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PRECONCEPTIONS REGARDING CONCEPT MAPS HELD BY PANAMANIAN TEACHERS

Norma L. Miller, Universidad Tecnológica de Panamá & Proyecto Conéctate al Conocimiento, Panamá
Alberto J. Cañas & Joseph D. Novak, Florida Institute for Human & Machine Cognition (IHMC), USA
E-mail: nmiller@conectate.gob.pa

Abstract. Many studies have shown that, as a tool for the organization and representation of knowledge, concept maps can support meaningful learning and knowledge construction processes. Good concept maps can lead to the discovery of new and unsuspected relations among concepts, thereby stimulating students' creativity. In Panama, concept maps have been known and used for years. This study examines Panamanian public elementary schoolteachers' preconceptions about concept maps and their use. The study was carried out with teachers beginning training in the *Conéctate al Conocimiento* Project's workshops, and shows that although a very high percentage of teachers are familiar with concept maps, and a great many claim to use them in their classrooms, most of them have serious conceptual errors regarding this tool. Results highlight possible reasons why concept maps have not had the expected impact in Panama's schools, and allow us to make adjustments to the teaching strategies implemented at the workshops in order to improve their outcome.

1 Introduction

In what has come to be known ad the *Information and Knowledge Society*, it is generally agreed that individuals will need to be able to adapt to rapid, continual and turbulent change, both in their personal lives and in the workplace. In such a setting, the ability to construct new knowledge, be creative, and work collaboratively, will prove invaluable. In schools, children have the opportunity to acquire and practice these skills through work with various pedagogical tools such as concept maps.

Numerous studies (see Coffey et al., 2003) have demonstrated the potential of concept maps in helping students construct their own knowledge, as well as in stimulating their creativity. Additionally, with the advent of concept-mapping computer programs and their integration with Internet, many novel forms of collaborative work have become possible.

1.1 Concept maps

Concept maps are not new in education. They were developed during the 70's by Joseph Novak and his colleagues at Cornell University, as a tool to help record and understand changes in students' comprehension of science concepts. Over the years, their potential to involve students in significant learning processes became evident. This was eloquently presented in the book *Learning how to learn* (Novak & Gowin, 1984), thus contributing to spread the use of concept maps throughout the world.

A concept map is made up of *concepts* joined by *linking words* or *phrases* to form *propositions.* Novak (1998) defines a concept as "a perceived regularity in objects or events, or in representations of objects or events, which is designated by a label." More informally, a concept can be thought of as the mental image we associate to a word or set of words. As the term itself suggests, propositions "propose" or state something; thus they constitute semantic units or units of meaning. The linking phrase expresses the relationship that is claimed to exist, in a given context, between the joined concepts. There is no specific limit as to the number of words a linking phrase may contain. However, as a general rule, relations should be expressed as clearly and succinctly as possible.

Concept maps can support meaningful learning in many ways. In what follows we highlight only some of these ways. According to the Theory of Meaningful Learning (Ausubel, Novak & Hanesian, 1978), in order for meaningful learning to take place, the learner must possess a framework of relevant, well-organized knowledge into which new knowledge can be inserted in a flexible and dynamic manner. The problem, in practice, is how to reveal this knowledge structure. As a tool for the organization and representation of knowledge, concept maps help expose the knowledge that a learner has on a given topic or subject. Due to their simple proposition-based structure, it is easier to detect conceptual errors in a concept map than in a piece of linear text, where the language itself often obscures clear ideas, or disguises erroneous ones. In this manner, concept maps provide a structure into which a students can insert new concepts and propositions, whilst they re-examine previous ones.

1.2 The Conéctate al Conocimiento Project

Conéctate al Conocimiento (Tarté, 2006) is a project to transform Panamanian education. It is under the responsibility of the President's Secretary for Government Innovation and, presently, is directed at 4th, 5th and 6th grade teachers of Panama's public elementary schools. The project involves two mutually complementary aspects: 1) 2-week training workshops in the use of specific pedagogical and technological tools, and in the application of instructional methods and strategies conducive to meaningful learning in students; and 2) follow-up visits to schools to offer necessary pedagogical, technical and emotional support to guarantee the correct implementation of the workshops' content. During its first year (2005), the project incorporated over 130 schools, as part of its plan to include 1000 schools in five years. Almost all 4th , 5th, and 6th grade teachers from the participating schools were trained.

Concept maps are the main pedagogical tool on which the project is based. Throughout the workshops, concept maps are constructed, for the most part, by means of the computer program CmapTools (Cañas et al., 2004).

The task ahead is enormous and the challenges many, not least of which are the preconceptions teachers already have about concept maps and their use. In Panama, concept maps have been known for almost 20 years. Most elementary and secondary level teachers who have studied pedagogy at Panamanian universities have been exposed to concept maps. Unfortunately, it appears that most of them have a considerable number of conceptual errors. The purpose of this study, therefore, is to find out just what Panamanian teachers know about concept maps and their use. In this regard, the Conéctate Project offers a unique opportunity to collect valuable information from teachers just beginning their training. Knowing beforehand what teachers know about concept maps can help devise more effective training strategies which, it is our hope, will better guarantee a significant positive impact of the use of concept maps in Panama's elementary education.

2 **Materials and methods**

The data on which this article is based was obtained through a questionnaire given to 6 different groups, of approximately 20 teachers each, over the course of workshops 5-10, beginning in July 2005 and ending in September 2005. The full sample consists of 115 teachers.

The project directors are responsible for selecting the schools that participate in the program and, as a matter of policy, choose schools from all over the country. They too are in charge of assigning teachers to the various classrooms[1]. Generally, all schools participating in a given workshop are represented in each of the classrooms. As a result, our sample includes schools from 8 of Panama's 9 provinces[2], and from Kuna Yala, one of Panama's 5 Indian reservations. Furthermore, the places of birth of those included in the sample cover most of the country. Thus, although the sample is neither random nor representative in a strict statistical sense, it is sufficiently diverse so as to provide a fairly good idea of what goes on nationwide.

The instructions supplied to the teachers along with the questionnaire included a brief explanation of the purpose of the study, namely, to improve the effectiveness of the workshops. The document stated that all information was strictly confidential, and that under no circumstances would it be possible to identify any individual in the study's written report. Aside from the basic demographic information, all questions were multiple-choice. Only one choice per question was allowed. Emphasis was made that answers should reflect personal experience as accurately as possible. The teachers were supervised at all times throughout the giving of the questionnaire and, inasmuch as was possible, were kept from talking to each other. The questionnaire took about 15 minutes to complete, and was always given on the first day of workshop, as soon as the teachers were settled into their assigned classroom.

It must be pointed out that the questionnaire given in each of the 6 workshops covered by the study are not entirely identical. Changes were made as the need to modify certain questions or include new ones became clear. Consequently, the sample size may be somewhat different for different questions. The value of *n* next to each statistical result indicates the size of the sub-sample; if none appears, the statistic is based on the full sample.

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[1] During workshops 5 and 6 the project had 4 classrooms; from workshop 7 on, the number of classrooms increased to 8.

[2] At the time this study was conducted, no schools from Panama's Darién province had participated.

3 Results

The average age of the 115 teachers in the sample is 40.2 years, the range being 20 to 56 years. Approximately 70% of those surveyed completed their high school education at a Normal school, and 40% of them attended one particular Normal school, the Escuela Normal Juan Demóstenes Arosemena, in the province of Veraguas. As for higher education, 87% attended university. Specifically, 9% completed 1 to 2 years of university studies, 34% completed 3 to 5 years, 42% completed more than 5 years; 15% said they had either not attended university or had not finished their first year. Regarding years of service, 15% of those surveyed had 1-5 years of work experience, 23% had 6-10 years, 17% had 11-15 years, 15% had 16-20 years, and 30% had over 20 years of work experience $(n = 94)$.

The sample includes teachers with different levels of familiarity and comfort with technology. For instance, 46% $(n = 76)$ of the teachers worry they might damage a computer by touching it, 46% $(n = 74)$ fear that others know more about computers than they do, and 26% $(n = 76)$ worry about appearing foolish while using a computer. In terms of frequency of use, 47% report never having used a computer, 36% have used one once in a while, 10% use one often, and 8% use one all the time $(n = 92)$, Finally, only 20% of teachers indicate they possess an e-mail account $(n = 35)$.

Getting into the matter of concept maps, our results show that practically all of those surveyed are familiar with concept maps, and a large percentage of them claim to use them in their classes (figure 1).

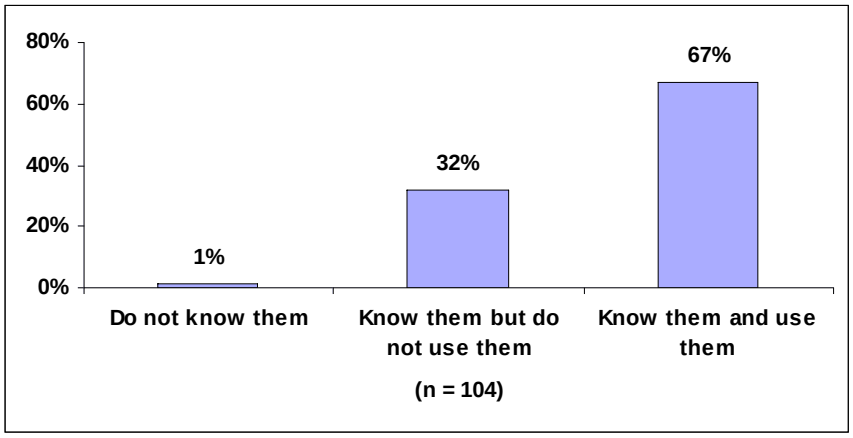

Figure 1. Familiarity with concept maps.

Figure 2 shows the various sources through with teachers have first come into contact with concept maps. As can be seen, universities, particularly *university professors*, have been the main conduit through which teachers have come to know this tool. Seminars are the second most common source. It's worth pointing out that although the questionnaire did not ask teachers to specify who was in charge of the particular seminar they attended, it is likely that it was either a university or the Ministry of Education, since in Panama it is generally the case that these institutions are the ones who organize such events. *Colleagues* and *books* come in third and fourth, respectively. Regarding the latter option we must note that it was first added to the questionnaire in workshop 7, but it wasn't until workshop 9 that we realized teachers were not distinguishing between regular books (which is what we had in mind) and their students' *text books*. Although later versions of the questionnaire added this distinction, for this article we were unable to obtain sufficient data to present reliable statistics. Finally, only 5% report learning about concept maps through a high school teacher. This seems somewhat surprising given that most educators in our sample attended Normal schools.

As to the benefits of concept maps for students, we found that practically all teachers in the sample (93%) agree that the most important benefit for students is that they "help them organize and represent their ideas." Few believe

their usefulness lies in that they “summarize material so that students can learn it faster” (5%), or “motivate students because they don’t have to write so much” (3%).

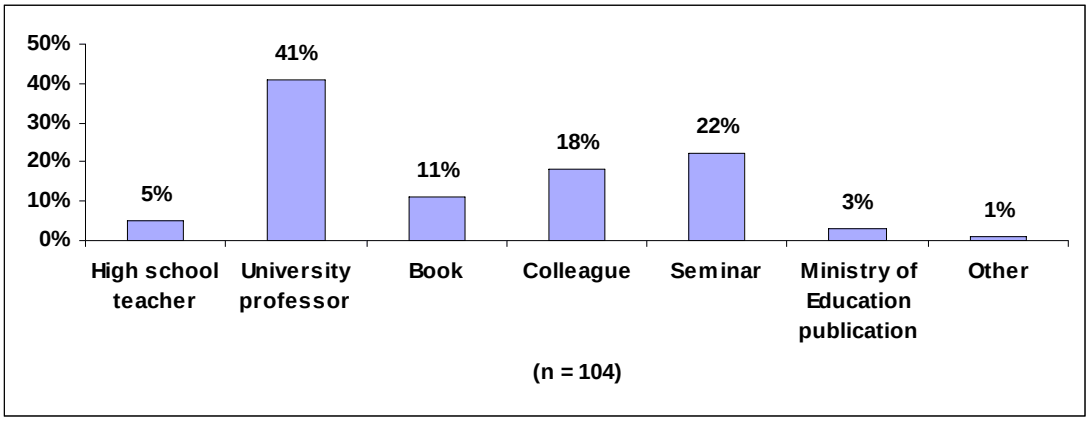

Figure 2. Primary source of information on concept maps

These results stand in contrast to the results on the didactic use that teachers make of concept maps (figure 3). The most common practice is for teachers to construct a concept map in class for students to memorize (51%), followed by providing students with an already-made concept map for them to memorize (32%). Fewer than 5% of educators allow students to construct their own concept map.

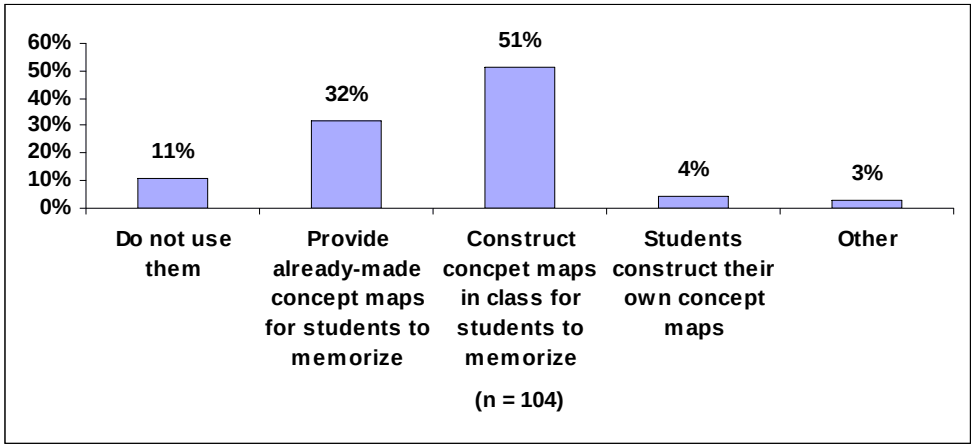

Figure 3. Main didactic use concept maps

As a tool for evaluation, 39% of teachers have never used them; 58% have done so by providing fill-in-the-blank structures, where students fill in either concepts, linking phrases, or both. A mere 1% of teachers who use concept maps as an evaluation tool actually ask students to construct a complete map from scratch (figure 4).

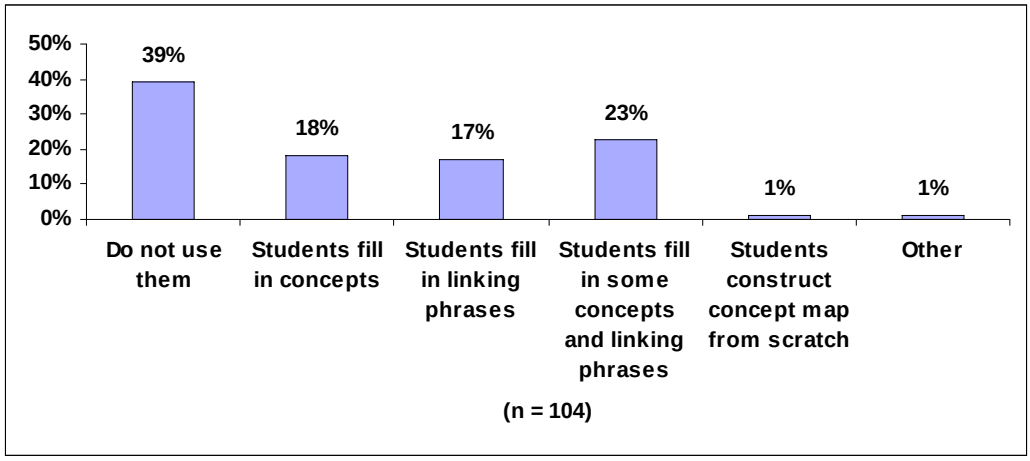

Figure 4. Main use of concept maps as an evaluation tool

Figure 5 shows the preconceptions teachers hold regarding linking phrases. Though the vast majority (97%) concur that linking words are necessary, 38% believe that only *prepositions* can be used, whereas 28% believe that *only one* word can be used, albeit any kind of word. Only a third (32%) of teachers believe that linking phrases can contain one or more words, of any kind.

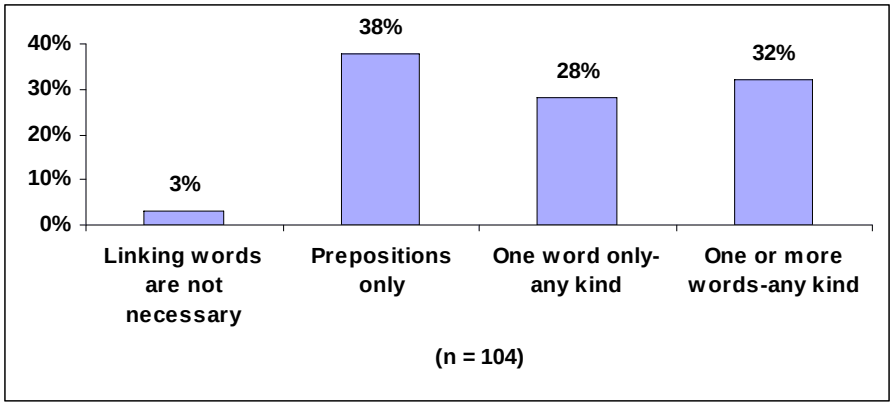

Figure 5. Preconceptions on the number and type of linking words

An interesting result is that 51% $(n = 47)$ are of the idea that connecting lines between concepts must not cross each other, and exactly half consider that connecting lines must be straight lines $(n = 36)$; 27% believe lines can not cross *and* can not be curved $(n = 30)$.

The survey inquired about other aspects of concept maps, such as the shape of the boxes in which concepts are written, the use of upper and lower case letters in writing concepts and linking phrases, the use of arrows on connecting lines, and the direction in which concept maps are read. We found that 83% feel boxes can be of any shape, but 16% say they must be elliptical. More than half (53%) believe concepts must be written in upper case, linking words in lower case; 11% say concepts must be in upper case, linking words any way; and 36% say it doesn't matter how concepts or linking words are written. The arrow at the tip of connecting lines is obligatory for 32% of surveyed teachers, optional for 15%, and optional except in case it is unclear how to read the concept map for 48% of teachers. Lastly, 30% of sampled educators say concept maps are always read in the downward direction, 22% say they ought to be able to be read in both directions, and 42% believe they are read downward unless arrows indicate otherwise.

4 Discussion

We open this discussion section with the following question: In view of the high percentage of teachers (67%) who, as indicated by this study, use concept maps, and the potentiality of concept maps to facilitate meaningful learning, why is it that this is not reflected in the quality of Panamanian education? Perhaps the teachers themselves provide the answer.

Our results show that there are serious inconsistencies between what Panamanian educators think about concept maps and what they do with them. On the one hand, we find that when asked about the major benefit of concept mapping for students, 93% assert that they help them organize and represent their ideas. Nonetheless, when it comes to using them in the classroom as a tool for learning, fewer than 5% permit students to construct their own concept maps on a given topic. The vast majority of teachers (over 95%) expect students to memorize the concept maps they have given them, or the ones they have constructed in class. The general notion seems to be that, on any given topic, there is one "correct" concept map, and students must learn it. Needless to say, this entirely contradicts the theory on which concept maps are based. This equivocal notion is further reinforced by the fact that concept maps are generally used to study eminently classificatory curricular content[3] (types of plants, types of animals, types of words, among others), which does not easily lend itself to the construction of "personal" concept maps, i.e., concept maps that allow some degree of variation among one another. This is worrisome because as Moreira points out, "inasmuch as students use this technique to analyze articles, texts, chapters from books, novels, laboratory experiments and other educational materials pertaining to the curriculum, [in this measure] will they be using concept mapping as a resource for [meaningful] learning"[4] (Moreira, 2005). Hence, the picture that emerges reveals concept maps essentially being used to encourage memorization rather than construction of meaning.

Something similar takes place when using concept maps as an evaluation tool. Of the 61% of educators who use concept maps to evaluate their students, only 1% ask them to build a concept map from scratch. The usual practice is to provide students with a concept map framework for them to fill in the missing concepts and/or linking phrases. Once again, this is a practice that fosters memorization, not meaningful learning.

Cross links are an extremely important element of concept maps (Novak, 1998). Cross links are propositions that connect concepts located in different regions or domains of a concept map. Their importance resides in the fact that relations established through cross links tend not to be obvious and thus, require additional effort in terms of thought and creativity. Evidently, in order to establish a cross link, connecting lines may have to go across from one side of the concept map to the other, which often means crossing other connecting lines. However, as our results show, half of the teachers (51%) believe lines in a concept map can not intersect each other. This suggests that in their minds, cross links are not allowed as a possibility. Occasionally intersections can be avoided by using curved lines. But as our results show, 27% of teachers who do not admit intersections also do not admit curved lines, thereby eliminating altogether the possibility of connecting ideas in different regions of a concept map, even when connecting lines do not cross each other. These results provide evidence of a linear way of thinking which, once more, makes plain the gross inconsistencies between theory and practice held by many educators with regard to concept maps. For, if concept maps are a tool that promotes meaningful learning, and if learning in a meaningful way requires relating ideas, how can we hope to achieve this type of learning when the we deny the very physical actions needed to establish relationships between ideas?

Of much less consequence, from the point of view of their impact on education, would be teachers' preconceived ideas about the purely aesthetical elements of concept maps, if it were not for the importance that they themselves give to them. Throughout the 6 workshops during which the data for this article was collected, teachers sometimes strongly questioned the trainers about such aspects as shape of boxes, use of upper and lower case letters, among other things. Although many were receptive to the notion that such things were entirely subjective, others insisted in the need to establish "uniform criteria." Sadly, the reasons they gave to justify their thinking generally revealed that, at some point in their experience with concept maps they had come across a professor (usually a university professor) who had penalized their work for not complying with certain pre-established aesthetic criteria.

As a result of both the interest awakened by our questionnaire and the workshops themselves, a number of teachers provided us with originals and photocopies of texts they had used whilst studying concept maps at the university. In all of them we discovered limitations, inconsistencies and conceptual errors similar to the ones

[3] This statement is derived from our experience with teachers in the workshops, and was not part of the survey.
[4] Translation by Norma Miller.

maintained by the surveyed teachers. We were surprised, moreover, that from one workshop to the next we always got the same two or three texts. Thus, it would seem that such texts have contributed to a limited and distorted understanding of concept maps in both university professors and elementary school teachers, which simply perpetuates rote learning by Panamanian students.

5 Conclusions

This study set out to explore the preconceptions regarding concept maps and their use held by Panamanian teachers who were beginning training at the Conéctate al Conocimiento Project. Results indicate serious conceptual errors that not only limit but might actually annul any cognitive benefit resulting form this pedagogical tool. Results also show that teachers' primary source of information on concept maps are university professors. Thus, it would seem urgent to revise what is taught about concept maps at the university level. Additionally, it seems imperative to improve the quality and availability of materials in Spanish, as part of the problem might lie in the use, year after year, of the same conceptually limited or incorrect texts.

Specifically, in the context of the Conéctate al Conocimiento Project, knowing teachers' preconceptions about concept maps beforehand is important because it can help tailor the content and pacing of the workshops, and allow trainers to better prepare to handle a variety of pedagogical situations that might arise in the course of instruction. Some strategies that we believe may be useful to help overcome these preconceptions are: 1) presentation throughout the workshop of concept maps made by both children (including Panamanian students) and experts illustrating propositional structure, cross-links, and a number of different aesthetics; 2) use of devises such as "conceptual dice" (Hughes et al., 2006) as a means to break away from standard text-book statements and help generate novel propositions; 3) group discussions of maps to provide feedback and stimulate search for unnoticed connections among concepts; 4) introduction to Internet early in the workshop (usually third day) as a source of information and resources to enrich maps; and 5) application of concept maps in a variety of situations to illustrate their many possible uses.

To end, we return to the question with which we began the discussion section: Given the extended use of concept maps in Panama, why is it that they have not had the expected impact in Panamanian education? It might well be that a major part of the answer lies in the erroneous notions that Panamanian teachers have regarding concept maps and their use which this study has made evident.

6 Acknowledgements

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