Concept Maps: Making Learning Meaningful
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UNDERGRADUATION STUDENTS ATTITUDES TOWARD THE USE OF CONCEPT MAPS IN A BACTERIOLOGY CURRICULAR UNIT

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Abstract. Concept mapping is a tool originally designed to investigate how students learn, but it can be used also for assessment of competences/knowledge acquisition (Novak & Gowin, 1984). In this study 180 undergraduate Bacteriology students used CmapTools software for learning and assessment. During one semester the students developed electronic concept maps for three different themes studied in the laboratorial classes of Bacteriology course curriculum. At the end of the semester the students attitudes towards the use of concept mapping was assessed by the use of a questionnaire. The data from both the quantitative and qualitative part of the study revealed that undergraduate students have positive attitudes toward the use of concept mapping in Bacteriology course. They also considered the use of concept mapping as a tool that allows understanding of their own thinking processes and enhances their learning skills.

1 Introduction

Concept mapping is a tool for meaningful learning by presenting information in a visual format using hierarchical tree-like branching structures (Novak et al., 1984), thus the holistic relatedness of ideas can be readily illustrated. In concept mapping, one identifies the important concepts from a subject and describes the relationship between those concepts with linking words (Novak et al., 1984). The process also involves selecting the concepts by importance, and finding hierarchical relations between them. In fact, concept mapping is within a cognitive-constructivism framework were individuals create knowledge by linking new concepts to prior knowledge (Novak & Cãnas, 2006; Kinchin et al., 2009). In Europe, use of concept mapping at the University level is still restricted although successful use of it in Medical Education and research has been already reported (Fonseca et al., 2004; Rendas et al., 2006; Fonseca & Extremina, 2008). Learner's attitudes may have implications in their learning style, thus having great influence in their engagement and motivation to learn (Laight, 2006). Student attitudes to concept maps (CM) may indicate other important influences in the adherence to this educational tool, such as the academic workload, motivation and contextual institutional issues (Farrand et al., 2002).

The European Union education restructuration process named as "Bologna statement" is based on self search for knowledge being therefore of interest to assess the possibility and interest of implementation of computer-based concept mapping in curricular units of University of Porto courses. The aim of this study was to examine student perceptions to CM in undergraduate Bacteriology practical lectures.

2 Experimental Design and procedure

Concept mapping was done by the students using CmapTools, a software developed at the Institute for Human and Machine Cognition (Novak & Cañas, 2006). This software was created considering the Ausubel and Novak learning theory (IHMC; Cañas et al., 2004).

2.1 Participants

The study present in this paper was developed in the first semester of 2009/2010 and enrolled 180 undergraduate Bacteriology students (distributed by nine classes). This curricular unit is from the third year of a five years Pharmaceutical Sciences course and comprises a theoretical and practice component (2 hours per week each). During the first two weeks students were taught to use CM as an integrated part of their course work. The students developed CM in three different themes of the course core. The students did not have any previously knowledge or experience

of using concept mapping, so a first instruction course of one hour was done. The overall learning and assessment strategy was assessed at the end of the semester after the administration of an electronic questionnaire.

2.2 The questionnaire

Students' perceptions and opinions on the use of concept mapping was assessed through a questionnaire (Coutinho et al., 2008) completed at the end of the semester, after the definitive assessment. For the questionnaire open and closed questions were used and three sections were established. The first part includes items related to student characteristics such as age, sex and graduation year. The second part was composed of 17 items in the format of a 5 points Likert scale with the aim to assess students perceptions on the use of concept mapping as a cognitive learning tool for knowledge construction. The fourth part included a single open-ended question that asked students to do an overall global analysis of the concept mapping learning strategy.

3 Results and Discussion

3.1 Sample characterization

Fifty eight students out of 180 (32%) completed the electronic questionnaire. From the questionnaires received is was found that the age of the students was between 20-28 years old, 75,5% between 20-22 years old, 12,3% between 23-26 and 7% with 28 years old and as to gender 66,7% were female and 26,3 % were male. Table1 shows the results obtained for N=58. The relative percentages of agreement/disagreement are shown for each item. For discussion of the results the arithmetic mean and standard deviation was also, computed. The five points Likert scale for degree of agreement were used (1= Strongly Disagree, 2= Disagree, 3= Neither Agree or Disagree, 4= Agree, 5= Strongly Agree). The items 4, 9, 17 are written as negative statements and this is to prevent patterns of answer (Coutinho et al., 2008). For the analysis these items had to be reversed. The items shown in Table1 were also grouped according to a specific dimension under evaluation.

A first and global view of Table1, in particular the last columns, where mean and standard deviation for each item are described, it is possible to verify that students have a very positive perception and opinion concerning the learning and assessment experience with the use of CM. In fact, almost all items scored 4 (Agree) or over 4, and this is confirmed by the use of negative statements and their scores that were used in order to increase the questionnaire reliability.

The questionnaire dimensions under analysis were assessed: Two items of the Likert scale evaluated the process of knowledge construction with CM. Most of the students strongly agree that the construction of CM was helpful: concentration on key concepts (Item 2= 4,25) and stimulating critical thinking (Item 5= 3,71). Four items of the Likert scale evaluated the influence of using CM on learning and the answers show that the construction of the CM was considered very useful for learning (Item 3= 3,98) because it made me learn better (Item 1= 4,21). The negative mean score obtained for Item 9 (2,16) confirms the previous statement. In order to assess the influence of concept mapping in the ability to organize information in a non linear way, four items were evaluated: The development of skills in organizing information distinguishing what is essential from what is secondary (Item 6= 4,25), namely by better organizing the topics of the Bacteriology course (Item 7= 4,00), thus helping to better understand the program of Bacteriology in all its complexity (Item 8= 3,43). All of these statement were confirmed by the negative score obtained for Item 4 (1,79). One of the main forces of the "Bologna Statement" for higher education is the promotion of a more "student centered approach". So in order to evaluate if CM increased students control over their learning process, namely by the ability to "measure changes" in knowledge acquisition, four items were evaluated: The construction of the CM helped to reflect on my learning process (Item 10= 3,64), namely by allowing the review of what has been learned (Item 11= 3, 82), by becoming aware of the level of learning (Item 12= 3,59). For item 13 (2,98) some students perception is of a negative statement and this could explain the score. The item 15 (3,86) shows that collaborative learning using CM was useful for learning and the item 16 (3,84) confirms the interest in using CM as an educational tool in other curricular units.

Results obtained also show that students are available and willing to collaborate in future work related to the use of CM as an educational tool.

	Likert Scale Questionnaire items	%						
		1-SD	2-D	3-NA/D	4-A	5-SA	Mean	SD
2	The construction of the CM forced me to concentrate on key concepts	0	5,3	7,0	43,9	42,1	4,25	0,82
5	The CM stimulate critical thinking	0	7,0	28,1	49,1	14,0	3,71	0,80
3	The construction of the CM was very useful for my learning	0	1,8	15,8	63,2	17,5	3,98	0,65
9	I do not think it was important the construction of the CM to learn Bacteriology	24,6	47,4	10,5	12,3	1,8	2,16	1,01
14	The construction, modification and maintenance of CM activities were very motivating	7,0	26,3	28,1	36,8	0	2,96	0,97
1	The construction of the CM made me learn better	0	3,5	1,8	63,2	29,8	4,21	0,65
7	The construction of the CM has helped me to better organize the topics of Bacteriology curricular unit	0	5,3	10,5	61,4	21,1	4,00	0,74
8	The CM helped me to understand the Bacteriology program in all its complexity	0	22,8	14,0	57,9	3,5	3,43	0,89
4	Instead of simplifying the CM just confused me more	38,6	45,6	10,5	3,5	0,0	1,79	0,78
6	The CM develop skills for organizing information distinguishing what is essential from what is secondary	0	3,5	7,0	49,1	38,6	4,25	0,75
11	When building a CM for a work of Bacteriology I did a review of what has been learned	0	8,8	14,0	61,4	14,0	3,82	0,79
12	Building CM was helpful to my learning because I became aware of my level of learning	0	14,0	19,3	57,9	7,0	3,59	0,83
13	The construction of the CM helped my learning because it curricular unit forced me to have more discipline	5,3	35,1	17,5	36,8	3,5	2,98	1,05
10	The construction of the CM has helped me reflect on my learning process	0	8,8	24,6	57,9	7,0	3,64	0,75
15	Showing CM to colleagues was useful for my learning	0	3,5	22,8	56,1	15,8	3,86	0,72
16	I understand that the CM is a tool for future use in other curricular units	0	7,0	22,8	45,6	21,1	3,84	0,86
17	The time invested in building the CM "does not pay", even in cases where the CM is a positive factor for the final classification of a curricular unit	24,6	31,6	15,8	17,5	7,0	2,49	1,26

Table 1. Students' perceptions of their learning experiences with concept maps (CM). SD- Strongly Disagree; D- Disagree; NA/D- Neither Agree or Disagree; A- Agree; SA- Strongly Agree; SD- standard deviation. Items underlined- negative statements.

3.2 Comments on the concept mapping experience

In the fourth part of the questionnaire in the open-ended question students commented the concept mapping experience and made their suggestions for future work. Here are few selected comments:

Item 18 - Please make your suggestions/comments on the use of CM (refer to its use, eg, as a diagnostic and study tool, etc.).

"*I had never worked with CM and I really enjoyed the experience. I think it was a big advantage for my learning process. I think it's a way we can simplify/resume our study, focusing only in the main points, so I intend to use it more often.*"

"*In my opinion the CM are useful because they allow the perception of what part of the program is now more consolidated and which points need more attention. They are useful tools for studying because they enable the relation of the principal and important concepts allowing us to have a better idea of the course program*"

"*Indeed, when studying for the final exam I remember clearly trying to follow a logical line of reasoning based on the CM. I note that while a university student, I consider this experience very positive, believing that if we had devoting more time to do so, the results would be even more visible*"

"*It was a new experience since I had never tried making a CM for whatever. At the end of the semester, I see now that the CM helped me to assimilate the program, facilitated the study for the final exam and most of all allowed the relationship between different concepts of specific subject taught by the teacher. It was a good experience and without any doubt I will like to use CM in other curricular units*"

"I understand the relative usefulness of CM. However, the time needed to invest in this type of connection of ideas does not exist in the overall scheme of Bologna"

Although some of the comments speak for themselves this study shows that concept mapping needs a very proactive attitude from the students and it also demands time management skills and confirms that the students attitudes and perceptions to concept mapping is greatly influenced by the academic workload and institutional context, and this is in accordance to previously published work (Farrand et al., 2002).

4 Conclusions

Students were very interested in creating good CM, being therefore engaged to the learning process which is in accordance to the more student-centered approach proposed by "Bologna statement". Students perceptions confirm that CM promoted their ability to organize, think and relate to prior knowledge. There are, however, several limitations of this study that should be explicit. Although the number of questionnaires obtained was relative high it represents only 32% of the students; the curricular unit instructor was also the researcher but there were three observers/evaluators of the learning experience.

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