

## Using concept maps with postgraduate teachers in a web-based environment: an exploratory study

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**Abstract:** In this paper we report how 26 in service teachers enrolled in a post graduate education program in Curriculum Development, used Cmaptools software for class work and assessment in Research Methods in Education (RME). For one semester teachers were taught to use electronic concept maps as a constructivist learning strategy. Teachers developed electronic concept maps to reflect on the course readings, plan course projects and to compare and contrast information from course discussions. Concept maps created were posted in the course website for the instructor and other students to visualize and comment. At the end of the semester the learning strategy was assessed thru survey techniques in order to identify students' opinions on the experience of building maps with Cmaptools in RME. Results show that post graduate teachers considered that the process of using this constructivist strategy was important to enhance their learning skills in studying RME contents and also grew to understand their own thinking processes. The findings also suggest that the use of CMS within a web-based environment made it easier for teachers to constantly revise maps, increasing performance at representing knowledge and creating meaning of the course core.

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### Introduction

According to the literature, adult students often enter higher education programs relying on learning strategies that have worked well for them in the past (Merriam & Caffarella, 1999). These previous learning strategies often include rote learning, passive learning, and memorization and so it is important to broaden students learning strategies as a major factor contributing to their academic and professional success (Gibbons, 1990; Novak, 1990). The use of concept maps has shown effective to promote a constructivist learning approach that helps adult students to understand the learning processes of linking and creating meaningful schemes in the construction of knowledge (Daley, 2004).

Research reports on the use of computer-based concept mapping as cognitive tools (Jonassen & Reeves, 1996), suggesting that these techniques could be successfully used to enhance teacher's thinking about effective teaching (Lederman & Latz, 1995). More recently educators began to analyze the use of computer-based concept mapping tools in teacher education programs (Ferry, Hedberg & Harper, 1997). Since then, the collaborative features of electronic concept mapping to support constructivist learning (effects on learning, task performance, attitudes, interactions) become one of the major research trends around the use of concept maps in education (Basque & Lavoie, 2006; Novak & Cañas, 2004).

In the empirical study 26 in service teachers enrolled in a post graduate education program in Curriculum Development used Cmaptools for class work and assessment in Research Methods in Education (RME) program. For one semester teachers were taught to use electronic concept maps as an integrated part of their course work. Students developed concept maps to reflect on the course readings, plan course projects and to compare and contrast information from course discussions. At the end of the semester the learning strategy was assessed thru survey techniques in order to identify teacher's opinions on the experience of using concept mapping in RME classes.

### Conceptual Framework

Merriam and Caffarella (1999) define five different learning styles including: behavioural, social, humanistic, cognitive and constructivist learning. They believe that within each of these learning orientations different assumptions exist about the nature of learning and the strategies that instructors can use to facilitate learning.

For a long time teaching has been considered the act of transferring information from the teacher (the one who knows) to the learner who was seen as empty vessel to be filled with knowledge. This view of learning was due to the popularity of behaviourist learning theories which focused on how the presentation of the information affected learning outcomes (Coutinho, 2006). Therefore, it is not surprising that the art of teaching became the art of presenting information. Later on, cognitive scientists emphasized the study of how information is stored and processed in memory and this view of learning changed the paradigm. For cognitivism, learners are processors of information who use a variety of strategies to store and retrieve knowledge (Coutinho, 2008). Thus the learner is a person who can engage in activities that will aid in the

processing of information. Such mental activities help people to acquire, organize, and remember incoming knowledge more efficiently (Novak & Cañas, 2006).

This constructivist learning from the cognitive approach defended by David Ausubel and Jerome Brunner (c.f. Daley, 2004), express the belief that individuals create knowledge by linking new information with past experiences to create a personal process for meaning-making. Within a constructivist framework, the learner progressively differentiates concepts into more and more complex understandings and also reconciles abstract understanding with concepts garnered from previous experience (Novak, 1998; Novak & Cañas, 2006). New knowledge is made meaningful by the ways in which learners establish connections among knowledge learned, previous experiences, and the context in which learners find themselves.

Novak (1998) operationalized constructivist learning theory by creating concept maps that can be defined as follows: "A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions" (Novak, 1998, p.15).

Concept maps are created with the broader, more inclusive concepts at the top of the hierarchy, connecting through linking words with other concepts that can be subsumed. This tool helps facilitate understanding of conceptual relationships and the structure of knowledge. Novak (1990) found in an analysis of multiple studies using concept maps that the technique promoted novel problem solving abilities, raised mean scores on achievement of content units, decreased students' anxiety levels and increased students' positive attitudes toward the content of study (Plotnick, 1997). From an educational perspective, a growing body of research indicates that the use of concept maps can facilitate meaningful learning (Coffey, Carnot et al., 2003).

## The CmapTools Software

The CmapTools software (available for download at: <http://cmap.ihmc.us>) developed at the Institute for Human and Machine Cognition brings together the strengths of concept mapping with the power of technology, particularly the Internet and the World Wide Web (WWW) (Novak & Cañas, 2004). The software does not only make it easy for users of all ages to construct and modify concept maps in a similar way that a word processor makes it easy to write text, it allows users collaborate at a distance in the construction in their maps, publish their concept maps so anybody on the Internet can access them, link resources to their maps to further explain their contents, and search the WWW for information related to the map (Cañas et al, 2004).

The software allows the user to link resources (photos, images, graphs, videos, charts, tables, texts, WWW pages or other concept maps) located anywhere on the Internet to concepts or linking words in a concept map through a simple drag-and-drop operation. Links to these resources are displayed as icons underneath the concepts, and by clicking on one of these icons will display a list of links that the user can select from to open the linked resource (Cañas et al, 2004). Using CmapTools, it is possible to use concept maps to access any material that can be presented digitally, including materials prepared by the mapmaker. In this way, concept maps can serve as the indexing and navigational tools for complex domains of knowledge (Cañas et al., 2001).

According to Novak & Cañas (2006) CmapTools was designed to support collaboration and sharing and can be used either for face to face activities as well as for distance learning. The current focus of research is on the web-based CMs with synchronous and asynchronous communicative facilities (Cañas et al., 2001). Collaborative CMs has therefore become feasible even when participants are distributed. The trend towards web-based CMs systems provides opportunities for the application of concept mapping within electronic learning environments (Khamesan & Hammond, 2004).

## Design

The study we present in this paper was developed in the first semester of 2007/08 and enrolled 26 post graduate teachers who attended a program on Research Methods in Education (RME) as part of their Master Degree in Curriculum Development. For one semester teachers were taught to use concept maps as an integrated part of their course work. Students developed concept maps to reflect on the course readings, plan course projects and to compare and contrast information from course discussions. In fact, the complexity of the course program claimed for the search of learning activities requiring deep engagement of the student with learning materials and concept mapping was the mind tool used to enhance learning of the course core.

A concept mapping task begins with the instructor selecting a limited domain of knowledge to be mapped by the student (Novak, 1998). This knowledge domain should be tied to course material. The student then lists key concepts in the domain and arranges them from inclusive to general and by type. The student completes a concept map by drawing lines between concepts to illustrate relationships and by writing proposition statements on these connecting lines to describe the nature of the relationship. For maps that depict multiple knowledge domains, students may also draw cross-links to show how concepts that are not directly connected relate to one another on some level. In our study, students used Cmaptools to map the main topics of RME program: "Research Paradigms", "Sampling Methods", "Methods for data collection", "Qualitative data

analysis”, “Quantitative data analysis”, etc. Concept maps created by students were posted online in the course website for the instructor and other students to visualize and leave comments. Students could modify concept maps before posting online a final version for assessment. The overall learning strategy was assessed at the end of the semester thru an online questionnaire.

## The Questionnaire

Teacher’s perceptions and opinions on the learning strategy were assessed thru an online questionnaire fulfilled at the end of the semester. A mixture of open and closed questions was used. The questionnaire was divided into three sections. The first part included items related to student characteristics such as age, sex, previous acknowledgement with concept mapping as a cognitive learning theory and tool as well as difficulties felt in building maps with the new the software. The second part was composed of 21 items in the format of a 5 five points *Likert* scale and intended to assess students’ perceptions on: a) concept mapping as a cognitive learning tool, b) the potential of Cmaptools to help students learn the complexity of RME core. The third part included a single open-ended question that asked teachers to do an overall critical analysis of the concept mapping learning strategy.

The reliability of the questionnaire was obtained thru two complementary procedures: a) two experts evaluated the content of the items and recommendations were used to refine item redaction and organization in the questionnaire; b) 5 students of another post graduation class who were also using the tool filled out the questionnaire for testing its empirical validity (Coutinho, 2000; Wiersma, 1995).

## Results

### Sample characterization

Twenty six teachers completed the online questionnaire developed in surveymonkey.com. The age of teachers was 35% between 18-25 years old, 31% between 26-35 years old, 19% between 36-45 years old, and 15% between 18-25 years old, and as to gender 81% were female and 19% male. Almost of all were in service teachers (92%) who worked in public schools; 8% were not teaching at the moment. 31% taught elementary classes (31%); the remaining participants had graduation in Foreign Languages (19%), Portuguese (15%) and Mathematics (12%).

### Knowledge about Concept Mapping

The first question inquired about the previous acknowledgment of concept maps: 54% had already heard about concept maps, some said that they had some activities with maps during their graduation. But 46% said that had never heard about concept mapping.

### The software Cmaptools

As we already said in the introduction of this paper, we used the software CmapTool to implement the concept mapping activity. 96% (almost all) of the respondents said that didn’t know Cmaptool software yet. Just one respondent said that he already knew Cmaptool as well as Mindmanager, but he considered Cmapstools as a better tool to build electronic maps. As to difficulties in using the tool the majority of the respondents (66%) said it was easy to use and built maps with Cmaptools. As to the functionalities of the tool, the possibility to modify and change previous maps was important for 80% of the respondents; 95% pointed out its versatility, the possibility to add images and colour (76%) as well as to add links to internet resources (72%).

### Attitudes on the Learning Experience With CMs

Twenty one items of the questionnaire evaluated students’ perceptions on the potential of Concept maps as an educational tool to organize link and present the information, to monitorise the learning process of RME core and to verify if the activity challenged teachers to use the tool in their own classroom contexts. Table 1 shows results obtained for N=26. The % of agreement/disagreement are shown for each item. It was also computed the arithmetic mean, and this value was also used for discussing results; as we used a 5 points *Likert* scale for degree of agreement (1=Strongly Disagree, 2=Disagree, 3=Neither agree or disagree, 4=Agree and 5=Strongly Agree), we considered the mean of 3 as the cut point for considering the existence of agreement/disagreement to each statement presented. Some of the questionnaire items were written in a negative statement in order to prevent patterns of answer (Pinedo, s/d), and so they had to be reversed for data analysis purposes. In order to facilitate data analysis and discussion, the order of the items presented in Table 1 was organized according to the dimensions under evaluation.

A first and holistic view of data obtained, particularly if we focus the attention in the analysis of the last column where means for each item are computed, we realise that students opinions on the learning

experience with CMs are very positive (most means over 4 confirmed by the negative scores obtained in negative statements that were used to strength the questionnaire reliability).

Table 1: Attitudes on the Learning Experience With CMs

Nº	Likert Scale QuestionnaireItems	%					Mean
		SD	D	NA/D	A	SA	
2	To build maps allowed me to relate complex subjects in a visual representation	0	0	0	50	50	<b>4,5</b>
4	Relating concepts helped to a deeper understanding of contents	0	0	7,7	26,9	<b>65,4</b>	<b>4,58</b>
5	I don't believe that to build CMs enhances learning	<b>57,7</b>	34,6	3,8	0	3,8	<b>1,58</b>
7	To construct CMs makes one organize topics in a logical format	0	0	0	31	<b>70</b>	<b>4,69</b>
8	It is compulsory to focus on key concepts	0	0	0	19,2	<b>80,8</b>	<b>4,81</b>
9	To build maps was very useful for my learning	0	0	4	48	48	<b>4,44</b>
10	Instead of simplifying it only confused me more	<b>61,5</b>	30,8	3,8	3,8	0	<b>1,5</b>
11	It encourages non-linear thinking	7,7	11,5	7,7	<b>61,5</b>	11,5	<b>3,58</b>
12	It develops skills for organizing information distinguishing what is essential and secondary	0	0	0	30,8	<b>69,2</b>	<b>4,69</b>
13	To build CM helped me to organize better RME topics	0	0	0	50	50	<b>4,5</b>
1	It helped to understand the complexity of RME core	0	0	3,8	38,5	<b>57,7</b>	<b>4,54</b>
14	I don't think it was important to build maps to learn RME core	<b>61,5</b>	30,8	3,8	3,8	0	<b>1,5</b>
15	To build CMs helped to reflect on my learning process	0	0	3,8	<b>53,8</b>	30,8	<b>4,15</b>
16	While doing a CMs for a RME topic I was making a balance of what was already learned	0	8	8	<b>44</b>	40	<b>4,16</b>
17	Build maps was useful for my learning because I was aware of what I needed to study	0	0	11,5	<b>46,2</b>	42,3	<b>4,31</b>
18	To build CMs helped learning as it forced me to discipline myself	0	0	15,5	<b>50</b>	34,6	<b>4,19</b>
19	To construct, modify and maintain online CMs was very motivating	0	0	11,5	<b>46,2</b>	42,3	<b>4,31</b>
20	To visualize the maps of other colleagues was useful to my learning	0	7,7	11,5	<b>42,3</b>	38,5	<b>4,12</b>
21	The feedback of the instructor helped me to increase performance on building maps	0	0	0	19,2	<b>80,8</b>	<b>4,81</b>
3	I will certainly use CMs in my professional life	0	3,8	3,8	34,6	<b>57,7</b>	<b>4,46</b>
6	I think I will use this tool class with my pupils	0	4	8	<b>52</b>	36	<b>4,2</b>

Seven items of the Likert evaluated the process of knowledge construction with CMs. We could verify that the majority of the respondents either strongly agreed or agree that to create concepts maps helped: to develop the ability to organize information (It 7=4,69); to relate complex subjects (It 2=4,5) facilitating a deeper understanding of contents (It 4=4,58) and enhancing learning (It 9=4,44, confirmed by the low score in the opposite statement presented in It 5=1,58). Three items of the Likert scale intended specifically to evaluate the influence of building CM on learning the RME core. The answers show that to create concepts maps helped to organize better RME topics (It 13= 4,5) enabling teachers to understand the complexity of RME core (It 1=4,54). The negative mean score obtained in It 14=1,5, confirms the previous deduction.

Concept maps helped students to organize the contents and information in a non-linear way (It 11=3,6); it also helped to find new information and to relate different and complex concepts in a simple visual diagram (It 2=4,5). This idea is reinforced by the low score obtained in the negative statement- *Instead of simplifying, I think that CM only helped to confuse the concepts* (It 10=1,5), that certifies that the concept mapping strategy helped to understand the concepts. They also strongly agreed that to built concept maps was very useful for learning (It 9=4,5).



To understand the development of concept mapping, you need to follow some procedures such as: 1) a deep reading of the topic, and 2) identify the key concepts of the topic. The respondents strongly agree that built concept maps requires to focus attention on key concepts (It 8=4,81), to distinguish the essential from the accessory (It 12=4,7), and also to organize the contents on a logical way (It 7=4,7).

Another feature of CMs described in literature is that it helps students to control the learning process allowing to “measure” changes in knowledge acquisition (Khamesan & Hammond, 2004). According to data, students recognized that building CMs helped *to reflect on the learning process* (It 15=4,15); *it was useful for my learning because I was aware of what I needed to study* (It 17=4,31), and because *it forced me to discipline myself* (It 18=4,19).

When concepts and linking words are carefully chosen, CMs can be useful classroom tools to share and improve learning as students can observe nuances of meaning, different forms to organize thinking and summarize subjects of study. In our learning activity, CMs were available online for all class to accede and comment. According to the answers to items 20 and 21, students recognized that *to visualize the maps of other colleagues was useful to my learning* (4,12) and also that *the feedback of the instructor helped to increase performance on building maps* (4,81).

As teacher educators, we believe that a new methodology to be adopted by teachers must be motivating and convincing. Teachers do not adopt new pedagogy simply because they think they possess the skills and knowledge to do so but because they believe it can function in real classrooms (Ulmer & Timothy, 2002). The high level of agreement on the item (It 6=4,2) - *I think I will use this tool with my pupils* -, shows that respondents intend to use Cmaptools with their own students. They also intend to use electronic concept mapping in other situations of their professional life (It 3=4,46).

### Comments on the concept mapping experience

In the final open ended question students critically commented the concept map experience and gave suggestions for future projects. Here are some of the student's comments:

*“Develop concept maps allows to review the whole of RME program, finding points of intersection between content in order to understand the complexity of the issues. The tool is very useful and intuitive, allowed me to organize learning”*

*“It was a very positive experience and I believe it to use it in my professional activity. I think it is motivating and stimulating for the clarification of concepts and relations and for “self learning” since it shows how pleasant and schematic the subjects we study are.”*

*“Cmaptools is a tool that I didn't know, but which may be applied in order to organize learning as it allows reading much faster and easier a complex knowledge base. I think it will be a good way to organize complex concepts facilitating their understanding.”*

*“It was an interesting experience, and certainly because we knew enriching program. Mapping of concepts was extremely useful as it allowed to structure the topics we studied, organizing the concepts discussed, separating what was more and least important. It is a great tool for work and study.”*

*“I consider very important and fits to my method of studying, which include doing visual schemes for easily understanding the structure obtained in a particular concept. I need to record the keywords, which I can retain and build relations within the concepts. This method allows for a quick reading and now with this tool, my work is further facilitated.”*

*“Building concept maps with Cmaptools was addictive, as in my case, besides forcing me to study more and more the topics, forced me to find new concepts that were related to those already introduced so that the map could be the more and more complete and as detailed as possible for a certain concept.”*

### **Final remarks**

Cmaptools is free and available in the web, and is relatively easy to use. The pedagogical experience we present in this paper illustrates a possible usage of concept maps as a way for adult learners (in our case in-service teachers) to study and organize a complex knowledge base, important for the development of a research project in education, that requires deep study and understanding of a wide variety of new concepts.

Teacher's developed electronic CMs on specific curricular topics and posted them in the class website in order to help themselves and the other students to understand the core concepts of the of Research Methods in Education program. The instructor scaffold the learning strategy sending feedback and helping students to

revise and complete initial maps.

Concept maps are flexible cognitive tools that engage students in the learning process promoting activities that require students to read, to think, to organise, to relate with prior knowledge, to draw, to revise, to reflect to rebuild and to communicate (Novak & Canas, 2006). Results of this preliminary study indicate that post graduate teachers who attended our program considered that the process of using this constructivist learning strategy was important to enhance their learning skills in studying RME contents and also they grew to understand their own learning processes. The findings also suggest that the use of CMs within web-based environments made it easy for students to constantly revise maps monitoring and improving their own learning.

In summary this study indicates that concept maps within web-based environments can effectively promote learning of adult students and so are recommended to be added to the teaching strategies of faculty in higher education programs.

## Limitations

The number of participants in the study limits the scope of the study. Future research with more participants will certainly lead to more robust results. The course instructor was also the researcher and the single observer/evaluator of the learning experience.

The data presented in this paper are only an initial feedback from the in-service teachers' perceptions and opinions of building CMS. Further quantitative analysis to be performed will include the scoring of the maps according to the formula created by Novak & Gowin (1984) in order to evaluate the evolution registered in concept maps scores from initial to final versions. Finally we are also considering the possibility of interviewing a sample of the participants in this study within a year in order to verify if they are still using Cmaptools either for class preparation or for classroom activities with students.

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