

An alternative methodology for teaching and evaluation in medical education: crosswords

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Abstract

Introduction: Crosswords have been used to complement medical education in a fun way, yet they were not used as a method for the evaluation of students' performance. **Objective:** The aim of this study was to describe the development of crosswords and verify their validity as a method of performance evaluation in embryology. **Materials and Methods:** We used crossword based on subjects about stages of embryonic development with different levels of difficulty. To validate the crossword as the evaluation method of teaching, two evaluation methods were applied (the traditional and with crosswords, simultaneously) on students of Federal University of Piauí. The performance of students was analyzed with Pearson's correlation coefficient and data were analyzed to check for normal distribution through the Shapiro-Wilk test with significance level of 0.05. The tests were performed on the BioEstat statistical software version 5.0. **Results:** As result a total of 28 students were evaluated. It was observed that the resulting score of both the traditional and crossword evaluation methods demonstrating normal distribution ($p=0.4127$ and $p=0.7016$, respectively), did not present vices and tendencies. The average scores were 7.1 ± 2.0 and 6.9 ± 1.7 for the traditional and crossword evaluation methods, respectively, showing statistically significant difference ($p=0.0001$; $r=0.67$), demonstrating a moderate Pearson's correlation between the methods. **Conclusion:** In conclusion, crosswords may be used as supplementary material for teaching embryology. Also, crossword functioned as validated and reproducible method of performance evaluation that can be used in as alternative and/or complementary teaching of embryology or other disciplines in the medical field.

Keywords: testing, basic science education, quantitative research methods.

1 Introduction

Many efforts have been made in the medical field to render the most effective teaching-learning process. For this purpose, several methodologies have been and continue to be used as: board game (ROSE, 2011), cards games (ROSADAS, 2012), information and technology communication (BUTTON, HARRINGTON and BELAN, 2013; KOIVUNEN, ANTTILA, KUOSMANEN et al., 2014; VASCONCELOS and VASCONCELOS, 2013), using the internet (ALFIERI, PORTELANCE, SOUHAMI et al., 2012), the use of social networks (FORGIE, DUFF and ROSS, 2013; MCANDREW and JOHNSTON, 2012; TAM and EASTWOOD, 2012), teaching video (KNÖSEL, JUNG and BLECKMANN, 2011), as well as the crosswords (BAILEY, HSU and DICARLO, 1999; CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012; GAIKWAD and TANKHIWALE, 2012; RAINES, 2007; SAXENA et al., 2009; SHAH, LYNCH and MACIAS-MORIARITY, 2010; SPEERS, 1994).

The crossword appeared around the thirteenth century before Christ more advanced than the current configuration. In 1913, the first crossword puzzle was published in a newspaper, in New York, in a section called "Fun" (English - funny, fun, joke). Since then, the crossword has appeared in newspapers and magazines as a way to pass time, and as fun and entertainment. Nevertheless, these characteristics are contributing in different areas of medical education (RAINES, 2007).

A study showed that 88.1% of medical students reported the crosswords to be a useful tool for teaching, and 93.5% of students were favorable to its continued use as a supplementary tool in teaching pathology (SAXENA et al., 2009).

In pharmacology, the crosswords were also used to assist teaching on antiulcer agents, being considered as promoters of self-learning (GAIKWAD and TANKHIWALE, 2012). Teaching of caring for critically ill patients in nursing also employed this methodology as an alternative (SPEERS, 1994).

In physiology, the crossword assisted in teaching about the urinary system (CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012) and the gastrointestinal tract, with positive results in the teaching-learning process, revealing to students the important for the sedimentation of knowledge in a fun way (BAILEY, HSU and DICARLO, 1999).

In embryology, several methodologies have been employed in order to facilitate the process of teaching and learning. A 2013 study showed that when the subjects of embryology were correlated with clinical findings in recent years, college students became more active (SCOTT, CHARLES and HOLLAND, 2013). Another study used for teaching on-line classes on embryology at an American university described crosswords as a new methodological approach in the area (NIEDER and BORGES, 2012).

In Brazil, medical students in a private university in São Paulo had the support of embryological models at different stages of

human development in the discipline of embryology. The study revealed that this method encouraged the self-learning in an active way (OLIVEIRA, KERBAUY, FERREIRA et al., 2012).

The benefit that crosswords can bring to the teaching-learning process is remarkable (BAILEY, HSU and DICARLO, 1999; CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012; GAIKWAD and TANKHIWALE, 2012; RAINES, 2007; SAXENA et al., 2009; SHAH, LYNCH and MACIAS-MORIARITY, 2010; SPEERS, 1994), but none of these works investigated the possibility for crosswords to function as a method for the evaluation of students' performance, since the evaluation in higher education is essential for a diagnosis of university performance and the level of knowledge of the health professional future.

Traditionally, the evaluation, most of the time, sets up a negative aspect, where on one side appears the teacher, and on the other side appears the student learning things by heart. For the student, the only way is to be approved by the good performance in the ratings. Thus, the assessment may interfere with the educational learning process (BURIASCO, 2000; DAVIS, PONNAMPERUMA and KER, 2009).

The objective of this study was to describe the development of crosswords as supplementary teaching material and its use as a valid tool for the evaluating of students' performance in the discipline of embryology alternative method.

2 Materials and Methods

2.1 Ethics principles

This experience report obeyed all current resolutions and it was approved by the Ethical Committee in Research of Federal University of Piauí (CAAE: 07666212.3.0000.5214), also followed the code of Ethics of the World Medical Association (Declaration of Helsinki).

2.2 Development of the crossword on embryology

The crossword created subjects that are basic for the teaching courses in the area of health. Evolved crosswords divided according to the syllabus of the discipline of embryology, as follows: 1st Week of Human Development (WHD); 2nd WHD, 3rd WHD, 4th to 8th WHD; fetal period; placenta and embryonic annexes. Crosswords were developed based on scientific articles in reputable books on embryology, in two different ways: with a specific program for this purpose, and without the aid of this program.

The development of the Crossword Eclipse Crossword™ (ECLIPSECROSSWORD, 2015) used the program. As the "answer" was inserted, there was already a specific field to place the tip, and who did the crossing of crosswords was the program itself automatically.

The other form of development of Crossword was without the aid of this program. Crosswords were built with the help of Microsoft Office Excel™ - the 2007 version, in a worksheet in which 300-400 cells were selected (20x15 - 20), 20 vertically and horizontally 15 to 20. All intersections of words were visually created (Figure 1), allowing a crossword with different levels of difficulty: easy, medium and hard.

2.3 Crossword difficulty

For the graduation of the difficulty, we used some techniques that were arranged in crossword tips as prior knowledge, word association, structural and specific letters. Prior Knowledge

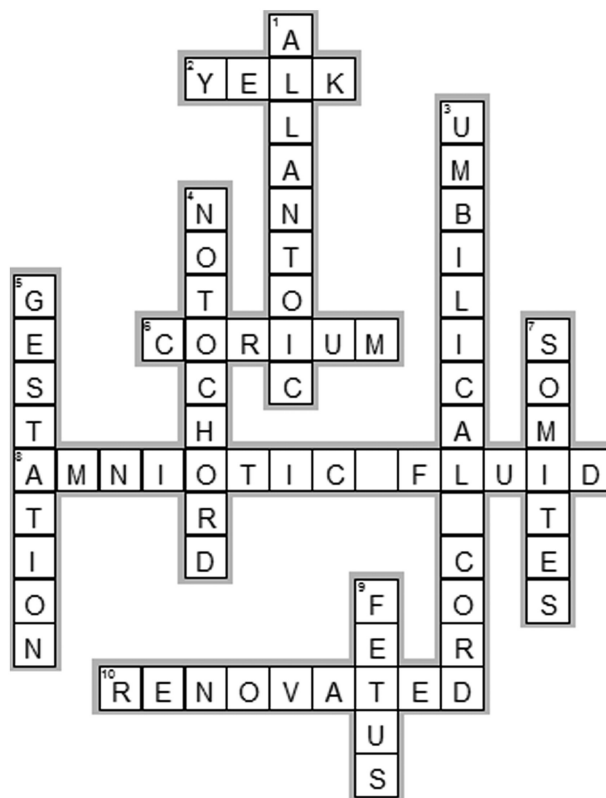


Figure 1. Crosswords developed for the evaluation of students' performance.

refers to all knowledge previously acquired over a subject matter or simply through a brief contact with it. The tips were used as a means of inducing the response precisely or with a lower precision (Table 1). The word association can use the tips with contradictory words or terms, or tips that make up the association by similarity and by derivation of words with prefixes or suffixes (Table 1). Another method used to moderate the level of difficulty of crosswords was the structural technique, in which the very word with its cell number (letters of each answer) contributed to the discovery of the correct word from the sentence (Table 1). Moreover, the specific letters helped in controlling the difficulty, because as responses were discovered and completed in the crossword, it became easier to know what are the crossword (letters) that would miss being completed. Thus, to make the most difficult crosswords, it was necessary to maintain such a word with fewer intersections with it, decreasing the chances of fulfillment by knowing the answer of another clue (NICKERSON, 2011; SKOTKO, KENSINGER, LOCASCIO et al., 2004).

For example, in Figure 1, the tip for 6 sentence is "structure that develops in the second week of human embryonic development; in the future, it will give rise to part of the placenta and its early development is formed by: syncytiotrophoblast, cytotrophoblast and extra-embryonic mesoderm" and the answer that properly completed it was "corium", which showed two intersections with the tips: which were "notochord" (4) and allantoic (1) positioned on the vertical lines.

Table 1. Example of ways to scale the difficulty crossword.

<i>Fore knowledge</i>	Induce an answer specifically	<i>Answer</i>
	Male gamete	Spermatozoon
	Organ where the fetus develops	Uterus
	Induce the answer with less precision	<i>Answer</i>
<i>Crossword association</i>	Fusion of espermatozoon with oocyte II	Zygote
	Repeated mitotic divisions of the blastomeres	Cleaving
	Contrast tips	<i>Answer</i>
	Testicles	Ovary
	Penis	Vagina
	Similarity tips	<i>Answer</i>
	Scrotal sac	Testicles
	Uterus	Endometrium
	Tips with derivation of words	<i>Answer</i>
	Esperm	Spermatozoon
<i>Structural</i>	Number of cells and its intersections with the words	–
<i>Specific letters</i>	Specific letters that appear in accordance with filling	–

Table 2. Data for the two ways of evaluation.

	Evaluation methods	
	<i>Traditional</i>	<i>Crossword</i>
Students	28	28
Grades (mean)	7.1	6.9
Standard deviation	2.0	1.7
Median	7.1	7.0
Pearson's correlation	r=0.67 (<i>p</i> =0.0001)	

2.4 Crossword as supplementary material for teaching embryology

The developed material featured 150 crosswords in three difficulty levels. Students used the crossword as a supplementary activity in laboratory embryology classes.

Application of crosswords as an alternative method for assessing the performance

Crosswords were not previously held, in any way, by the students who were assessed, so that there was influence of the learning correlation with the methodology, with an unprecedented form of assessment for these students. This study evaluated the crossword, developed without the use of Eclipse Crossword™ program, for students in the 2nd semester of 2013 in a biomedicine school Federal University, during a normal theoretical evaluation of the semester. Crosswords that addressed the broad and basic course contents provided to the discipline mode were created. Crosswords were then applied as a theoretical review of embryology individually. This evaluation was performed by 28 students enrolled, who answered the two assessments (traditional and with crosswords) simultaneously (within a time period of 120 minutes). Traditional assessment contained 22 questions, worth 10 points, with 18 to judge whether the sentence was true or false (value of 0.33 point for each correct sentence), a descriptive question (worth 2 points) and two multiple-choice questions with five alternatives (worth 1 point each), based on studies that found the forms most commonly used in the evaluation of higher teaching (OLIVEIRA and SANTOS, 2005).

2.5 Correction of ratings

Evaluation with the crossword presented 10 sentences arranged in columns (vertical) and rows (horizontal) (Figure 1), in which each sentence completely and correctly filled was worth one point. For the traditional evaluation, we compared the responses with the contents of books with respected texts, papers and lectures on embryology.

2.6 Statistical analysis

Data were analyzed to check for normal distribution through the Shapiro-Wilk test. To compare the academic performance of students according to the evaluation method, Pearson's correlation coefficient was used. For both tests, a significance level of 0.05 was considered. The tests were performed on the BioEstat software version 5.0 (Belém, PA, Brazil).

3 Results

150 crosswords were developed and classified into 3 levels of difficulty: easy, medium and hard. Crossword topics addressed the issues commonly belonging to any discipline plan of Embryology in the medical field, such as: 1st WHD, 2nd WHD, 3rd WHD, 4th to 8th WHD, fetal period and embryonic annexes, in which each topic presented words crossed as easy, medium and hard.

When comparing the two forms of assessment, data showed that in both the traditional method and the method that used the crossword, the grades had a normal distribution (*p*=0.4127 and *p*=0.7016, and the traditional crosswords respectively) as is showed in Figure 1.

The mean scores were 7.1 and 6.9 for the methods: traditional and crosswords respectively, with statistically significant difference (*p*=0.0001; *r*=0.67), demonstrating a correlation positive and strong; the standard deviation and median can be seen in Table 2.

4 Discussion

This study describes the development of a series of crosswords, which were used in embryology practical classes, as a way to make learning more interesting, fun and productive for the

student of embryology, corroborating with other studies (BAILEY, HSU and DICARLO, 1999; CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012; GAIKWAD and TANKHIWALE, 2012; RAINES, 2007; SPEERS, 1994).

A traditional method and one which used the crossword: Two evaluations were applied. The traditional mode of assessment applied to students is also being used in other institutions of higher education. A private university in São Paulo showed that the most commonly used forms of assessment was essay tests (32.9%), followed by tests with multiple choices (10.6%), both performed individually (OLIVEIRA and SANTOS, 2005).

Another study conducted in Portugal showed that multiple-choice tests were used in 70.8% of the methodology (PEREIRA and FLORES, 2012), standards followed by our study for the development of traditional evaluation.

Regarding the development of the crossword, use of the EclipseCrossword™ program allowed the creation of crosswords in an easier and quicker way. This is due to the features presented by the program, which can save the crossword developed in different file formats (Rich Text Format - RTF, Windows metafiles - WMF, PostScript - EPS, Across Lite Text Format - allowing the export of crosswords to other editors of crosswords Interactive with JavaScript and Java applet - which enable the use of crosswords on a website on the internet). Another feature was the possibility of creating different types of crosswords with the same tips, but arranged differently, with a simple mouse click.

Concerning the development of crosswords without the aid of Eclipse Crossword™ program, the work became more manual and slow, since every crossing between words was carried out in a visual and orderly manner. That allowed a possibility that was limited when using the program Eclipse Crossword™: the greater control over the level of difficulty of crosswords created. By using the Eclipse Crossword™ program, it automatically made the crossing between words, making it impossible to construct crossword based on techniques: structural and specific letters, as illustrated in Table 1. Decreasing the possibility of adjusting the difficulty level of the crossword created.

Crossword puzzles have been developed in both ways and were applied to students of embryology as an alternative assessment developed without the use of Eclipse Crossword™ program given to create crosswords with greater possibilities in adjusting the degree of difficulty.

In literature, there is the report of a patient with amnesia who solved 277 crosswords; by analyzing such crosswords solved, the researchers found that patients had a greater number of errors (54%) to complete the crossword puzzle that had hints horizontally, compared with those displayed vertically (45%). However, researchers justify that difference may only be a matter of personal preference on how to solve the puzzle, since the patient studied solved the tips arranged in horizontal lines before the vertical lines (SKOTKO, RUBIN and TUPLER, 2008).

Another study showed that even the crossword is not developed symmetrically, ie., equal number of tips arranged in vertical and horizontal lines, the crossword functioned quite complementary and in a fun way (CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012).

In crosswords applied to students of embryology as a method of assessment, care was taken to prepare the crossword so that they were distributed in equal number of tips positioned

in horizontal lines and vertical lines, although a study have shown that the positioning of the tips in the vertical and horizontal lines did not present statistically significant difference compared to the solution (HAMBRICK, SALTHOUSE and MEINZ, 1999).

Possibly such care during the development of crosswords contributed so that in both reviews the notes were distributed as normal (Figure 1). That represented that such methods of evaluation were not addicted and did not show trends.

Why use the crossword as an evaluation method in embryology? Crosswords tested as an alternative assessment tool showed a strong Pearson's correlation ($p=0.0001$; $r=0.67$) between different methods from the academic performance evaluation that was performed in the traditional way, suggesting a possible replacement and / or supplement of the assessment methods commonly used.

For the student, the only way to obtain the approval is through the assessment; the assessment may become an influencing factor in learning.

What may limit the depth in other related matters, since the student will study only the content that will be asked (OLIVEIRA and SANTOS, 2005)? Students end up devoting themselves to decorate content just to make good grades, resulting in a short-lived memory. Note, this case does not represent the actual knowledge of the student and gets a negative review with the teacher charging on one hand, and students learning by heart on the other (BURIASCO, 2000). Crosswords used could minimize this negative aspect, since they are recognized as a recreational activity (BAILEY, HSU and DICARLO, 1999; CALDERON, SACHDEVA, ROY-CHAUDHURY et al., 2012; GAIKWAD and TANKHIWALE, 2012; RAINES, 2007; SPEERS, 1994), even if applied in groups rather than individually.

What could enable the evaluation process to become more tranquil (KARIMBUX, 2013), interfering positively in the teaching-learning process? Not only in the discipline of embryology, as well as in other disciplines in medical education, to enable this evaluation method, the crossword.

5 Conclusion

Crosswords proved to be a developed method for the alternative and/or complementary validated and reproducible method for the verification of academic performance assessment when compared with the traditional method of assessment in the discipline of embryology.

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