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Scope of Use of Crossword Puzzles in Competency-Based Medical Education: An Experimental Study.

Ruchita Ramesh Khandre¹, Vaishali Praful Bansod², and Shradha Shripad Kulkarni^{3*}.

¹Senior Resident, Department of Community Medicine, Bharatratna Atal Bihari Vajpayee Medical College (BAVMC) Mangalwar Peth, Pune, Maharashtra, India 411011.

²Assistant Professor, Department of Community Medicine, Bharatratna Atal Bihari Vajpayee Medical College (BAVMC) Mangalwar Peth, Pune, Maharashtra, India 411011.

³Associate Professor (Department of Community Medicine, Bharatratna Atal Bihari Vajpayee Medical College (BAVMC)) Mangalwar Peth, Pune, Maharashtra, India 411011.

ABSTRACT

A crossword puzzle as an active learning approach is an effective tool to enhance their interest in learning and promote their critical thinking. The study was planned to compare the effectiveness of crossword puzzle and traditional teaching method based on student's performance and to understand their perception regarding cross-word puzzle as a teaching learning method. The experimental study was conducted among medical undergraduate students in their second year of M.B.B.S. by the Department of Community Medicine. The students who consented to participate in the study were randomly divided into two groups i.e. the Crossword puzzle group & traditional teaching group. Two suitable topics (Food Hygiene and Air Pollution) from the syllabus were chosen, and the crossword puzzles that were incorporated into the lecture were prepared. Performance of students of both groups was assessed by Multiple Choice Questions (MCQs) exam. Student's perception was also recorded using pre-validated questionnaire based on 3-point likert scale. Data was analyzed in MS Excel and R software. Scores between two groups were compared using unpaired Student's t-test. The 35 students in the crossword puzzle group ($M = 7.46$, $SD = 1.07$) compared to the 34 students in the traditional teaching group ($M = 6$, $SD = 1.325$) demonstrated significantly better result in the MCQ test on topic of food hygiene, $t(67) = 5.213$, $p = 0.001$. Similarly, the 31 students in the crossword puzzle group ($M = 7.24$, $SD = 1.53$) compared to the 30 students in the traditional teaching group ($M = 6.23$, $SD = 1.60$) demonstrated significant better result in the MCQ test on topic of air pollution, $t(59) = 3.007$, $p = 0.003$. The feedback from the students suggests that the majority of the students agreed that the crossword puzzle was an innovative educational tool that improved their understanding, lateral thinking, memory, and communication skills in a team and encouraged effective and active participation. The effectiveness of crossword puzzles and their acceptability by students favour their usefulness as an innovative teaching tool in the curriculum.

Keywords: Medical education, crossword puzzle, learning.

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**Corresponding author*



INTRODUCTION

Didactic lectures are common in medical classrooms, where the lecturer occupies the central role while students are passive listeners. We need to emphasize competencies like critical thinking, teamwork, and problem solving, which are not part of didactic lectures. Learning must be dynamic, pleasant and supported by educational techniques that encourage students to actively participate in learning. A teacher should be able to serve as a facilitator in the learning process by creating all learning designs to encourage active and innovative learning [1].

Crossword puzzles are a sort of word jigsaw puzzle and frequently made up of grids of squares with white and black shading that are arranged vertically or horizontally. A crossword puzzle as an active learning approach is an effective tool to enhance their interest in learning and promote their critical thinking [2, 3]. By solving puzzles, students may fill up their knowledge gaps and improve their weak areas. In other words, when one finds the correct answer, they feel more confident in their knowledge, which in turn boosts their sense of self-sufficiency and satisfaction. It has been demonstrated that crossword puzzles are useful as educational tools for terminology, definitions, spelling, and pairing key concepts with related names, leading to improved retention of memory. Crossword puzzles have been effectively employed as teaching tools in a variety of academic disciplines and have been proven to be beneficial for learning novel concepts or technical terminology, instructing students to distinguish between similar terms, accurately spelling, and drawing conclusions [3, 4].

The current study was conducted to test that whether the crossword teaching method is suitable for Community medicine topics and to assess its effectiveness on students' performance. Thus the study was planned to compare the effectiveness of crossword puzzle and traditional teaching method based on student's performance and to understand their perception regarding cross-word puzzle as a teaching learning method.

METHODOLOGY

Study Design

The crossover experimental study was conducted among medical undergraduate students in their second year.

Study Setting

This study was conducted by Department of Community Medicine in a Medical College in Maharashtra among second year Medical Students of batch 2021-22 after obtaining Institutional Ethics Committee Approval.

Randomization

The students were briefed about the objectives and a brief outline of crossword puzzle and traditional teaching method as pedagogical tools were elaborated. The students who consented to participate in the study were randomly divided into two groups i.e. the Crossword puzzle group & traditional teaching group. Randomization was done by lottery method. One batch had a traditional teaching method and the other batch a crossword puzzle teaching method.

Study Material

A crossword puzzle on Food Hygiene (Fig 1a) and Air Pollution (Fig 1b) was prepared by the faculty and the clues (across and down) were created using standard reference textbooks of Community Medicine. The two topics were decided after looking at their importance in the syllabus and post-discussion with the faculty. The Content validity was ensured by linking the clues and answers to specific learning objectives of the topic. Content and format of crossword puzzle were validated by subject experts.

Figure 1a: Crossword Puzzle on Food Hygiene

Across

- Which helminth is the most common in raw meat?
- The process in which, milk is heated for specific temp. & duration to kill all pathogens?
- Clean, Cook, Separate, _____ are steps for food safety.
- A diarrheal disease transmitted from food handlers.
- What is the minimum essential procedure that helps to prevent microbes spread?

Down

- _____, consistency, appearance, smell should be look for fresh meat.
- _____ is the rare but most deadly foodborne illness.
- Which is the statutory body for food safety in India?
- In _____ method of pasteurization, temperature of milk raised to 65°C then rapidly to 5°C.
- For how much minimum duration you should wash your hands?

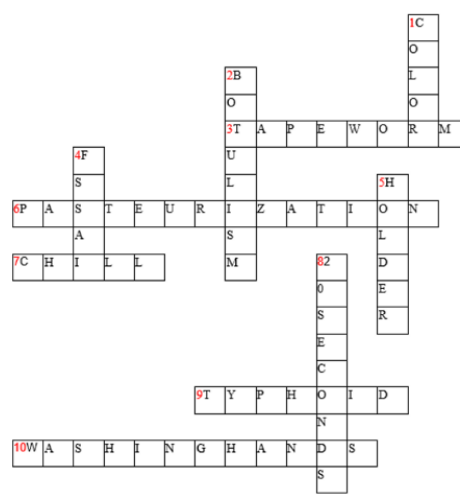


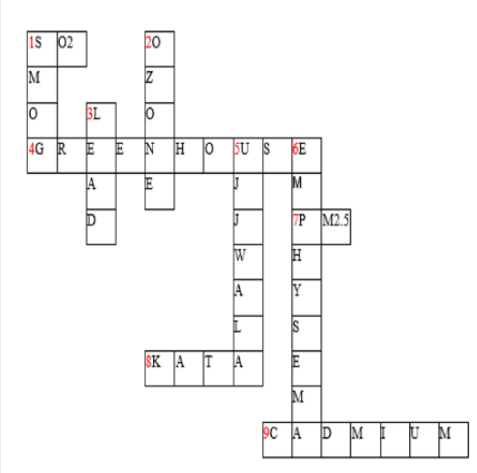
Figure 1b: Crossword Puzzle on Air Pollution

Across

- _____ is considered as best indicator of air pollution.
- _____ effect causes global warming.
- _____ pollutant/indicator is used in Air quality index and World ambient Air Quality index.
- _____ thermometer uses for measuring cooling power.
- Guess the pollutant present in cigarette along with tobacco.

Down

- The combination of fog and smoke.
- One of the secondary pollutants.
- _____ poisoning causes mental retardation in child.
- _____ scheme aims to safeguard the health of women and child by providing clean fuel.
- One of the respiratory illness due to air pollution.

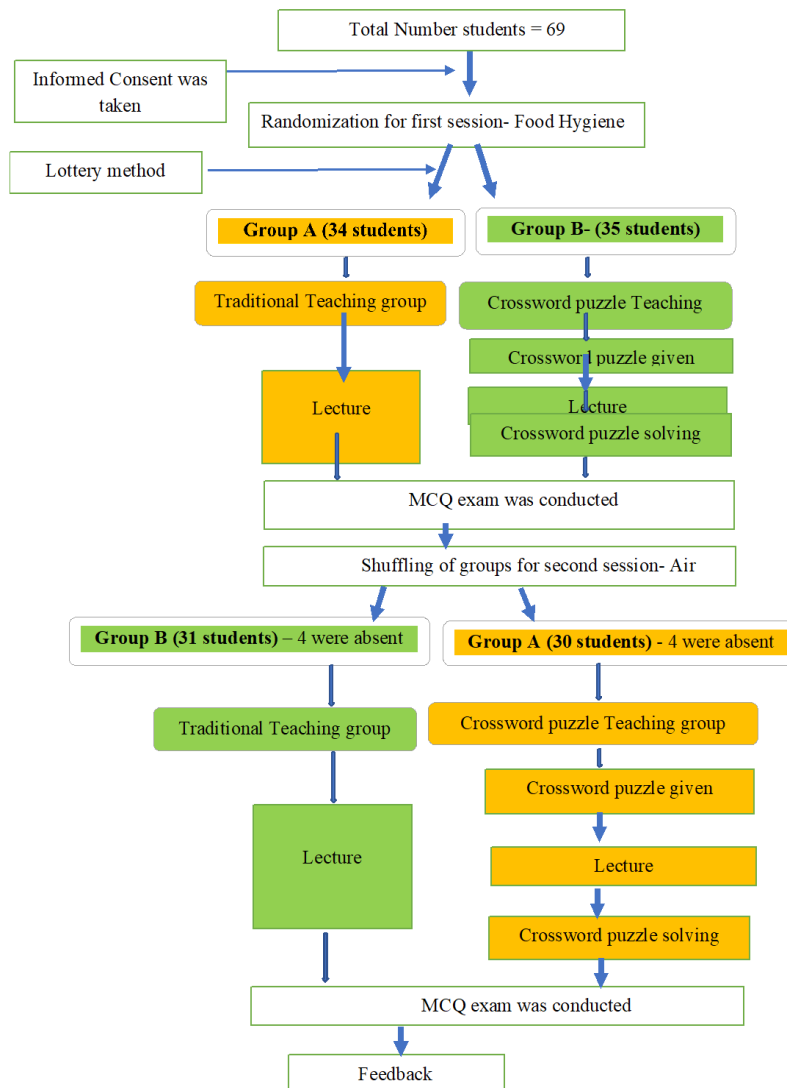


Crossword Activity

In the first lecture, the crossword puzzle on ‘Food Hygiene’ was distributed to students of Crossword puzzle group and asked them to solve it based on their existing knowledge in a few minutes to sensitise them regarding the importance of the topic, and then the lecture was begun. They were told the answers of the puzzle are present in the lecture content. After the lecture, students were asked to solve the remaining puzzle again, and then the correct answer was displayed. While on other hand traditional teaching group had didactic lecture. At the end, the MCQ exam was conducted to assess performance of students of both groups.

For the second lecture, a crossover of groups was done, but the faculty members were kept as per the previous session for both traditional teaching and crossword puzzle teaching. The previous batch, who went for traditional teaching now, were called for cross-word puzzle teaching. Similarly, to the previous session, a crossword puzzle on ‘Air Pollution’ was distributed to the students, and a few minutes were given to solve the puzzle. After the lecture finished, a few minutes were allowed to solve it, and later on MCQ exam was taken in both groups. (Fig 2) A post-lecture exam in MCQ format was conducted through Google form to assess their performance.

Figure 2: Flowchart of conduction of study and data collection



Feedback

The feedback questionnaire was validated by the subject experts and Cronbach's alpha was calculated for coefficient of reliability with internal consistency of 0.89. Feedback was taken from the students by administering a pre validated questionnaire using Google form to evaluate their perceptions about crossword puzzle as an active learning tool using 3-point Likert scale where 1 = Disagree, 2=Neutral, 3=Agree.

Statistical Analysis

The collected data was coded and entered into Microsoft excel and analyzed. Percentages and proportions were calculated. Mean scores and standard deviation for each question on perceptions using Likert scale was calculated. Data was analyzed in MS Excel and R software. Scores between two groups were compared using unpaired Student’s t-test. The p-value <0.05 was considered statistically significant.

RESULTS

Out of 100 students, 69 were present for food hygiene topic class and, 61 were present for air pollution topic class. Rest students were absent on that particular day.

Mean score of the students in Multiple Choice Question (MCQ) tests taken after teaching with crossword puzzles of both topics were found to be 7.46 and 7.24 as compared to 6 and 6.23 mean score after traditional teaching method and the difference is statistically significant. ($p < 0.05$) (Table 1)

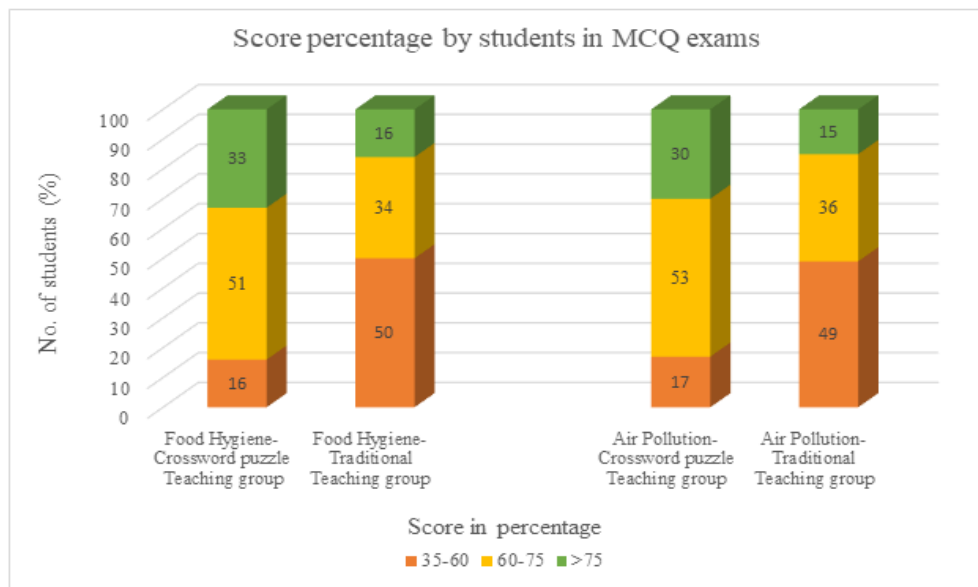
Table 1: Performance of students

Topic	Topic 1: Food Hygiene		Topic 2: Air Pollution	
	Group A (n=34)	Group B (n=35)	Group A (n=30)	Group B (n=31)
Teaching-learning method	Traditional	Crossword puzzle	Crossword puzzle	Traditional
Mean (Score out of 10)	6	7.46	7.24	6.23
SD	1.325	1.07	1.53	1.60
Independent t-test	5.213		3.007	
p-value	<0.001*		0.003*	

*= significant

Nearly one third of students in the cross-word puzzle teaching group scored more than 75% in the MCQ exam in the food hygiene and Air pollution topics. (Fig 3)

Figure 3: Score percentage by students in MCQ exams



Based on feedback, we found that 80% of students have enjoyed solving crossword puzzles to the fullest. (Fig 4a) 42.65% and 53.92% of students strongly agreed with the use of crossword puzzles as assessment methods in formative exams and their incorporation in medical education as self-directed learning methods, respectively. 67.46% of students strongly agreed with the recommendation of more use of crossword puzzles in further teaching and learning methods. While half of the students (53.07%) strongly agreed on the competitive aspect of the crossword puzzle, which encourages their effective participation. 56.35% and 57.20% of students strongly agreed that crossword puzzles help them build teamwork and play a role in students' active participation in learning, respectively. Also, 54.34% and 61.90% of students strongly agreed that crossword puzzles help in remembering core terminology and concepts of topics and stimulate lateral thinking, respectively. 61.48% of students agreed that the crossword puzzle improved their understanding of the topic. (Fig 4b)

Figure 4a: Feedback of students

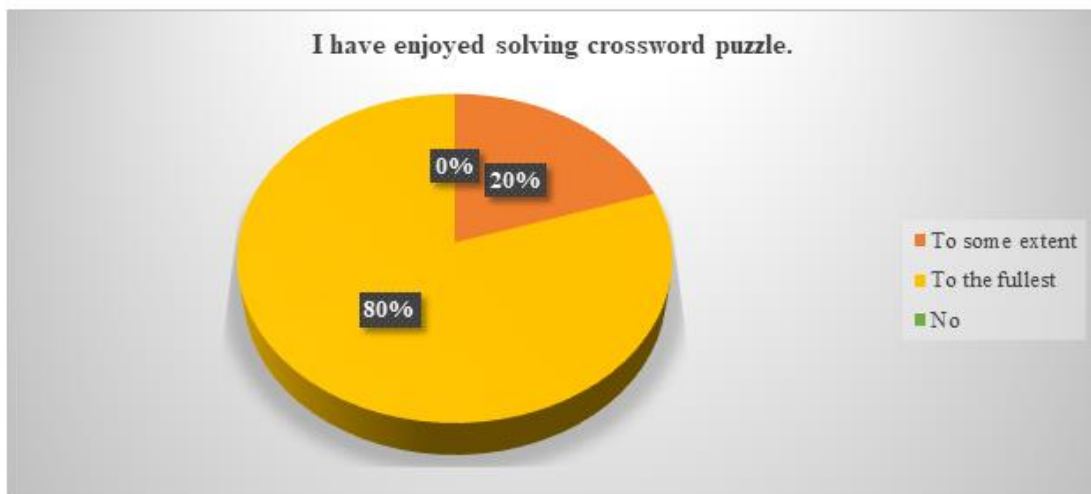
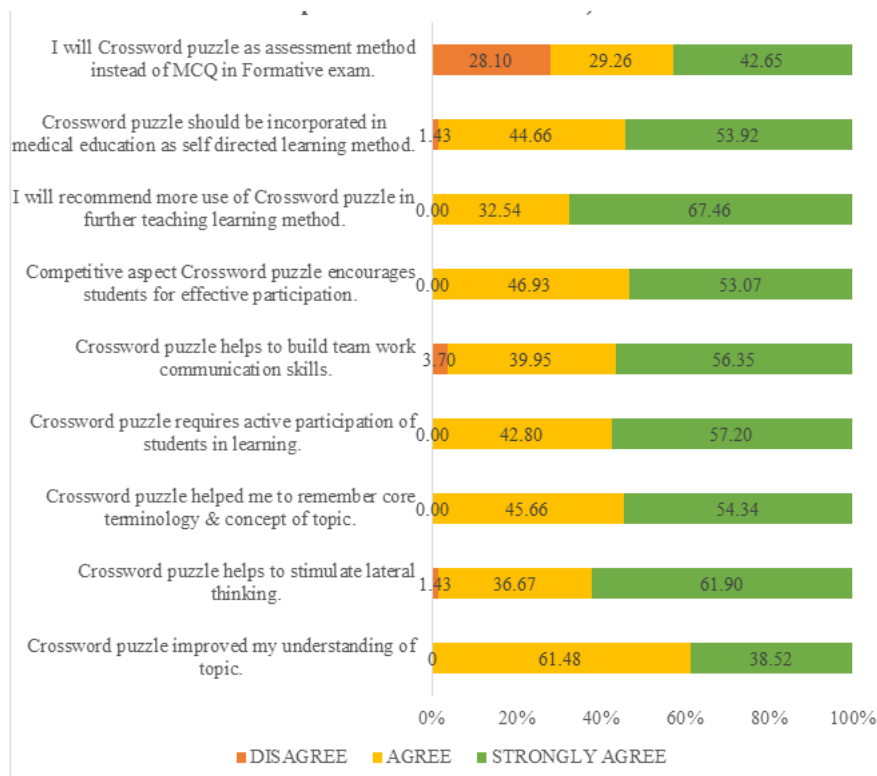


Figure 4b: Feedback of student (Questionnaire responses on a three-point validated ordinal scale)



DISCUSSION

The crossover experimental study was conducted among second-year medical graduates using an innovative teaching-learning method, i.e., crossword puzzles, on two important topics in two different sessions. The 35 students in the crossword puzzle group ($M = 7.46, SD = 1.07$) compared to the 34 students in the traditional teaching group ($M = 6, SD = 1.325$) demonstrated significantly better result in the MCQ test on topic of food hygiene, $t(67) = 5.213, p = 0.001$. Similarly, the 31 students in the crossword puzzle group ($M = 7.24, SD = 1.53$) compared to the 30 students in the traditional teaching group ($M = 6.23, SD = 1.60$) demonstrated significant better result in the MCQ test on topic of air pollution, $t(59) = 3.007, p = 0.003$. (Table 1) The result was consistent with the study done by Torres et al. among students of different fraternities.(5) A similar result was found in a study done among medical students for topics under the biochemistry and pharmacology subject [3, 6]. The result might be due to an increased

attention span with crossword puzzles instead of traditional teaching, which gives students the opportunity to think critically and recall. The study results were consistent with the results of other similar studies of other clinical and paraclinical subjects in the medical profession [3, 7-9].

The given study demonstrated the potential advantage of including crossword puzzles in traditional lectures. In two separate MCQ exam, nearly 50% of the crossword puzzle group's students scored between 60 and 75%, while approximately 30% of the crossword puzzle group's students scored more than 75%. (Fig 3) Different articles have shown that crossword puzzles are effective tools to teach different terminology, definitions, and key concepts with greater retention of memory, which can enhance their performance [3, 10, 11].

The student performance reflected in the MCQ exam suggests how the students from each group were involved in the teaching-learning session, and the active participation of the students in the crossword puzzle was evident. The innovative teaching method using crossword puzzles drives the attention of students, enhances critical thinking, and promotes active participation. Thus, innovative teaching should be promoted, which can be made possible with the incorporation of fun exercises like word scrambles, hidden words, word puzzles, and word searches into the didactic lectures [11].

The feedback (Fig 4) from the students suggests that the majority of the students agreed that the crossword puzzle was an innovative educational tool that improved their understanding, lateral thinking, memory, and communication skills in a team and encouraged effective and active participation. The feedback from students suggests the acceptance of crossword puzzles in regular teaching and as formative exams, too. The findings were similar to those of other studies based on the perspective of students on crossword puzzle teaching [10,12,13].

The study carried out by N. Gaikwad among second-year undergraduates in the Department of Pharmacology mentioned the enthusiasm and enjoyment students felt in crossword puzzle teaching [14].

The written comments of students indicated their enthusiasm and desire to solve puzzles regularly. One student stated, "*More such interactive teaching methods should be incorporated into regular teaching*". Others supported with comments, "*Use more puzzles*", "*Yes, I agree with using crossword puzzles to include in a self-directed learning programme because it enhances our ability to think*." Other comments were "*The frequency of this teaching method should be increased*", "*more such types of group discussions should be taken*," and "*great idea of taking puzzles in regular lectures*."

Based on the findings, we recommend the use of crossword puzzle teaching in regular teaching, which is feasible and consumes less time in preparation. Other educational tools, like word scrambles, word searches, and hidden words, are also available to be incorporated into didactic teaching to enhance the students' participation as well as their performance.

The study strength was the use of validated study tool. The feedback questionnaire was analyzed for coefficient of reliability by Cronbach's Alpha and gave an internal consistency of 0.89. But due to the lack of sufficient time as the schedule was tightly packed, we could not implement it to all the units of Community Medicine. However, there is scope to assess the study results on a larger scale with horizontal and vertical integration of topics under different subjects of the medical profession.

CONCLUSION

The effectiveness of crossword puzzles and their acceptability by students favor their usefulness as an innovative teaching tool in Community Medicine. The crossword puzzles were found to be an effective teaching and learning method as compared to traditional methods involving students' active participation in learning in groups as a team, allowing them to do lateral thinking, resulting in understanding the core terminology and concept of the topic and the development of communication skills.

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