*Original Article*

International Physiology
Vol. 8 No. 3, September – December 2020
DOI: https://dx.doi.org/10.21088/ip.2347.1506.8320.1

# Reinforcing concepts of renal physiology by crossword puzzles

**[1]Bharati Mehta, [2]Bharti Bhandari, [3]Ayush Kaushal**

**How to cite this article:**
Bharati Mehta, Bharti Bhandari, Ayush Kaushal, Reinforcing concepts of renal physiology by crossword puzzles, International Physiology.2020;8(3):8–10.

**Author's Affiliations:** [1]Professor, Department of Physiology, All India Institute of Medical Sciences, Jodhpur, Rajasthan 342005, India. [2]Associate Professor, Department of Physiology, Government Institute of Medical Sciences, Greater Noida, Uttar Pradesh 201310, India. [3]Trainee, Emirates Specialty Hospital, Dubai Health care city, Dubai, United Arab Emirates.

**Corresponding Author: Bharati Mehta,** Professor, Department of Physiology, All India Institute of Medical Sciences, Jodhpur, Rajasthan 342005, India.

**E-mail:** drbharati2005@yahoo.com

## Abstract

Medical teachers work tirelessly to develop innovative and effective educational tools that enhance and supplement the conventional didactic lectures. We introduced crossword puzzles prior to didactic lectures, as a supplemental learning tool to help students get primed with upcoming terms and concepts.

Before traditional lectures, the crossword puzzles were administered in groups of 8 students each (n=73) on two different occasions. They were allowed to discuss and refer to books/internet to solve the puzzles. A batch of 82 students was not given crossword puzzles served as the control group. A Multiple Choice Question test (MCQ) was conducted and the scores in crossword group and control group were compared.

Students' perceptions on the crossword puzzles were assessed using a questionnaire.
The average raw scores in MCQ test of the students in crossword group (n=73) and control group (n=82) were 36.43 ± 6.14 and 31.59 ± 7.18 respectively (p =0.000) and the students' satisfaction with this learning method was >75% for most of the items of the questionnaire.

Crossword puzzles constitute an interactive and fun-filled active learning with peers in a non-threatening environment. Given before teaching the topic, they primed the students with the upcoming concepts and later during traditional teaching, the same were reinforced. Solving crossword puzzles enabled students to self-assess their own understanding of concepts and also to identify their weak areas, which can be corrected later through a targeted approach.

**Keywords:** Crossword; Active Learning; Self- directed Learning.

## Introduction

For years, the mode of presenting facts or concepts to the students has been through passive teaching, primarily didactic lectures. Gradually methods are evolving that engage students in the learning process. Competency based medical education (CBME) encompasses a shift in the teaching-learning (TL) paradigm from teacher-centric to student-centric medical education. With the implementation of CBME curriculum in India, innovation in the active TL method is the need of the hour. The advantages of the use of games or puzzles as learning tools have been widely reported in various medical specialities. [1,-3] Puzzles are problem-solving activities that require learners to formulate solutions and are gradually proving their effectiveness in medical education 4. Crossword puzzles as a learning tool has been used successfully in pathology, pharmacology, physiology, nursing and veterinary sciences as a fun activity.[1,3,5-7] Solving crossword puzzles has shown to stimulate the intellect, intensify the glossary and preclude passive memorization of facts.[8] Thus, solving of crossword puzzles promotes critical thinking and analytical skills and also improves self-directed learning skills among the learners.[7] The above-mentioned studies that introduced crossword puzzles, examined the students' perceptions on crosswords but most of them did not compare the scores of the students. Also, in all of the studies, the crosswords were given after the didactic lectures. The current study was planned to introduce crossword puzzles prior to the didactic lectures, as a supplemental learning tool to help first year undergraduate medical students get primed with and understand the terms and concepts of renal physiology by a collaborative approach. The objectives of the study were to evaluate the effectiveness of crossword puzzles in reviewing and understanding the concepts of renal physiology when used along with traditional teaching and to describe students' perceptions on introduction of crosswords in Physiology teaching.

## Materials & Methods

The study was commenced after taking approval from Institutional Ethics Committee. A total of 155 first year undergraduate medical students participated in the study.

Before traditional lectures on some topics of renal physiology, the crossword puzzles were administered to 73 students, in a non-testing environment in groups of 8 students each, on two different occasions. The crossword puzzles were made online at the Discovery School's puzzle maker Web site http://puzzlemaker.school.discovery.com. The puzzles (Fig. 1 and 2) had vertical columns with words running from top to bottom and horizontal rows with words running from left to right. None of the words ran diagonally or were inverted. Before introducing the crossword puzzles to students, the contents of both the crossword puzzles were validated by experts from the Physiology Department. Each crossword contained 20 clues covering two topics - glomerular filtration and tubular reabsorption. Since the students were given these crosswords before teaching the renal system, many of the questions were factual (lower levels in Bloom's taxonomy) but some were conceptual testing higher degrees of Bloom's pyramid. The students were given one hour to complete the crossword puzzle; for solving these puzzles, they were allowed to discuss among themselves and refer to books/internet. A teacher and two residents were present in the class during the activity. Thereafter the answers of the crosswords were discussed.
The activity was followed by didactic lectures in the given topics over a period of three days where the facts and concepts which were asked in crosswords were reinforced. After finishing all the teaching lectures on renal physiology, a system completion test of 50 MCQs was organized. The test consisted of a mix of factual and conceptual questions; testing all the levels of Bloom's hierarchy.

A group of 83 students, were not given crossword puzzles. However they appeared for the same system completion MCQ test after their didactic lectures were over. They served as the control group of our study.

A feedback on the crossword activity was obtained from the students (n=73) by administering a pre-designed and validated questionnaire.[9] The responses were measured on a Likert scale. The Likert scale was reversed for items 6 and 9; this was intentionally done because people have a tendency to check the best responses in feedback forms without sometimes reading the questions. So to ensure that they read the questions and then answer, the scale in these items was reversed. Students were asked to complete the survey during class time in the presence of the tutors. They were asked not to record their names for anonymity. Feedback responses of the students were recorded and satisfaction index for each item was calculated with the following formula:-

$$[(n1 * 1) + (n2* 2) + (n4* 4) + (n5* 5)] * 20$$
$$(n1+ n2 + n4 + n5)$$

Where, n is the total number of students gaining the score mentioned in the subscript for that particular item (n3 is not included because it is the neutral response).

Statistical analysis was performed using the IBM Software (Statistical Package for the Social Sciences) SPSS 21. The data was tested for normality. The mean and standard deviation of marks obtained were calculated and scores in both the groups were compared using an Independent Student t test. A $p<0.05$ was taken as statistically significant.

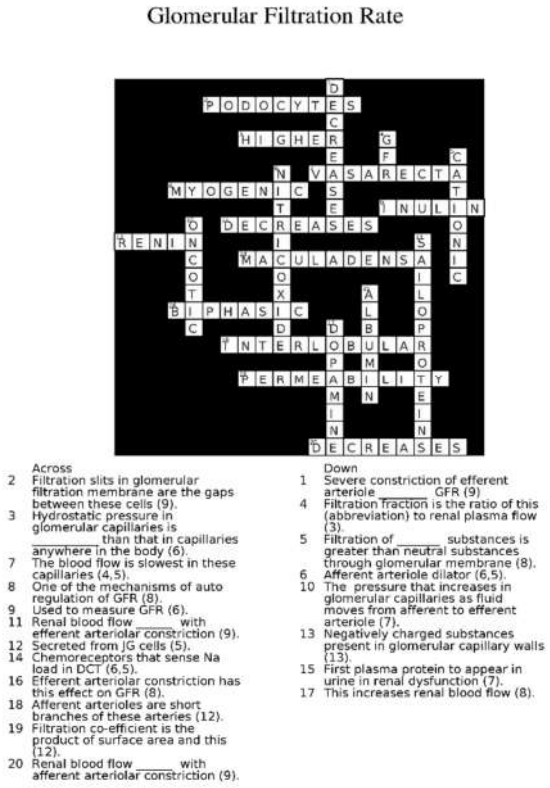


**Fig. 1:** Crossword puzzle: GFR.


**Fig. 2:** Crossword puzzle: Tubular Reabsorption.

## Results

The average scores of the students of crossword group (n=73) and control group (n=82) were 36.43 ± 6.14 and 31.59 ± 7.18 respectively. Minimum score (out of 50) in crossword group was 22, and maximum 47 while in control group, the minimum and maximum scores were 12 and 47 respectively. The data was tested for normality by plotting histograms and Q-Q plots. The Independent Student t test was applied to compare the scores in both the groups. Additionally, the homogeneity of variances was satisfied by Levine's F test with F (153) = 1.87, p= 0.173. The independent samples t-test was associated with a statistically significant effect T 153=-4.48, p=0.000. Thus the students of crossword group obtained significantly higher scores than controls. We also compared the scores of control group and crossword group on MCQ tests on two other systems (GI system and Respiratory system) in which crossword puzzles were not administered to any of the groups; and the difference in scores was not significant. Perceptions of the students (n=73) on incorporation of crosswords were obtained on a validated questionnaire. (Table 1) In our study, for all of the items of the questionnaire, the satisfaction score was >70%. The best score was given to item 9, which stated that the activity was enjoyable. This was followed by item 1, according to which the crossword activity was useful in comprehending the given topic. However, item no. 3 that stated "the activity helped in enhancing communication skills" was rated the lowest by the students. As the students were not asked to make any presentations about their experiences with the crossword activity, this could be the reason for their rating badly to this item.

**Table 1:** Students (n=73) responses to the feedback questionnaire and the satisfaction index.

| Items | Scores | | | | | Satisfaction Index (%) |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| The crossword activity was useful in comprehending the given topic. | 5 | 7 | 5 | 33 | 23 | 78 |
| The activity enabled in depth coverage of the topic. | 6 | 9 | 18 | 26 | 14 | 72 |
| The activity helped in enhancing communication skills. | 8 | 9 | 14 | 28 | 14 | 71 |
| A thorough discussion on the crossword puzzles increased analytical ability. | 6 | 11 | 3 | 35 | 18 | 74 |
| The activity helped in overcoming shyness and hesitation in the class. | 6 | 5 | 15 | 33 | 14 | 75 |
| This form of exercise should not be incorporated for all the topics in physiology. * | 6 | 11 | 16 | 20 | 20 | 73 |
| Are you confident that this knowledge could be applied in clinical practice? | 5 | 11 | 13 | 26 | 18 | 74 |
| The activity helped me to score better in my formative tests. | 6 | 8 | 19 | 25 | 13 | 72 |
| The exercise was not enjoyable. * | 3 | 8 | 5 | 35 | 22 | 79 |
| Crossword puzzle is an effective way of learning. | 5 | 9 | 10 | 33 | 16 | 75 |

**Table 1:** Students (n = 73) responses to the feedback questionnaire and the satisfaction index. Scores were determined as follows: 1=strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. *Scores were reversed for items 6 and 9 (5 = strongly disagree, 4 = disagree, 3 = neutral, 2 = agree, and 1 = strongly agree).

## Discussion

The overall goal of medical education is to make an undergraduate medical student competent, and the medical educators strive to make their teaching effective by introducing innovative teaching-learning tools. The current study was planned to evaluate crossword puzzles as a teaching-learning tool to supplement traditional didactic lectures. Use of games and puzzles for teaching concepts have been shown to improve knowledge and identify the gaps in knowledge.[3,10] In addition, games help in developing critical thinking and analytical skills among students.[2] They enhance cooperative and collaborative skills as students work together in groups to reach a common conclusion.[7,11] Gaming, as an active teaching-learning strategy, has been used in gynecology, pediatrics, pharmacology, psychiatry etc. in addition to didactic lectures.[6,12-14] There are many studies involving successful implementation and evaluation of games like crossword puzzles, jigsaw puzzles, quizzes etc. for understanding concepts in Physiology[3,11,12,15-17], however they mostly evaluated only the perception of students, not the scores.

In our study, the scores in the MCQ test were compared and found significantly higher in the crossword group than controls. The controls were comparable to the crossword group in demographics as well as their level of knowledge because the pattern and difficulty level of the entrance exam to join the medical course was similar for both the groups. However, as compared to controls, the students in crossword group got extra two hours of classroom time and interaction with instructors. The beneficial effect of crossword puzzles may be attributed partly to this too which is a limitation of our study.The perceptions of the students were obtained on a validated questionnaire.

The students enjoyed the interactive learning session with their friends in a fun filled, non-threatening environment. This is in congruence with findings by Shah S et al., 2010.[3] Crosswords given before teaching the topic, primed them with the upcoming terms and concepts. The students also felt that this intervention aided comprehension of topics, and retention of the concepts. Similar findings were observed in other studies also.[3,6,7] since the crosswords were introduced prior to teaching the system, high order questions were few in number. However, all the concepts that were asked in the crosswords were completely comprehended by the students. Enhanced comprehension could be due to thorough discussion on clues with their peers while searching for answers, and recalling and reviewing the text while solving the puzzle. The discussion on the answers by the instructor immediately after the crossword sessions made them understand the concepts which they read at the time of solving the crossword but could not interpret. As for example in Figure 1, answer to clue number 3 across is "the hydrostatic pressure in glomerular capillaries is higher than that in the capillaries elsewhere in the body". The students read this concept while searching for the answer and understood when the answers of the crosswords were discussed. The same concept was reinforced during traditional lectures.

The students recommended that these activities should be continued as a supplement to didactic lectures. The crossword puzzles have been used successfully as a supplement to traditional didactic lectures in obstetrics and gynecology, psychiatry, and physiology.[1,13,14,17-19]

It is seen that if crossword puzzles are administered before lectures, it can be used as a method of priming the students before the lectures for upcoming terms and if given after lectures, it can be a method of assessing the students' learning. Also, crossword puzzles can be employed for taking a revision class where a fair number of varied concepts can be taught in one enjoyable class.

## Conclusions:

The results of this study show that crossword puzzles incorporated as a supplement to traditional lectures can engage students and encourage them to collaborate learning with their peers. This may also increase the understanding of the concepts. Solving crossword puzzles also enabled the students to evaluate their own understanding of concepts and also to identify their weak areas, which can be corrected later through a targeted approach. This method thus promotes self-directed learning among students. It increases their involvement in the learning process and keeps them motivated.

## References


1. Gaikwad N, Tankhiwale S. Crossword puzzles: self-learning tool in pharmacology. Perspect Med Educ. 2012; 1: 237–48. doi: 10.1007/s40037-012-0033-0.
2. Kuhn MA. Gaming: a technique that adds spice to learning? J Contin Educ Nurs. 1995; 26: 35–9.
3. Shah S, Lynch LMJ, Macias-Moriarity LZ. Crossword Puzzles as a Tool to Enhance Learning About Anti-Ulcer Agents. Am J Pharm Educ 2010; 74: 117. doi: 10.5688/aj7407117.
4. Kalyani P. Crosswords as a learning tool in Anatomy & Physiology teaching. Med Teach. 2007; 29: 513. doi: 10.1080/01421590701299306.
5. Bartley PD. Crossword puzzles. J Emerg Nurs. 1997; 23 :64–7. doi: 10.1016/s0099-1767(97)90067-2.
6. Patrick S, Vishwakarma K, Giri VP, Datta D, Kumawat P, Singh P, et al. The usefulness of crossword puzzle as a self-learning tool in pharmacology. J Adv Med Educ Prof. 2018; 6:181–5.
7. Saxena A, Nesbitt R, Pahwa P, Mills S. Crossword puzzles: active learning in undergraduate pathology and medical education. Arch Pathol Lab Med. 2009; 133:1457–62. doi: 10.5858/133.9.1457.
8. Abuelo A, Castillo C, May SA. Usefulness of Crossword Puzzles in Helping First-Year BVSc Students Learn Veterinary Terminology. J Vet Med Educ. 2016; 43:255–62. doi: 10.3138/jvme.0915-149R.
9. Mehta B, Bhandari B. Engaging medical undergraduates in question making: a novel way to reinforcing learning in physiology. Adv Physiol Educ. 2016 ;40(3):398–401. doi: 10.1152/advan.00068.2016.
10. Henry JM. Gaming: a teaching strategy to enhance adult learning. J Contin Educ Nurs. 1997;28: 231–4.
11. Marcondes FK, Moura MJCS, Sanches A, Costa R, de Lima PO, Groppo FC, et al. A puzzle used to teach the cardiac cycle. Adv Physiol Educ. 2015 Mar;39(1):27–31. doi: 10.1152/advan.00116.2014.
12. O'Leary S, Diepenhorst L, Churley-Strom R, Magrane D. Educational games in an obstetrics and gynecology core curriculum. Am J Obstet Gynecol. 2005 Nov;193(5):1848–51. doi: 10.1016/j.ajog.2005.07.059.
13. Odenweller CM, Hsu CT, DiCarlo SE. Educational card games for understanding gastrointestinal physiology. Am J Physiol. 1998 Dec;275(6 Pt 2):S78-84. doi: 10.1152/advances.1998.275.6.S78.
14. Talavinia-Pasek T. Pediatric/neonatal critical care respiratory crossword puzzle. MCN Am J Matern Child Nurs. 1995 Feb;20(1):46–7, 55.
15. Bhandari B, Mehta B, Mavai M, Singh YR, Singhal A. Jigsaw Method : An Innovative Way of Cooperative Learning in Physiology. Indian J Physiol Pharmacol 2017; 61: 315-321.
16. Bryant J. Crossword Puzzles Entertaining tool to reinforce lecture content in undergraduate physiology teaching. Int J Biomed Res. 2016;7: 346–9. doi:10.7439/IJBR.V7I6.3314.
17. Speers AT. Crossword puzzles: a teaching strategy for critical care nursing. Dimens Crit Care Nurs DCCN. 1994 Feb;13(1):52–5.
18. Kumar LR, Bangera S, Thalenjeri P. Introducing innovative crossword puzzles in undergraduate physiology teaching- learning process. Arch Med Health Sci 2015; 3:127-30. doi: 10.4103/2321-4848.154964.
19. Nazeer M, Sultana R, Ahmed MM, Asad MR, Sami W, Hattiwale HR, et al. Crossword Puzzles as an Active Learning Mode for Student Directed Learning in Anatomy Teaching: Medical Undergraduate Perceptions. Int J Med Res Health Sci. 2018;7: 12–9.