Concept Maps: Theory, Methodology, Technology
Proc. of the Fifth Int. Conference on Concept Mapping
Valletta, Malta 2012

# USE OF CONCEPT MAPS AS AN ASSESSMENT TOOL IN A PATHOPHYSIOLOGY COURSE

*Teresa Gamboa, Patrícia Rosado Pinto P, António Rendas*
*Faculdade de Ciências Médicas, Universidade NOVA de Lisboa, Portugal*
*Email: tprstg@gmail.com*

**Abstract**. The aim of this study was to determine, in a group of medical students, whether the acquired knowledge in Pathophysiology was comparable when assessed using a concept map based test, with MCQ's embedded (CM test) or a traditional context-free MCQ test (MCQ test) and to evaluate the feasibility of implementing CM test as an assessment tool. CM tests consisted of incomplete concept maps, with concepts left blank for the students to fill in, choosing the correct answer among five possible options. The same questions were used to produce two traditional context-free multiple-choice tests one on the pathophysiological mechanisms of liver cirrhosis and the other on circulatory shock One hundred and eleven volunteers were allocated in two groups: Group 1 (n=56), performed a liver cirrhosis CM test and a MCQ test on circulatory shock and Group 2 (n=55) performed CM test circulatory shock and a MCQ test on liver cirrhosis. Both groups performed better in CM tests (cirrhosis test score: 49.2 %; circulatory shock test score: 51.1%) than in MCQ tests (cirrhosis and circulatory shock scores: 42.9%) and were able to complete the tests within the scheduled time (15 minutes for each part of the test. These results support the relevance of applying CM tests in the evaluation of the students in a Pathophysiology course using concept maps as learning tool.

## 1 Introduction

In the Faculty of Medical Sciences (FMSc) of the New University of Lisbon, problem-based learning (PBL) has been used as a major educational approach in the discipline of Pathophysiology of the undergraduate Medicine course since 1999. Pathophysiology is a curricular discipline placed in the third year of a six-year generally medical curriculum (two basic sciences academic years, one pre-clinical, two clinical oriented academic years and a 6th professional year). The main objective of the discipline is to improve the students' understanding of the mechanisms of diseases as physiological dysfunctions of the various body systems (Guzek, 1994).

The early years of the Pathophysiology educational project have already been described as well as the use of a computer simulation especially designed by the group to support a student-centered tutorial system, based on PBL principles (A Rendas, Rosado Pinto, & Gamboa, 1999) and to produce a detailed record of the identified students' needs and learning resources (Correa, Rosado Pinto, & Rendas, 2003). Concept maps (CMs) have been introduced in the Pathophysiology course since 2002, aiming at improving contextual learning (A. Rendas, Fonseca, & Rosado Pinto, 2006).

The practical course of Pathophysiology, based on tutorial sessions, is organized in six units, covering, successively, the general pathophysiology of the gastrointestinal, cardiovascular, blood, respiratory, kidney and endocrine systems. Each unit lasts for six sessions, twice a week, where complete clinical case (full medical history) is analyzed according to the problem-based learning (PBL) methodology. In addition, six short clinical cases based on pre-prepared incomplete concept maps are also discussed in separate sessions, in order to cover relevant issues not addressed in the complete clinical case. CM were designed by the teaching staff, aiming to give a broad picture of the pathophysiological mechanisms involved in the context of a specific clinical situation and a certain number of concepts were hidden. During the practical course of Pathophysiology, a total of 36 concept maps with hidden concepts were displayed with a Datashow and the students were asked to fill the gaps and discuss one case per session.

A final evaluation is compulsory and consists of a context-free multiple-choice questions (MCQ) test and an oral exam, each contributing 30% to the final mark, the remaining 40% coming from continuous assessment during the tutorial sessions.

The approach during the oral exam is identical to that used during the tutorial sessions, since students should read a short clinical case and be able to explain the pathophysiological mechanisms of the alterations found. However, the written test consists of a traditional context-free MCQ with 60 questions, thus not aligned with the adopted learning strategy.

## 2 Objective

The aim of this study was to determine, in a group of medical students in which learning of general pathophysiology involves the analysis and discussion of clinical cases using concept maps, whether their

acquired knowledge was comparable when assessed using a concept map based test, with MCQ's embedded (CM test) or a traditional context-free MCQ test and to evaluate the feasibility of implementing CM test as an alternative assessment tool.

## 3 Methods

This study took place at the end of the first semester of the academic year 2010/11, after the students had attended the pathophysiology lectures and the tutorial units on gastroenterology (1st unit), cardiology (2nd unit) and hematology (3rd unit) and were already familiar with use of incomplete concept maps.

Students were invited to participate in the experiment and informed that it would be anonymous and, thus, that the results would not have impact on their final evaluations and that specific preparation for the test was not required.

### *3.1 Tests Design*

Two concept maps were created using the same methodology developed for those used in the teaching sessions. One CM addressed a case of liver cirrhosis and the other, circulatory shock.

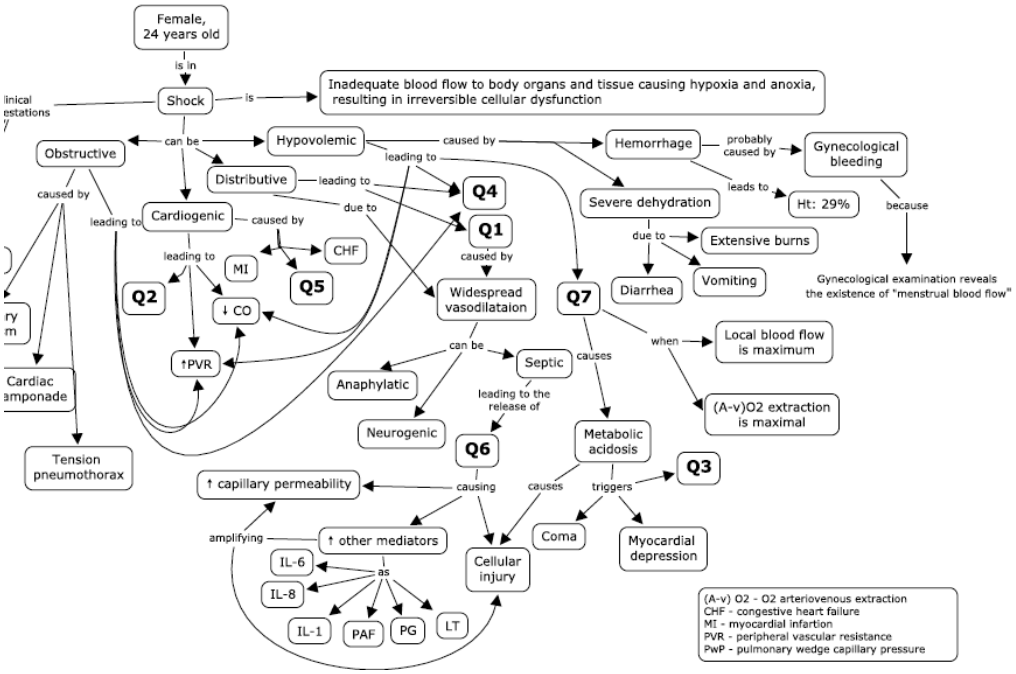


**Figure 1**. Example of CM test on pathophysiology of circulatory shock. Concepts were left blank (Q), each corresponding to a question in the MCQ test

For each CM test, ten questions, each one with five options and one single right answer, were created (CM test) based on ten propositions already existing in each map. Those propositions were left incomplete in each map and blank spaces were numbered from Q1 to Q10, thus relating the concepts with the questions (Figure 1), in a "select-an-fill-in" (SAFI) format aligned with that described by Schau (Schau, Mattern, Zeilik, & Teague, 1999). The phrasing of the questions was the same for all: "*The most appropriate answer to Qx is:*" Thus, students would have to choose, among five, the concept or the sequence of concepts that best completed a specific concept map proposition. The same questions were used to produce two traditional context-free MCQ tests, one on the pathophysiological mechanisms of liver cirrhosis and the other on circulatory shock (Figure 2).

One hundred and eleven volunteers, of the 250 enrolled in the pathophysiology course, participated in this study and were allocated in two groups:

- Group 1 (n=56), received the information of the short clinical case of liver cirrhosis, the corresponding incomplete concept map with the CM test embedded and the MCQ test on circulatory shock;

- Group 2 (n=55), received the information of the short clinical case of circulatory shock, the corresponding incomplete conceptual map with the CM test embedded and the MCQ test on liver cirrhosis.

| **Group 1 (n = 56 )** | **Group 2 (n = 55 )** |
|---|---|
| Test 1 | Test 2 |
| Q1. Which of the following mechanisms can be the cause of distributive shock? | Q1. Which of the following is the most appropriate answer to Q1? |
| a. Decreased pulmonary wedge capillary pressure<br>b. Decreased peripheral vascular resistance*<br>c. Decreased pulmonary capillary permeability<br>d. Increased cardiac output<br>e. Increased venous return | |

**Figure 2.** Example of questions received by each group. Both groups of students had to choose the appropriate answer among the same five options. * - correct answer

Students were given 15 minutes to solve each of part of the tests (total time: 30 minutes) and were not allowed to consult the bibliographic sources used in the tutorial sessions.

### *3.2 Test scoring*

The overall score of the tests (CM test + MCQ test) as well as the partial scores (Liver cirrhosis CM test, Liver cirrhosis MCQ test, Circulatory shock CM test and Circulatory shock MCQ test) were expressed as percentage of correct answers (range: 0% to 100%), according to the following formulas: total score: n/20*100; partial scores: n/10 (n = number of correct answers).

### *3.3 Statistical analysis*

The total and partial scores of the tests were analyzed with the SPSS statistical package (version 19). The results are expressed as mean scores and its confidence intervals (CI). Independent *t* Student test was applied to compare: Group 1 vs Group 2 overall scores, Liver cirrhosis MCQ vs. CM test and Circulatory shock MCQ vs. CM test. The level of significance was set at $p < 0.05$.The Kolmogorov Smirnov test was used to test normality of data distribution and the Levene test to calculate the homogeneity of variances.

## 4 Results

Each part of the tests was completed by all the students within the scheduled time. Total and partial test scores were all normally distributed and no significant differences were found between variances, except when Group 1 and 2 global scores were compared. In this particular case, *p* was determined for equal variances not assumed.

No significant differences were found between the mean overall scores obtained by Group 1 (Liver cirrhosis CM test + Circulatory shock MCQ test) and Group 2 (Circulatory shock CM test + Liver cirrhosis MCQ test) (Table 1).

The results of both cirrhosis and circulatory shock MC test were significantly higher (Table 1) than those of the corresponding MCQ tests, meaning that both groups of students performed better when the questions were embedded in the concept map, especially in the circulatory shock CM test. Regarding CM tests, 61% of the students scored 50% or above in liver cirrhosis and 62% in circulatory shock, while the corresponding MCQ test percentages were 46% and 49%.

## 5 Discussion

The purpose of the present work was to ascertain whether the students' acquired knowledge in pathophysiology, was comparable when assessed by a CM test and a context free MCQ test, and to evaluate if the CM test could be applied as a feasible assessment tool, aligned with the learning strategy adopted.

Regarding the time spent to solve the CM test, it has been shown that it was feasible, since all the students completed each part within the scheduled time. On the other hand, as it is expected when using the select-and-fill format (Himangshu, 2010), the scoring system was simple and reliable.

**Table 1** - Comparison of test scores

| | | n | mean | sd | CI (LL-UL) | P |
|---|---|---|---|---|---|---|
| Total scores (%) | | | | | | |
| | Group 1 | 56 | 46.1 | 11.74 | 43.7 – 49.4 | ns |
| | Group 2 | 55 | 45.5 | 15.21 | 41.1 – 49.5 | |
| Partial scores (%) | | | | | | |
| Liver cirrhosis | CM test | 56 | 49.2 | 15.47 | 45.8 – 53.6 | 0,004 |
| | MCQ test | 55 | 42.9 | 15.69 | 35.1 – 45.1 | |
| Circulatory shock | CM test | 55 | 51.1 | 19.90 | 45.5 – 56.4 | 0.017 |
| | MCQ test | 56 | 42.9 | 15.72 | 39.5 – 47.1 | |

n– number, sd – standard deviation, CI – confidence interval, LL – lower limit, UL – upper limit

The overall scores achieved by Groups 1 and 2 were similar, demonstrating that the level of acquired knowledge in the topics evaluated was identical in both. Thus, despite the scores obtained for CM and MCQ tests on circulatory shock and liver cirrhosis came from different groups of students, the groups were considered to be comparable. The significantly higher scores obtained in CM tests when compared with the context free MCQ tests, performed without previous specific preparation, support the hypothesis that, while the traditional MCQ tests mainly appealed to memory and rote learning, the concept map embedded test privileged conceptual knowledge acquired during the tutorial sessions. Therefore, these results support the use of CM tests in the final assessment of the students in the Pathophysiology course.

## 6 References


Correa, B. B., Rosado Pinto, P., & Rendas, A. (2003). How Do Learning Issues Relate with Content in a Problem-Based Learning Pathophysiology Course? *Advances in Physiology Education, 27*(2), 62-69.

Guzek, J. W. (1994). Teaching pathophysiology to medical students: present status and prospects. *Pathophysiology, 1*(1), 73-77.

Himangshu, S. (2010). *Beyond individual classrooms. How valid are concept maps for large scale assessment?* In J. Sánchez, A. J. Cañas, J. D. Novak (Eds.), *Concept Maps: Making Learning Meaningful, Proc. of the Fourth Int. Conference on Concept Mapping,* Viña del Mar, Chile: Universidad de Chile.

Rendas, A., Fonseca, M., & Rosado Pinto, P. (2006). Toward meaningful learning in undergraduate medical education using concept maps in a PBL pathophysiology course. *Adv Physiol Educ, 30*(1), 23-29.

Rendas, A., Rosado Pinto, P., & Gamboa, T. (1999). A computer simulation designed for problem-based learning. *Medical Education, 33*(1),.

Schau, C., Mattern, N., Zeilik, M., & Teague, K.W. (1999). *Select-and-Fill-in Concept Map Scores as a Measure of Undergraduate Students' Connected Understanding of Introductory Astronomy*. Paper presented at the Annual Meeting of the American Educational Research Association. Montreal, Canada.