

Original Research Article

Crossword puzzle: a tool for enhancing medical students learning in microbiology and immunology

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ABSTRACT

Background: Incorporation of active-learning methods into classroom allows students to be motivated and enhances their learning experience. Crossword puzzles are found to be an interesting educational tool for teaching medical students as it evokes interest, motivates, enhances their critical thinking, allows a better understanding of concepts, and helps in reinforcing the material acquired during lecture. Aims and Objectives of the research work was intended to implement and evaluate the use of crossword puzzle as a tool in effective learning of Microbiology and Immunology.

Methods: Using free online resources, crossword puzzles were created and provided to the students during microbiology and immunology lectures. Students' perceptions of the crossword puzzle activity were assessed through an 8-item questionnaire using a 5-point Likert scale. The data was collected, tabulated, and statistically analyzed.

Results: More than 85% of the students indicated that crossword puzzles enhanced their learning, oriented them to the important topics, and served as good tool in effective learning of microbiology and immunology.

Conclusions: Students perceived that crossword puzzles enhanced their learning of microbiology and immunology. Use of crossword puzzles provides a simple, creative, and effective means to incorporate active learning of microbiology and immunology in the classroom.

Keywords: Active learning, Crossword puzzles, Immunology, Microbiology

INTRODUCTION

In spite of advances in modern medical education, the bulk of undergraduate teaching is through traditional powerpoint lecture presentations in majority of the medical schools all over the world.¹⁻³ Research shows that such passive learning activities are boring to the students and provide less knowledge retention and less encouragement in learning.^{1,2} In contrast, recent studies have shown that an implementation of active learning exercises which involve discussion, practicing by doing, or games and puzzles result in much more effective in stimulating the cognitive functions of the students.⁴ Active learning exercises provide major benefits such as

the development of critical thinking, communication skills, a better understanding of concepts and increasing motivation.^{5,6} Modern technology provides important tools which always help faculty members to develop inventive and creative educational materials that would complement and augment the traditional classroom power point teaching.⁵⁻⁸

Crossword puzzles are found to be an interesting educational tool for teaching medical students as it evokes interest, motivates students, enhances their critical thinking and helps in reinforcing the material acquired during lecture.^{5,9-11} Furthermore, crossword puzzles have been used successfully in many different disciplines as

teaching aids and have been found to be helpful in acquiring new vocabulary or technical terminology, imparting the ability to distinguish between similar terms, correctly spelling these terms, drawing conclusions, evaluating options, and developing logical thinking.^{4,12}

The fifth-year medical undergraduate students at Oman Medical College are introduced to many new terms and concepts in Microbiology and Immunology. This has posed a challenge to the faculty in providing adequate practice and necessary repetition to reinforce key concepts. Crossword puzzles are found to be one of the easy and inexpensive activities to quickly summarize and emphasize the important facts and concepts delivered during regular lectures. Hence, this study was carried out to determine students' perception in Microbiology and Immunology crossword puzzles as an active and effective learning tool.

METHODS

Using a free online resource (<https://worksheets.theteachercorner.net/make-your-own/crossword/#>), crossword puzzles were designed for many of the Immunology (autoimmunity, transplantation, hypersensitivity, tumor immunology, and vaccination) and Microbiology lectures. These lectures are part of the Microbiology and Immunology integrated course in the fifth year at Oman Medical college. Oman Medical College follows seven-year MD curriculum and is in academic collaboration with West Virginia University, USA. A sample of the type of questions prepared is shown in Figure 1.

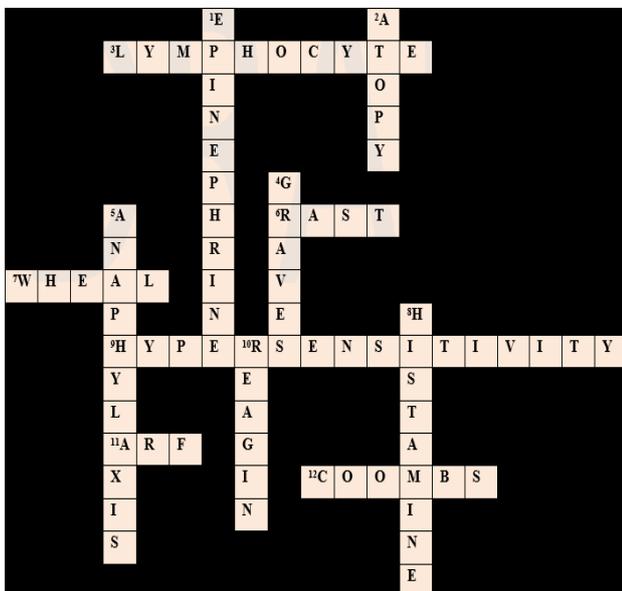


Figure 1: A sample of immunology crossword puzzle.

Across

- A type of cell predominantly involved in chronic rejection of the graft (Lymphocyte)

- An immunological test used to detect antibodies against specific allergen (rast)
- During allergic skin testing, development of edema at the site of injection is referred as (wheal)
- A phenomenon that occurs due to an exaggerated immune response to harmless environmental antigens is called as (hypersensitivity)
- A non-suppurative complication associated with post streptococcal infection due to a phenomenon of molecular mimicry (ARF)
- An investigation commonly done to diagnose autoimmune hemolytic anemias (coombs).

Down

- A drug which is considered to be lifesaving in severe allergic reaction (epinephrine)
- Genetic tendency to synthesize inappropriate levels of IgE specific to external allergens is called as (atopy)
- An autoimmune disorder that develops due to production of autoantibodies against thyroid stimulating hormone (TSH) receptor (graves)
- A severe allergic condition that develops within few seconds to minutes following exposure to allergen is called as (anaphylaxis)
- Potent inflammatory mediator released by the degranulation of mast cells (histamine)
- An antibody that binds to high affinity FcεR1 receptors on mast cells is also called as (reagin).

The lectures were taught in detail in the classroom, covering various aspects of the topic such as definitions, key concepts, terminologies, mechanisms of diseases, and investigations. Definitions of terms introduced in the class and specific information such as concepts of autoimmunity, types and factors contributing to transplant rejection, development of cancer, mechanisms of diseases, and laboratory investigations presented in the lecture were supplied into “down” and “across” clues to solve the crossword puzzle. The puzzle clues were developed in alignment with the learning objectives for the lecture. The printed crossword puzzle sheets were distributed to all the students in the classroom at the end of the lecture. After informing rules of the activity, students were asked to complete the puzzle in 15 minutes. At the end of the activity, each question was discussed, and their doubts and misconceptions were clarified.

Approval to conduct study was obtained from the Institutional Research and Ethical committee. Informed consent from the students for participation was taken. A Questionnaire on the perceptions of the students regarding the usefulness of crossword puzzles in teaching and learning were distributed to all the 5th-year medical students at the end of the course for evaluation. The evaluation was performed on a 5-point Likert scale (1= strongly disagree and 5 = strongly agree). The data was collected, tabulated, and statistically analyzed.

RESULTS

A total of 114 students out of 120 enrolled in the class of batch 2019 evaluated the crossword puzzle activity. An anonymous questionnaire survey was developed to assess the student's perceptions of crossword puzzle activity as a tool to enhance their learning in the classroom. The questionnaire consisted of 8 statements with a 5-point Likert scale (strongly disagree to strongly agree) to assess the responses of the students in relation to various outcomes of the activity (Table 1).

The statements in the questionnaire measured students' responses such as the strengthening of classroom learning skills, an ability to identify key areas of the lecture, a better understanding of concepts, communication skills, a better understanding of key terminologies, a better performance in examination, and overall improvements in their learning skills.

In addition to the 8 questionnaire statements, students were asked to provide additional comments regarding the activity if they desired.

Table 1: Results of questionnaire survey on usefulness of crossword puzzle activity in classroom learning.

Questions	Responses %					Mean (SD)
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Crossword puzzles helped me to identify important areas of the topics	0.9	2.6	2.6	9.6	84.2	4.74(0.72)
Crossword puzzles are helpful in connecting different aspects of the topic	2.6	5.3	7.0	13.2	71.9	4.46(1.01)
Solving crossword puzzles in the classroom are entertaining way to boost my understanding of the topic	1.8	3.5	6.1	12.3	76.3	4.58(0.89)
Solving crossword puzzles in the classroom are good reviews of lecture content	0.9	0.9	7.9	20.2	70.2	4.58(0.75)
Solving crossword puzzles improved my examination scores	0.9	5.3	7.9	16.7	69.3	4.48(0.91)
I would enjoy doing more crossword puzzles	-	2.6	4.4	6.1	83.3	4.74(0.66)
Crossword puzzles improved my knowledge of vocabulary	2.6	5.3	6.1	7.9	78.1	4.53(1.01)
Crossword puzzles enhanced my overall learning	-	0.9	7.0	12.3	79.8	4.71(0.63)

Over 88% of the students (101 out of 114 students) either agreed or strongly agreed that use of crossword puzzles in the classroom is a good active learning exercise and it enhanced their learning of Microbiology and Immunology. More than 90% of the students indicated that crossword puzzles helped them to identify the important areas of the lecture topics and it provided a good review of the lecture content.

Also, 85% of them believed that crossword puzzles improved their ability to connect different areas of the topic. Majority of the students (92.1%) opined that crossword puzzles greatly enhanced their overall learning and clues helped them to retain knowledge of different key concepts and terminologies.

Most of the students (89.4%) suggested for more frequent use of crossword puzzles in the classroom as it is great fun doing in the classroom and unique way of testing their comprehension of the lecture contents. Nearly 86% of the students indicated that crossword puzzles helped them to improve their examination grades.

DISCUSSION

The aim of our study was to assess students' perception of crossword puzzles in the classroom as a creative and interactive educational means to strengthen their learning skills. The Students' responses to survey questions strongly suggest multiple benefits of the use of crossword puzzles in adjunct to the routine didactic lectures. Students reported crosswords to be of benefit in identifying key concepts, comprehend and get conversant with new medical terms. The majority of the students described crossword puzzles as a unique active learning tool that helped them to learn better as they were interactive, enjoyable, and provided a change from routine monotonous didactic lectures. The students pointed out that completing the crossword puzzles provided a good review of the content discussed in the classroom lectures and also it enhanced their collaborative learning.

A majority of the students also indicated that crossword puzzles stimulated and strengthened their overall learning skills and provided a good review for the examination. The results of our study are consistent with previous

studies that assessed the effectiveness of the crossword puzzles in students learning.

Samith Shah et al and Htwe TT et al in their studies indicated that crossword puzzles contributed to the students learning by identifying key areas of the topic and enhancing their vocabulary, critical thinking and knowledge retention.^{5,6} Using recreational games during classroom lecture decreases stress among students and thereby provides a relaxed environment to learn better.^{1,13} In many of the previous studies, crossword puzzles were found to contribute to the overall learning of the undergraduate medical students.⁵⁻¹⁰ Crossman EK in his study on psychology course also showed that students achieve better scores after using crossword puzzles.¹³

A contributing factor to the enhanced learning skills in crossword puzzles is due to dry and monotonous nature of the regular didactic lectures. Studies have shown that adult students have an attention span of 20-30 minutes and hence it is good to shorten the traditional lecture and implement recreational learning exercises such as crossword puzzles, online quizzes, and audio-video clips. The crossword puzzles enhance their learning skills because it involves students to read through the clues, recall and review the lecture material, and engage in discussion with other students to clear any misconceptions about the lecture topic.^{5,9} This contributes to better comprehension and retention of the knowledge and will prepare them better for examination.

CONCLUSION

From the findings of our study, it can be concluded that crossword puzzles are useful in enhancing students learning and aid in their exam preparation. Use of classroom crossword puzzles provides a simple, creative, and effective means to incorporate active learning into a number of medical courses including Microbiology and Immunology.

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