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DESIGN AND VALIDATION OF A TEACHING SEQUENCE BASED ON CONCEPT MAPS TO ACHIEVE MEANINGFUL LEARNING OF SCIENCE CONTENT IN PRIMARY EDUCATION

Guadalupe Martínez[1,*], Milagros Mateos[1], Francisco L. Naranjo[1]

Department of Didactics of Experimental Sciences, Faculty of Education
University of Extremadura, 06006 Badajoz , Spain
mmarbor@unex.es

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Introduction

Science teaching in primary education is important, because it helps students to achieve greater intellectual maturity.

Among the different methodologies for teaching science, in many school it is still preferred the traditional teaching

This teaching is mainly focused on content acquisition, which is made by rote learning without adequate knowledge construction

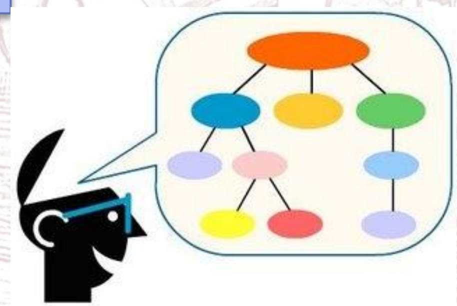
One of the problems of traditional teaching is that, given the importance assigned to content, it has encouraged a rote learning of knowledge, without verifying whether the student is able to apply it in their daily lives.

For this reason, one of the teaching methods of our research group is the use of teaching tools that promote meaningful and lasting learning in our students.

Meaningful learning: Concept Maps

For learning to be considered long-term, it must be meaningful learning (Ausubel, 1968).

One of the main cognitive learning tools that help building meanings of scientific concepts are concept maps (Novak and Gowin, 1984).



Graphical representation of a set of relationships between concepts in our cognitive structure

Cañas et al. (2003)

Diagram representing knowledge in an organized manner

Novak & Gowin (1984)

Concept maps are very effective tools to capture the knowledge of an expert by developing Knowledge Models based on concept maps.

Cañas et al., 2000;
Nesbit and Olusola, 2006;
Novak, 1998.

ADVANTAGES

Previus works

Various research works which showed that concept maps are very effective tools to capture expert knowledge and develop "Knowledge Models" have been conducted **(Cañas et al., 2000; Nesbit y Olusola, 2006; Novak, 1998)**

- **Fuatai, 1986** used the technique of concept maps with children in primary school
- **Stewart, Van Kirk y Rowell, 1979** emphasize the value of the concept mapping technique in the design of curriculum materials, planning and evaluation.
- **Fraser y Edwards, 1985** analysed whether concept maps affected the academic performance of students in traditional class tests and they found that the construction of concept maps by students produced an improvement in these tests.

Martínez et al. (2013) conducted a study on the teaching effectiveness of concept maps and knowledge models for learning physics concepts in engineering studen

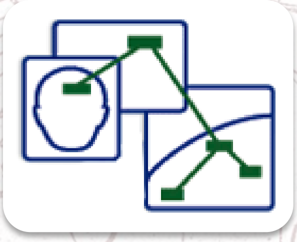
Concept maps have been used to explain the reasoning of an expert teacher in solving problems of kinematics, showing their effectiveness in students of secondary education **Martínez el al. (2015)**

In the present work

We will use concept maps as a teaching resource to develop a teaching sequence as a methodology we will compare with traditional teaching, in order to determine experimentally the educational value to achieve a significant and long-term science learning in primary education.

Objectives

Improve the acquisition of scientific literacy in the primary classroom using a knowledge model built with concept maps.



Specific Objectives

Objective 1:

- Design and validation of a teaching sequence based on the use of concept maps to improve the acquisition of scientific competence in the primary classroom.

Objective 2:

- Comparison, in terms of the learning reached by students, of a traditional teaching methodology versus a methodology based on the delivery of content using a knowledge model.

Objective 3:

- Check whether scientific concepts learned by primary students through different methodologies persists or is forgotten over time.

Hypotheses

Hypothesis 1 (H1):
There are statistically significant differences in the mean learning achieved by students using traditional methodology versus an experimental methodology based on the development of a knowledge model with concept maps.

Hypothesis 2 (H2):
Traditional teaching facilitates rote learning of scientific concepts, which are easily forgotten over time.
.

Hypothesis 3 (H3):
Concept maps facilitate long-term, meaningful learning in primary students

Sample

2014 - 15

Primary School in the region of Extremadura was randomly selected

Comparative study between the two teaching methodologies the 4th grade students (aged 9-10) were chosen

78 students divided into 4 groups of sample size of 17 to 21 students each

Two groups were randomly selected to form the control group, and the other two formed the experimental group.

Specifically, from the four school groups (G1, G2, G3 and G4), G1 and G4 were randomly selected as experimental groups, and G2 and G3 as control groups.

The independent variable was the teaching methodology used with each group: using concept maps (Experimental Group, EG) or not using them (Control Group, CG). The dependent variable was the average learning achieved by each group.

Experience Design

Control Group

A traditional teaching methodology conducted by their teachers has been followed.

Experimental Group

A teaching methodology based on the construction of a Knowledge Model.

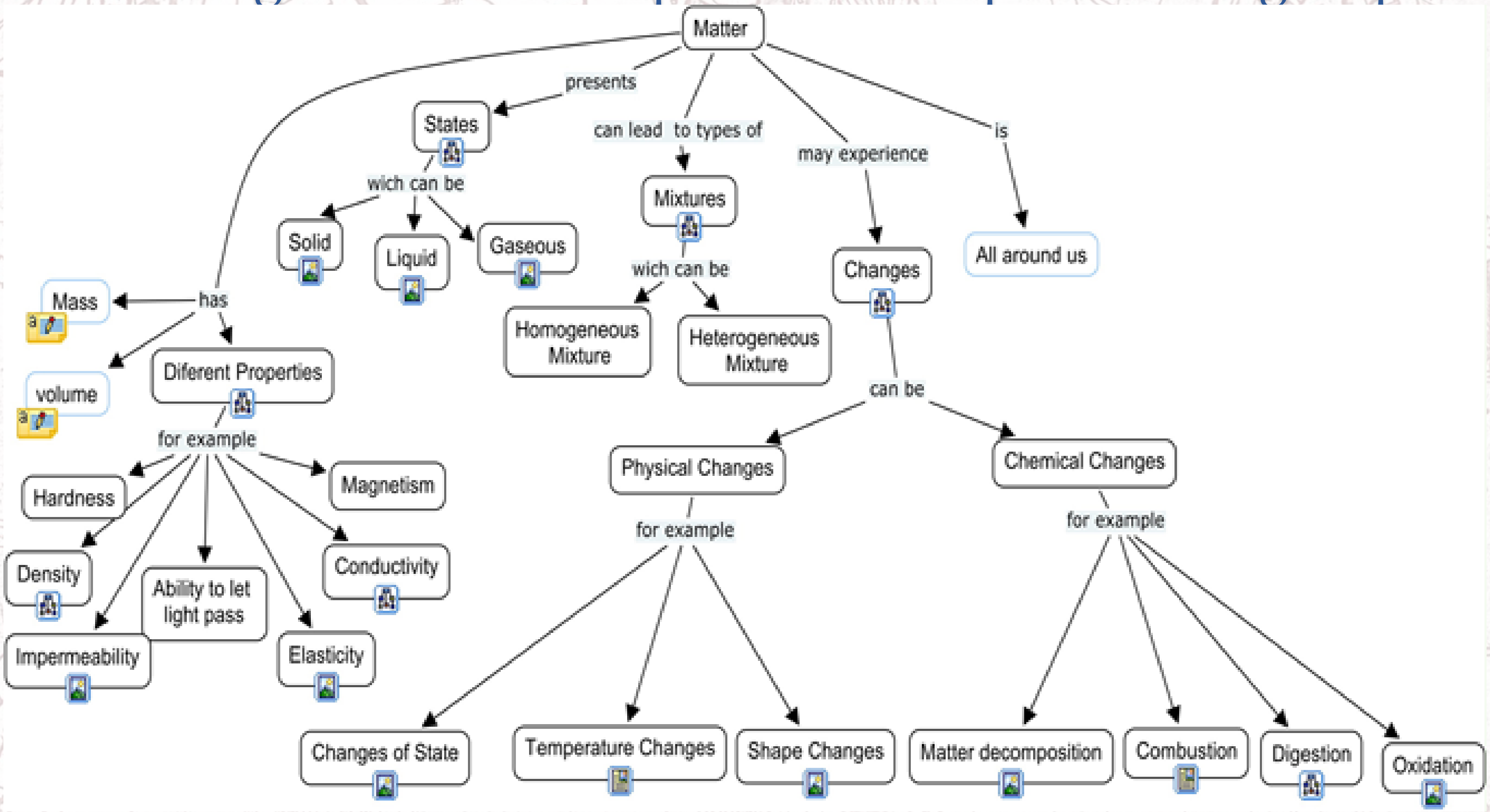
The resources used in the classroom have been their textbooks and complementary and reinforcing sheets

This model consisted of several interconnecting concept maps, made with the CmapTools software to append interactive resources.

The unit chosen belongs to the module "Matter", from the 4th grade topic of "Knowledge of the Environment".

This unit was chosen because it is an issue that appears daily in our lives, and we thought about how could the students acquire the concept in a meaningful and lasting way, and so maintained in time. For this reason, we decided to work on the EG with concept maps.

Example of one of the concept maps that make up the knowledge model developed for the experimental groups



Evaluation instruments

Three questionnaires

Pre-test

It was designed to detect the initial knowledge possessed by the students. It was taken at the beginning of the course, before starting to impart the content.

Post-test I:

It was designed to test the effectiveness of the teaching methodology used in each group. The students took it as a final evaluation test to determine the degree of acquisition of the contents explained in terms of the methodology used.

Post- test II:

It was designed to verify if students remembered the contents explained, and if they had performed a meaningful learning of these contents. It was taken by all students 7 months after the Post-test I

Results: Pre-test

The results obtained by all students in the Pre-test done at the beginning of the course revealed an initial lack of knowledge regarding the subject of matter.

Overall, it should be noted that approximately 90% of students did not know what to answer in the Pre-test. They did not know the concepts and they had misconceptions about them.

Thus was settled the selection of the topic, as it was confirmed that the initial knowledge would not be an interfering variable in this study when making the comparative analysis between the two working methodologies selected

The poor Pre-test results allowed us to establish a uniform and common starting point in the four working groups.

Results: Post-test I

Post-test I (December 2014)		N	Mean	Std. Deviation	Std. Error Mean
4th grade (9-10 years old)	Group 1 (EG1)	20	7.75	2.04	0.456
	Group 2 (CG1)	20	7.19	2.90	0.649
	Group 3 (CG2)	17	6.18	2.47	0.599
	Group 4 (EG2)	21	7.45	1.84	0.401

Mean, standard deviation and standard error mean in Post-test I for control and experimental groups.

- **Table 1 shows that the groups had a good performance on the test.**
- **This suggests that both methodologies (traditional based on the textbook and experimental based on concept maps) have been effective for student learning. However, a small difference is shown between different groups.**
- **To check whether this difference is statistically significant (Sig < 0.05), an ANOVA test was performed, whose results are shown in Table 2**

	Sum of Squares	d.f	Mean Square	F	Sig.
Inter-grupos	24,951	3	8,317	1,519	0,217
Intra-grupos	405,074	74	5,474		
Total	430,026	77			

Results: Post-test I

These results indicate that students in all groups, both control and experimental, have a priori learned similarly the scientific content instructed in the classroom, fulfilling the Objectives 1 and 2 proposed in this paper.

Results: Post-test II

Post-test II (June 2015)	N	Mean	Std. Deviation	Std. Error Mean
Group 1 (EG1)	20	6.39	1.93	0.43
Group 2 (CG1)	20	2.55	1.60	0.35
Group 3 (CG2)	17	2.51	2.29	0.55
Group 4 (EG2)	21	6.03	2.44	0.53

Mean, standard deviation and standard error mean in Post-test II for control and experimental groups.

Table 3 shows that there is a clear difference between the scores of the control groups against the experimental groups, which scored higher..

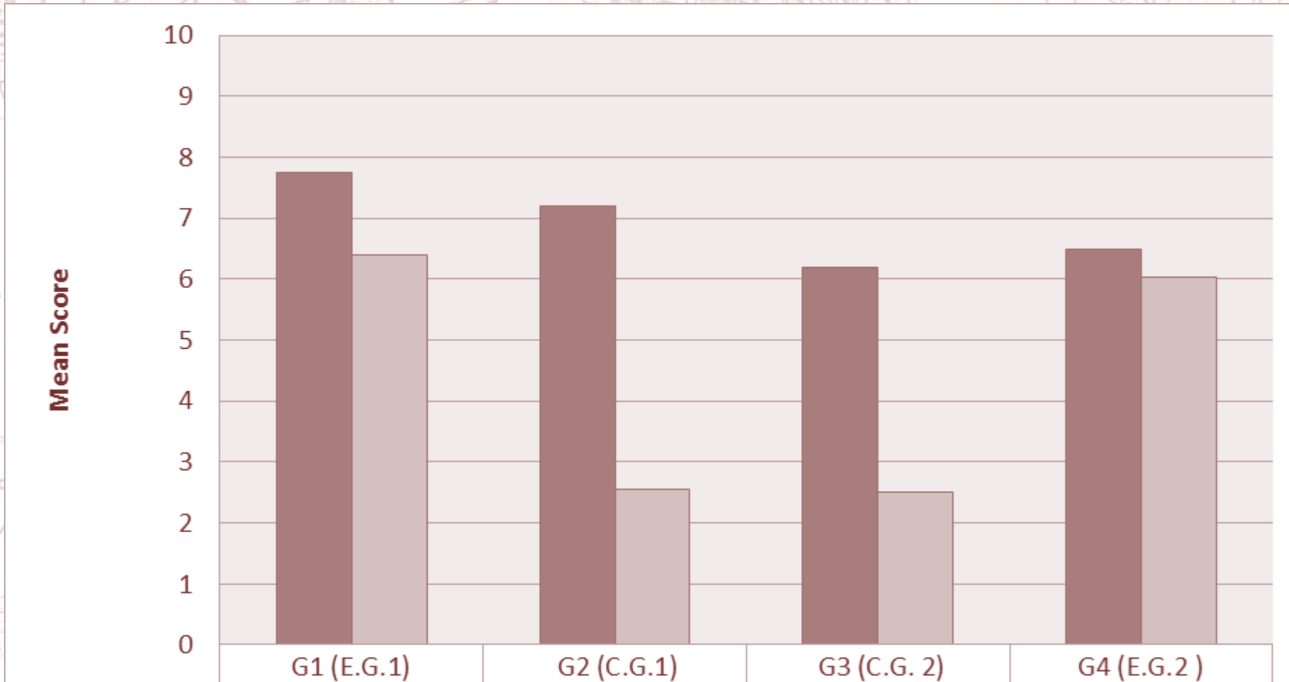
ANOVA

	Sum of Squares	d.f	Mean Square	F	Sig.
Inter-grupos	264,276	3	88,092	20,129	0,000
Intra-grupos	323,854	74	4,376		
Total	588,130	77			

H1 hypothesis of this research can be accepted:

"There are statistically significant differences in the mean learning achieved by students using traditional methodology versus an experimental methodology based on the development of a knowledge model with concept maps".

Comparison of the mean scores



	G1 (E.G.1)	G2 (C.G.1)	G3 (C.G. 2)	G4 (E.G.2)
Post-test I	7,75	7,19	6,18	6,48
Pos-test II	6,39	2,55	2,51	6,03

The comparison of the results between Post-test I and Post-test II in different groups allow us to accept the other hypotheses of this research, H2 (*"Traditional teaching facilitates rote learning of scientific concepts, which are easily forgotten over time"*) and H3 (*"Concept maps facilitate long-term, meaningful learning in primary students"*).

Results

These results make clear that the contents instructed during the traditional methodology are forgotten over time, but this does not happen in the groups who worked with concept maps.

Therefore, we consider it necessary to think about the way the delivery of content is carried out in many schools, with the aim of trying to promote the use of innovative methodologies that are useful to retain over time the content explained, promoting a meaningful learning in students.

Conclusions

The above results allow us to conclude that students of the EG, who worked with a knowledge model based on concept maps, have better assimilated the knowledge, and their learning last over time.

The students of the CG, however, have forgotten over time the contents obtained by the traditional methodology. This means that content learning through traditional methodology has been short term and probably rote.

Conclusions

We believe that these results **are evidence of the educational value of concept maps** when carrying out interventions of science teaching and learning.

Students tend to forget; it is therefore necessary to improve the models of science education at early ages.

This could be achieved by complementing these traditional methods with cognitive learning materials. The information can be presented, for example, in a consistent and structured way, building firmly the concepts, interconnecting them with each other in the form of knowledge models. Thus it is possible to obtain a real learning, i.e., a lasting learning not easily forgotten.

Thank you for listening!

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