tricking the students or giving them a red herring with a bootless errand is not the purpose of this study.

For assessing the effectiveness of these crossword puzzle exercises, a questionnaire was distributed to all the students to record their perceptions. This questionnaire consisted of 13 items. Items 1-12 were close-ended questions and the response to these questions was recorded on a 5-point Likert scale (1=strongly disagree to 5=strongly agree) which were expressed as percentages. Item 13 was an open-ended question and students were asked to give their comments which were evaluated qualitatively.

RESULTS

The major outcome evaluated in the present study is to access the student's perception of the crossword puzzles as a learning tool. The comments in item 13 of the questionnaire were analyzed and categorized as strengths and suggestions. The average crossword completion index was calculated as a percentage of correctly solved clues and was found to be 70.25%. Score improved from 50% in the first set to 84% in the eighth set. The response rate for the questionnaire was 100% as all the 150 students participated in solving the crossword puzzles (Table 1).

Table 1 Average scores achieved

Set	Topic	Average marks	Percentage (%)
Set-1	General Anatomy	25/50	50.00%
Set-2	Upper Limb	30/50	60.00%
Set-3	Lower Limb	33/50	66.00%
Set-4	Thorax	34/50	68.00%
Set-5	Abdomen, Pelvis, and Perineum	37/50	74.00%
Set-6	Head and Neck	39/50	78.00%
Set-7	Neuroanatomy	41/50	82.00%
Set-8	Osteology	42/50	84.00%
Average crossword completion index			70.25%

Around 80% of the students strongly agreed that solving crossword puzzle was a fun experience, 79% of the students enjoyed learning through recreation (Table 2). Total 73% of the students strongly felt that their understanding of the topic improved as a result of the crossword activity, 60% of students felt that the crossword puzzle activity was challenging and problem solving, 67% of students were of the opinion that the core area of the topic was emphasized by the crossword puzzle clues, 65% of students strongly felt that the crossword promoted active learning and 71% of students felt that it helped them to remember important terms from the topic, 65% of students recommended the use of crossword puzzles for other subjects also to encourage active learning. The findings are shown in Table 2.

Table 2 Student perceptions of crossword puzzle as a teaching tool

Statements	Number (%)				
	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)

Fun experience to solve crossword puzzles	06 (4.00%)	03 (2.00%)	04 (2.66%)	17 (11.33%)	120 (80.00%)
They were a waste of time	135 (90.00%)	09 (6.00%)	03 (2.00%)	02 (1.33%)	01 (0.66%)
Emphasized core area of topic	03 (2.00%)	04 (2.66%)	06 (4.00%)	36 (24.00%)	101 (67.33%)
Challenging and problem solving	04 (2.66%)	06 (4.00%)	20 (13.33%)	30 (20.00%)	90 (60.00%)
Improved my understanding of the topic	02 (1.33%)	03 (2.00%)	03 (2.00%)	32 (21.33%)	110 (73.33%)
Helped to remember important terms from the topic	03 (2.00%)	04 (2.66%)	03 (2.00%)	33 (22.00%)	107 (71.33%)
Recommend their use for other subjects also to encourage active learning	10 (6.66%)	04 (2.66%)	15 (10.00%)	23 (15.33%)	98 (65.33%)
The level of difficulty was uniformly maintained	09 (6.00%)	06 (4.00%)	10 (6.66%)	23 (15.33%)	102 (68.00%)
They helped me in working together and team building	04 (2.66%)	06 (4.00%)	09 (6.00%)	12 (8.00%)	119 (79.33%)
Promoted active learning	04 (2.66%)	12 (8.00%)	15 (10.00%)	21 (14.00%)	98 (65.33%)
Enjoyed learning through recreation	03 (2.00%)	06 (4.00%)	08 (5.33%)	15 (10.00%)	118 (78.66%)
Time allotted to solve the cross word was adequate	03 (2.00%)	04 (2.66%)	04 (2.66%)	27 (18.00%)	112 (74.66%)
What according to you were the strength for solving the crossword puzzles and suggestions to improve learning through crossword puzzles?					

The strengths and suggestions to improve learning through crossword puzzle exercise is summarised in Table 3 and Figure 1.

Table 3 Strengths for solving the crossword puzzles and suggestions to improve learning through crossword puzzles

Strengths	Suggestions
In-depth study	Crossword puzzles should be regularly given at the end of each topic
Makes learning enjoyable through recreation	They should be used as a learning tool in other subjects also
Enhances the knowledge on the topic	It is a good method for assessment
Are effective in improving vocabulary and concepts	More time should be allocated for solving the crosswords
The content reflected the key concepts	Should be given individually rather than in small groups
The crossword puzzle was challenging	Few tutorials should be based on crossword puzzles
Promotes active learning	Students should be pre-informed

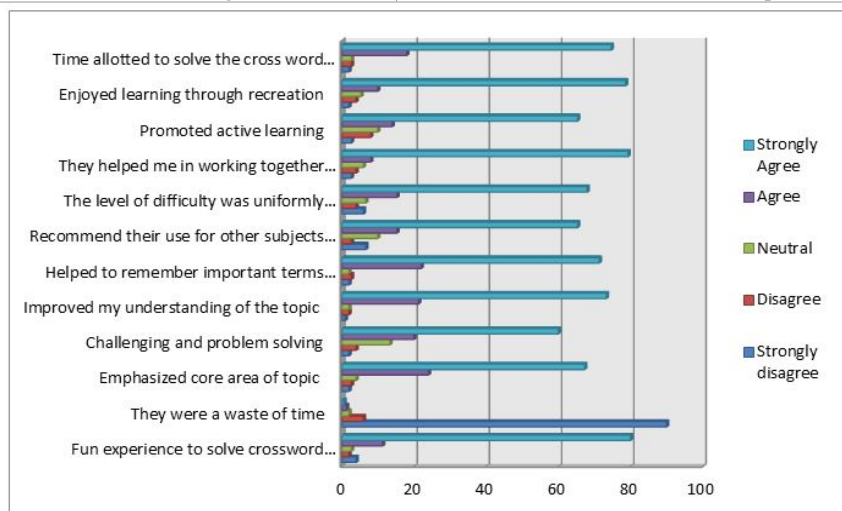


Figure 1 Students perception regarding crossword puzzles

The score achieved in each set of the crossword puzzle is shown in Table 4.

Table 4 Scores achieved in each of the crosswords

Score	Set-1	Set-2	Set-3	Set-4	Set-5	Set-6	Set-7	Set-8	Total sets
>80%	2	3	4	6	8	9	10	10	52
71%-80%	3	4	5	5	6	6	8	10	47
61%-70%	8	8	6	5	5	5	4	3	44
<60%	12	10	10	9	6	5	3	2	57

Total sets given	25	25	25	25	25	25	25	25	200
Fisher exact test value=34.05; p-value=0.035									

The percentage wise score in different sets of the crossword puzzle is shown in Table 5.

Table 5 Puzzle score

Score	No of Sets
>80%	52
61-80%	91
<60%	57

DISCUSSION

Basic medical science subjects like human anatomy have often been regarded by the students as a difficult and volatile subject that requires them to memorize and retain a lot of information. It is often difficult for the students to recall and reproduce the information during the written and oral examinations.

The present research demonstrates that studying challenging subjects like human anatomy with the use of crossword puzzles has proved to be an effective way of learning. To solve the exercise of the crossword puzzle the students were instructed to read the clues and then recall what had been taught in the lectures and practical sessions of human anatomy, they were then encouraged to participate actively in the discussion with their teammates to solve these puzzles. This helped us to create an environment for active learning, a process that motivates the students and increase their interest in the topic, which led to a better retention of the learning material and contributed towards the positive learning experience as perceived by the students in this study [13,22].

In the evaluation of these exercises, the majority of the students agreed that the crossword puzzle improved their understanding of the concepts, helped them to learn new words and remember important terms and promoted active learning. They felt that it was a competitive and entertaining method of effective learning. These findings are consistent with the results of the study done by Ritzko, et al., and Saran, et al., [23,24].

Most of the students in this study also agreed that crossword puzzles promoted group discussion and active learning and that they would like to have more puzzles to be used in teaching. Crossword puzzle provided the students with a much-needed break from the monotonous lectures, making them more enjoyable and interesting than traditional teaching techniques. Childers, et al., had reported similar results in their study, where the use of crossword puzzle had been considered as enjoyable and helpful for the students [12-25].

Majority of the students gave a positive response and commented in favor of the crossword puzzles as being “very interactive”; “enjoyed it hugely”; “better than lectures” and “interesting”. Some students also pointed out that few students in the groups did not participate wholeheartedly, whereas other commented that “more time is needed to understand and answer.”

Approximately 3% of the students reported “this activity to be a waste of time”, as in the case of beginner students, who may struggle in learning this patois [26]. None of the students found the puzzles unreasonable, too difficult, or constructed with misleading clues.

As far as student’s perceptions towards the crossword puzzles are concerned, our findings were consistent with previous studies conducted by Saxena, et al., Shah, et al., Kalyani, et al., and Nitin, et al., [10,25-27].

Crossman, et al., showed that students achieved higher test scores in a psychology course after using crossword puzzles as study tools [12]. Barclay, et al., observed an improvement in learning, demonstrated by a significant increase in the grades obtained in tests applied after the use of card games in the teaching of cardiology and infectious diseases in an undergraduate course in pharmacy [28]. In the present study also the students score improved from 50% in the first crossword puzzle to 84% in the last crossword puzzle.

Crossword puzzles provide a good break in a lecture as they are traditionally associated with being a recreational activity. Additionally, the advantage of using the crossword puzzles is that it allows students to continue their learning. Involvement in a different activity might also improve the attention span of the students for the remaining part of the lecture and ensure that students review the key concepts covered in a teaching session. Crossword puzzles have

a unique feature of self-correcting due to the length of each word and overlap of each answer from the other answer [24]. This unique feature helps students to correct their mistakes instantaneously. This facilitates in developing their critical thinking and helps them retain the knowledge gained.

Blouin, et al., pointed out in his research that the on-going trends to provide students with huge information in class, together with large class sizes from varied backgrounds, may result in the elimination of a meaningful student-faculty exchange of ideas [3]. This process of teaching and learning had created frustration among both students and faculty who aspire to engage the students at a higher level of learning. Bailey, et al., observed that use of the games which actively involves students during teaching motivates these students and creates an environment of interest not only for the students but also for the faculty [19].

These innovative methods of teaching decrease stress among students and thereby provide a relaxed environment that increases curiosity [29,30]. This enriched learning experienced by the students is due to the break in the monotony of a lecture, which provided an opportunity to restart their “attention clock”, as learners typically have an attention span of about 20-30 minutes [24,30].

According to Rodenbaugh, et al., the students experience a sense of fulfilment in solving and completing a crossword puzzle, as these games are challenging addressing the students ability to investigate, discover, visualize, predict and find solutions to the clues in the puzzle, thus boosting up the self-confidence of these students [31]. Davis, et al., in his study for the effectiveness of crossword puzzles in reviewing for examinations did not found any significant difference between learners who used crossword and those who did not [32]. This underlines the fact that since modern-day learners have more diversity in learning styles, educational games could cater to and stimulate a certain class of learners and enhance their performance.

Bryant pointed out that, the teachers in the present education system must design activities which focus on students learning on how to make use of the scientific knowledge to solve important questions [5]. The student performance in these courses has improved since the introduction of this intervention along with other active learning interventions as measured by increasing class average and the narrowing gap between the highest and lowest mark. In view of this general improvement in student performance, it is perhaps safe to claim that crosswords are a useful tool in expanding the repertoire of active learning methods. Our findings are consistent with previous studies [12,29]. Although we have not linked crossword items specifically to exam questions, other researchers have noted a positive correlation between exam questions and concepts reviewed in puzzles and games [33].

CONCLUSION

Crossword puzzles provided students with an opportunity to think critically, collaborate, compete and discuss salient concepts by using essential vocabulary associated with these concepts. This study provides insight into the utility of crossword puzzles in undergraduate medical education to reinforce concepts and vocabulary in an interactive learning atmosphere, and the response/perception of the students towards the inclusion of crosswords in anatomy teaching

LIMITATIONS

The limitation of our study was that the research was conducted in only one institution with a small sample size. A study involving successive batches and possibly other institutes could be more meaningful. The dual scoring system was not implemented.

Future Study

The present study provides a broad scope for further research which can be directed to determine the impact of such exercises on critical thinking, team building and retention of the vocabulary of challenging subjects in undergraduate medical education. The study can be extended in a form of a controlled experiment which can identify the key contributory aspects of this interposition.

- To design more crosswords on topics related to histology, embryology, and genetics
- To design crosswords on topics related to other subjects of basic medical sciences
- To compare the effectiveness of crossword puzzles with other learning methods
- To administer a Comprehensive Integrative Puzzle (CIP) after the completion of all the topics

DECLARATIONS

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Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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