Usefulness of Crossword Puzzles for Learning Veterinary Terminology

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Abstract

Appropriate terminology is essential for successful communication among health professionals. However, students were traditionally encouraged to learn terminology by rote memorization and recall, strategies that students try to avoid. The use of crossword puzzles as a learning tool has been evaluated in other education disciplines, but not for terminology related to veterinary science. Hence, the objective of this study was to test whether crossword puzzles are an effective aid in the process of learning veterinary terms. Forty-two first-year students were randomly divided into two groups and their previous knowledge of veterinary terms tested. One group received a list of 30 terms with their definitions and the other one the same list plus six specially designed puzzles incorporating these 30 terms. Subsequently, both groups completed a post-intervention test and the results were compared statistically. The results showed that the students using the crossword puzzles performed better in the post-intervention test, and retained correctly more terms than the students using just rote learning. In addition, qualitative data, gathered through an electronic survey and focus group discussions, revealed a positive attitude of students towards the use of crossword puzzles.

Introduction

Medical terminology can often seem like a foreign language, due to its Greek and Latin etymology, to students once they start to learn about anatomy and/or physiological/pathological conditions. It is essential that students become familiar with the language of medicine to facilitate understanding of veterinary terminology, texts and journal articles, and to support effective communication with other health professionals. Traditionally, students were encouraged to learn terminology by rote memorization and recall, recognized as 'passive learning' methodologies, which are perceived as boring and time-consuming tasks, and so students try to avoid them.[1]

There is growing interest in the use of games for educational purposes.[2] Although games can often be seen as a recreational activity,[3] when they are designed for learning, teaching, and training purposes, and thus serve as educational tools, they have been called "serious games".[4] Puzzles have been recognized as helpful for reviewing, summarizing, practicing, revealing gaps in knowledge, developing relationships between concepts[5], and facilitating critical thinking and reinforcing the knowledge acquired.[6-8] Crossword puzzles are known to expand the vocabulary, stimulate the mind, and help to develop several skills related to the acquisition of terminology: vocabulary, reasoning and spelling, among others[9]; and are appealing to different learning styles.[10] Grid games have been evaluated as a teaching tool in medical,[6, 11] pharmacy[12] and nurse education.[1] However, to the best of the author's knowledge, no previous study has investigated the use of crossword puzzles as a tool in veterinary education. Therefore, the aim of this study was to assess whether crossword puzzles are more effective than rote memorization for learning terminology by veterinary students.

Methods

Participants

We sought volunteers to participate in this study among the first year students of the Bachelor of Veterinary Science at the Faculty of Veterinary Science of the University of Santiago de Compostela (Lugo, Spain). These students were selected because they were enrolled in the basic sciences module and their exposure to specific veterinary terminology is at a minimum at that stage. As an incentive for participating, three £100 Amazon gift cards were raffled among all the participants at the end of the study. Forty-two students out of 112 (37.5%) agreed to participate in the study.

Study design

We used a randomized, two-group, pre-test/post-test study to compare the effectiveness of crossword puzzles with rote memorization for the learning of terminology. In addition, to obtain information useful to finding out what the students felt about the impact of the tool and to provide a deeper understanding of what the students did in each group, qualitative data were also gathered through an online survey

of all the participants and independent focus group discussions with students from both groups.

Intervention

Students were randomly allocated to one of the study groups –Crossword or Control- using the random function of Excel 2010 (Microsoft, Redmond, WA, USA), resulting in 21 students per group. Considering a power of 90% and a significance level of 0.05, the sample size is valid to unravel differences above 15% between the means of the two groups.

The intervention was performed simultaneously in two different rooms. Before commencing the intervention, the same test was delivered to both groups in order to assess their previous knowledge of veterinary terminology. This test comprised 10 multiple choice questions. In order to prevent any confounding effect of the memorization of the material tested,[13] and minimize the impact of the pre-test on the final outcome,[14] the terms included in this test were not used further during the intervention, and the questions employed were not similar to the ones of the post-intervention test (i.e. asking for location of condition rather than definition). In addition, considering that students were enrolled in the basic science module of the degree, only terminology related to pathological conditions was employed, in an attempt to minimize the effect of prior knowledge.

Subsequently, students in the control group were given a list of 30 terms with their definitions, whereas students in the crossword group received the same list of terms with definitions plus six specially designed crossword puzzles to match these definitions, with 6-8 terms each (Figure 1). Crossword puzzles were created using the freely available EclipseCrossword© (www.eclipsecrossword.com) software tool and presented on computers, embedded in a webpage. This allowed crossword puzzles to be self-corrected, and the students were not allowed to move to the following puzzle until the earlier puzzle was solved correctly. All the terms of the list were included in at least one crossword puzzle. Students were given 50 minutes to complete the task – memorize the terms (control group) or complete the crossword puzzles (intervention groups). During this time, no support was given by the facilitators to any of the groups regarding the definitions of the terms.

(Place Figure 1 here)

Immediately after the completion of the intervention, students from both groups completed a test of 10 questions, composed of 3 short answer, 4 multiple choice and 3 matching questions. At the end of the intervention, the students of the control group were also given the crossword puzzles, so they were not disadvantaged by the study.

Test scripts were marked independently by two assessors (AA and CC) who were not blinded to the group allocation. Each correct answer in the test was given a mark so participants received a score of 0-10. Misspelling of the terms was considered an incorrect answer, as it is not only important to know the definition of a term, but also to be able to use it correctly. The pre- and post-test and the crossword puzzles were

checked for accuracy by faculty not involved in their design. The scores from the pre- and post-intervention tests were analyzed statistically using JMP Pro v11 software (SAS Institute Inc., Cary, NC, USA) to reveal differences between the means of both groups. Data were checked for normality using the Shapiro-Wilk test. Due to non-normal distribution, non-parametric tests were applied and hence the Mann-Whitney U test was employed for comparison between groups of the pre- and post-test scores. Statistical significance was set at $P < 0.05$.

Survey and focus groups

After the intervention, students from both groups were asked to answer an anonymous electronic survey, delivered by SurveyMonkey[TM]. Students indicated the extent of their agreement with 7 statements[a] regarding the learning of terminology and the students' attitude towards the use of crossword puzzles on a 5-level Likert scale (1=strongly disagree; 5 = strongly agree).

In addition, all the students in the study were invited to participate in focus groups. Six students in the intervention group and four in the control group volunteered for this task. Hence, only one focus group per group was performed. The focus groups were planned following the recommendations of Moore et al.[15] Before commencing, the moderator (AA) explained the purposes of the focus group, and encouraged all the participants to speak up and explain their views, and sought participants' consent for tape-recording the discussion. The discussion included open-ended questions and follow-up probes (Appendix I). The focus-groups provided an opportunity to clarify and further explore points from the survey

Ethics approval

Approval for all the procedures of this study was granted before commencing by the Bioethical Committee of the University of Santiago de Compostela (Spain), participants gave their consent to their involvement, and were allowed to withdraw from the study at any time.

Results

Intervention

There were no significant differences in pre-test vocabulary scores between groups in the pre-intervention test (3.9 vs. 3.4, $P = 0.20$; Table 1). In the post-test, both groups improved but the students given the crossword puzzles had significantly better marks compared to the control group in the post-intervention test (5.2 vs. 7.0; $P = 0.001$). It was noted by the two assessors of the tests that, most frequently, students in the crossword group struggled in the questions were they needed to write the term, because of misspelling. Hence, this was studied further in the focus group discussion. No common pattern was identified in the students of the control group.

(Place Table 1 here)

Anonymous electronic survey

Thirty-seven out of 42 students completed the anonymous electronic survey (88.1% responsiveness), 18 (85.7%) from the crossword group and 19 (90.5%) from the control group. Cronbach's α was 0.71, indicating a good consistency of the responses. The results of the study showed that first year veterinary students find the learning of terminology a difficult task, with the majority of them employing rote memorization as their learning tool. However, almost all of the students in the crossword group found it a useful aid to learning veterinary terminology (94% of the respondents agreed or strongly agreed), which also made the learning process more fun while increasing their confidence (77.8% of the respondents agreed or strongly agreed). Students from both groups, although with a lower level of agreement than in previous statements, showed an overall interest in using crossword puzzles even if they are only made available as a self-learning tool (67.6% of students agreed or strongly agreed, with the respondents that disagreed -11.8%- belonging to the control group). Most of the "crossword" students showed a neutral answer (mean: 3.4) to whether or not this learning tool helped them to correctly spell the terms, and this was explored further in the focus group discussions.

(Place Table 2 here)

Focus-groups

Focus-group discussions confirmed consistently that when students face a new term they try to learn it by rote memorization. Even though they acknowledged that they thought that this system worked, they need to dedicate a considerable amount of time just to learning the terms and their meaning, making this a boring task that the students dislike. However, they agreed that terminology was important:

> *Student 2 (S2): It's important to know and be able to use specific terms, because it will make communication more accurate and easier, although sometimes the amount of new terms is overwhelming and it consumes a lot of time.*

Participants were also consistent in their appreciation of being given and having explained the meaning of new terms. However, academics do not generally provide any guidance or aids to integrating these terms into student knowledge. In line with the concern expressed by the students regarding the time needed for rote memorizing terms, all the participants from the "control" focus-group felt that the time given (50 minutes) was not sufficient for appropriately remembering all the 30 terms given. An example conversation with this group is shown below:

> *S3: Time was a limitation, of course, in the 50 minutes I could just barely go through the whole list a couple of times and then try to do some memorizing exercises.*
>
> *Moderator (M): What exercises have you done during the time given?*
>
> *S3: I just went first through the whole list and then covered the term column with a sheet (of paper) to see if reading the definition I was able to recall the term.*
>
> *M: What would you have done if you had more time?*

S3: I would have probably done the same thing a couple of times and then try to do it the other way around, reading the terms and covering the definitions.

M: So, in your opinion the time was a limiting factor?

S3: Definitively! With more time I would have been able to remember more terms and perform better in the exam. I didn't remember some of the terms that were asked in the exams, and for other I wasn't 100% confident on my answers.

S1: Yes, of course. In my opinion the time was not enough to memorize 30 terms. During the test I wasn't sure of many answers, and if I have had more time I think I would have done better.

During the discussion with the "crossword" focus-group, three main themes emerged relating to what the students liked the most about the use of crossword puzzles: (1) it was a game, which made the experience more fun than just memorizing; (2) they got to use the terms and associate them with their definitions; and (3) they could auto-assess themselves. The participants also agreed that, in their opinion, these characteristics helped them to recall more terms. However, in their opinion, they also felt they would have recalled more terms if they were given more time and crossword puzzles:

S6: The experience was good, but it was somehow stressful timewise, I didn't think at the beginning that I would have been able to complete the crossword puzzles within the time given.

S5: With more time and maybe more crossword puzzles it would have been better, I think. Some of the terms were used just one time, and the more I use a term, the more likely I am to recall it after.

With regard to the correct spelling of the terms, some ideas emerged in the discussion, with the time limitation being an underlying common factor:

S7: Most of the terms were completely new to me and some of them were very similar. Hence, without practicing them enough I cannot be sure of the correct spelling.

M: But the crossword puzzle did automatically correct your answers

S7: Yes, but if I write something wrong just one time, then I think it's a typo, correct it and move forward.

S5: Again, I would say that it was a matter of time and number of times that the terms are used. With more time, I would probably be more thorough with the spelling, and the same with the puzzles; if I use a term more times in the puzzles, I would have been corrected more times and I would have realized that I was always writing it incorrectly.

Discussion

The correct understanding and use of terms are essential skills to facilitate communication among professionals, as well as to draw appropriate conclusions from the literature. However, at the beginning of the clinical module we have noted problems in using, recalling and spelling terms correctly by veterinary students during in-class exercises, assignments and viva-voce exams. Previous research has shown that using

crossword puzzles leads to greater retention and better memorization of vocabulary.[17] Hence, we investigated whether crossword puzzles increased the short-term retention capacity of terminology related to veterinary science in first-year students,, in comparison to rote memorization.

The participants in this study revealed that they find learning terminology a time-consuming and tedious task, although they are aware of its importance. However, the focus-group discussions showed that, in the students' view, although academics usually explain the terms and their meaning, no guidance or aids are given to facilitate the retention of these terms. This is just the first-year students' perception, but it further highlights the need for resources that could aid students in this learning process.

Our study design presented a comparison between pre- and post-test within each group, as the tests were intentionally different to prevent test bias (changes on the second administration of the test as a result of having previously taken the test), and the tests were not calibrated for degree of difficulty. However, the scores of both groups increased numerically in the post-test, compared to the pre-test, and the intervention group showed a significantly higher score in the post-test compared to the control group. Only one previous study in education of health professionals used a randomized control design and pretest-posttest analysis to determine the effectiveness of crossword puzzles for learning drug names.[18] Our results are similar to the findings of that study: pre-test scores were similar in both intervention and control group, with a subsequent increase in the post-test scores in both groups, although the average score was significantly higher in the intervention group. This supports the view that the use of crossword puzzles during a defined learning period is more effective than just memorization of the terms and their definitions. This is in line with other related studies: Saxena et al.[6] showed that crossword puzzles are useful in medical education to reinforce concepts and vocabulary; and the students' confidence in test-taking and their comprehension of course materials was also increased after exposure to crossword puzzles in athletics education.[19] Crossword puzzles also serve to increase students' vocabulary in teaching of English as a second language.[20] If a student takes an active role in word learning, such as by solving a crossword puzzle, they assume increasing responsibility for their own vocabulary growth, gaining metacognitive and metalinguistic ability in the realm of word learning; this has been suggested as an important goal of vocabulary instruction.[21] Passive learning strategies, such as memorization, are unlikely to provide this level of learning engagement. The increase in retention shown by users of crossword puzzles can also be explained by the fact that using games increases the amount of attention given to the material.[22] However, our study focused on short-term retention and used an artificial environment for administering pre- and post-tests. Hence, further studies are needed to test long-term recall of the taught content in order to add more evidence to the value of this grid game.

The participants also showed a positive attitude towards the use of crossword puzzles as a teaching tool, considering it also a fun activity. Although only a few students consented to participate in the focus-group discussions and hence, the number of focus groups was below than recommended,[15] the survey responses further support it and this finding has been consistently reported in previous studies on the use of crossword puzzles.[1, 5, 6, 8, 12, 19, 20, 23-26] Attitude is known to influence the students' learning,[27] and

hence crossword puzzles have the potential of being beneficial for learning terminology in different settings. Indeed, previous research has shown that puzzles are effective both as an in-class activity[6-8, 12, 19, 23] and as a self-learning tool.[18] The participants of this study (including those not exposed to the puzzles in the intervention) said that they were likely to use the crossword puzzles if they were just provided as a self-learning tool.

Despite the crossword puzzles having the feature of self-correction due to the overlap of words,[12] if a mistake occurs in a cell where there is no overlap, it can still go unnoticed by the students. In addition, students like to be able to check the correct answers,[6] so either the answers should be also given to the students or some time allocated for the teacher to correct the crossword puzzles with them. Several software packages are now available on the Internet that allow the creation of web-interactive crossword puzzles where the students can check their answers online. This will help to retain the knowledge gained correctly. Therefore, the inclusion of such puzzles in the virtual learning environment could improve the use of crossword puzzles as a supplementary self-learning tool by the students. This is particularly important considering that during the focus-group discussion, the time needed to learn terminology arose as an important limiting factor. The conversation reproduced in the results section highlights the necessity of time and the need to provide enough practice opportunities to facilitate not only the learning of the meaning of the terms, but also their correct spelling. In the intervention reported in this study, we intentionally restricted the time to allow an accurate comparison between both groups. However, learning needs time to take place and, hence, facilitating access to the crossword puzzles could increase students' use of the tool,[28] leading to improvement in their retention of terms by providing adequate practice opportunities and necessary repetition, to reinforce concepts. However, a multifactorial approach to learning vocabulary is more effective than a single approach,[22] and therefore academics should also provide other aids for facilitating the learning of terminology.[24]

Conclusions

This study showed that students find learning new terms a tedious and difficult task. Students exposed to specially designed crossword puzzles showed a better short-term recall of terms than students that just used rote learning. In addition, veterinary students showed a positive attitude towards the use of crossword puzzles in their learning process, considering them both useful and a recreational tool for learning.

Given that several free software programs to design and create crossword puzzles are available, they can easily be created without incurring software-related costs. In addition, they could also be embedded in virtual learning environment platforms, to provide an interactive, self-learning tool for students, with the capability of self-correction.

Notes

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Table 1: Results of the marks of the pre- and post-intervention tests

	Control (*n=21*)				Crossword (*n=21*)				*P*-value
	Mean (SD)	Quartiles			Mean (SD)	Quartiles			
		25th	50th	75th		25th	50th	75th	
Pre-test	3.9 (0.63)	3	4	4	3.5 (1.40)	3	3	4	0.20
Post-test	5.2 (0.97)	5	5	6	7.0 (1.09)	6	7	8	0.001

Each test was marked out of 10 based on the number of correct answers. The differences between groups were assessed statistically using the Mann-Whitney *U* test. SD = standard deviation.

Table 2: Student questionnaire responses

Statements[1]	Mean	Total answers	% of responses (number of answers)				
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
S1. Retaining specific terms is a time-consuming and boring task	4.8	37	-	-	-	24.3% (9)	75.7% (28)
S2. I normally try to learn those terms by memorizing them	4.4	37	-	5.4% (2)	2.7% (1)	35.1 % (13)	56.8% (21)
S3. I would use crossword puzzles if they are available just as a self-learning tool	4.0	34	2.9% (1)	8.8% (3)	20.6% (7)	23.5% (8)	44.1% (15)
S4. Crossword puzzles were useful for helping retain terms	4.4	18	-	5.5% (1)	-	38.9% (7)	55.6% (10)
S5. I had fun solving the crossword puzzles	4.1	18	-	-	22.2% (4)	50.0% (9)	27.8% (5)
S6. The crossword puzzle increased my level of confidence regarding my knowledge of the terms	4.0	18	-	11.1% (2)	11.1% (2)	44.4% (8)	33.3% (6)
S7. Crossword puzzles helped me to focus on the correct spelling of terms	3.4	17	-	11.8% (2)	47.0% (8)	29.4% (5)	11.8% (2)

Statements 4, 5 and 6 were only made available to students in the intervention (crossword) group.

Figure Captions

Figure 1: Example of a crossword puzzle

The crossword puzzle was presented on an html environment in computers. The clues appeared when the student clicked on one row/column. The students had also to check their answers before moving to the next puzzle.

Clues:

ACROSS:

2. Inflammation of the radicle of a nerve

5. Bleeding from the nose

6. Excessive dryness of the conjunctiva and cornea

DOWN

1. Surgical procedure to repair a damaged or diseased cornea

3. Persistent watery mucus discharge from the nose

4. Inflammation of the testis

7. Absence of tears; tearlessness,

APPENDIX I: Open-ended questions and follow-up probes used during the focus group discussions

Topic	Questions and probes

Method of learning terminology	• When you see a new term, how do you usually try to learn and recall their meaning?
	    o Do you think that it works?
	    o Do you like doing it?
	• Do you think that terminology is important?
	• So far, has any of the academic staff provided any help specifically for the learning of terms?

Memorization
(only asked for the students in the "control" group)
	• What were your impressions about having to memorize 30 terms in 50 minutes?
	    o Where you confident in your answers when asking the test afterwards?
	    o Do you think that if you have had more time, you'd have done it better?

Crossword puzzles
(only asked for the students in the "crossword" group)
	• What was one thing you liked from using crossword puzzles for learning terminology?
	    o Where you confident in your answers when asking the test afterwards?
	    o Do you think that you retained more terms than if you were given the list of terms alone?
	    o Was it an enjoyable activity?
	• What do you think it could be improved for you to take more advantage of the use of crossword puzzles for learning veterinary terms and how?
	    o Was the time given enough to complete all the crosswords?
	    o Do you think that if you have had more time, you'd have done it better?
	• Knowing the term is one thing, but been able of using them appropriately is more important. Did the use of crossword puzzles increase your confidence in using these terms?
	    o Considering appropriate writing, do you think that the use of crossword puzzles as a learning tool helped you to spell correctly the terms and why or why not?