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# CmapTools as a Key Tool for Improving Academic Achievement in University Students

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### Abstract

For this study, 634 students were recruited and they consisted of an experimental group and a control group. The experimental group was instructed and elaborated conceptual maps through the CmapTools software with respect to the study of the taught contents. The control group used study techniques of their own free choosing and with no prior instruction. The objective was to detect whether statistically significant differences between the two groups occur at the level of academic performance. For this purpose, the whole sample was evaluated by means of using the same examination-type testing over the whole sample. The obtained data reveal that the scores are higher in the experimental group than in the control group. Hence, it can be concluded that simple modifications in pedagogical strategy significantly improve the teaching-learning process and consequently improve the average performance of the students.

## 1. Introduction

There are multiple styles of learning in the academic context, as well as tools that are used for the acquisition of knowledge, so that each individual uses the style and tools that best suit their abilities and qualities. Several papers within the body of literature affirm that different learning styles are linked to the personal characteristics of the student and analyze their relation with effectiveness or academic performance [1-7].

There is a long tradition of teachers from different academic levels using pedagogical strategies with objectives that advocate traditional and rote learning [8]. However, it has been shown that the information acquired through a meaningful learning model presents a greater resistance to the passage of time and gives the individual a greater capacity to solve new problems [9-10].

A synthesis process involving the development of a conceptual map is a tool that facilitates meaningful learning and has been considered as a very effective method, specifically with regards to the interactive type of learning [11-14]. On the other hand, the correct elaboration of a conceptual map has a positive effect on the attitudes and levels of satisfaction that students present with respect to their academic results [15-16]. It is for this reason that the CmapTools software that was created by the Florida Institute for Human and Machine Cognition (IHMC) has been chosen for use in the present study.

The final aim of this research was to evaluate whether, after using this study strategy, there are significant differences in academic performance with respect to the control

group, which implemented simpler strategies.

## 2. Methodology

All of the students regularly attended the lectures given by the same teacher. The intergroup difference is that the contents that were treated during the development of the discipline were practiced via different strategies depending on whether they belonged to the control or experimental group.

### 2.1. Participants

In the present study, there were 634 participating students (342 in the experimental group and 292 in the control group) from the Developmental Psychology and Educational Psychology courses that are included in the bachelor degree program for Teacher in Primary Education at the University of Alicante, Spain. The choice of belonging to either the experimental group or the control group was assigned randomly before starting the course.

### 2.2. Procedure

The experimental group was instructed in the development of concept maps using the CmapTools program. These maps are elaborated in a cooperative way and are aimed at providing interactivity maps, using contents that explain and extend knowledge that is exposed in the classroom. The lecturer responsible for teaching together with the rest of the researchers regularly collaborated in the elaboration of strategies that have guided the work and development of concept maps. The procedure followed was as follows:

- 1) Analysis and establishment of general or common criteria for instruction in and development of concept maps.
- 2) Selection of contents to be implemented.

- 3) Elaboration of activities in the classroom.
- 4) Review and evaluation of results.

The control group used techniques such as comprehensive reading, underlining, and development of schemes with respect to the theoretical content for further study. The strategies used for this purpose were subject to student choice and were implemented without prior instruction.

To evaluate the learning results, a final evaluation of contents was undertaken by using examination-type testing which takes in the whole of the sample. The test questions require application of the understanding of the content in order to provide correct answers. The purpose of this strategy is to assess whether the results that are achieved at the level of academic performance and acquisition of knowledge, as measured by the qualification after the performance of the objective test, present significant differences with respect to those results that are achieved by the students of the control group, who face the same theoretical content and the same final evaluation exercise.

Finally at the end of the course, in order to know a student's final grade, the student responds to a brief satisfaction survey, which queries their efforts in the preparation of content and results.

## 3. Results

The results show that the distribution of the students according to the scores they obtained in the examination-type testing favors the experimental group. As can be seen in Table 1, if the students that attained remarkable and outstanding scores are grouped, in the experimental group 73.8% of students meet the requirement while in the control group around 43.7% of students achieved a similar score.

*Table 1. Distribution of students according to grade obtained in examination-type testing.*

		Experimental		Control	
		n	%	n	%
Frequency rating ( $\chi^2 = 7.35; p = 0.014$ )	Outstanding	80	23.4	36	12.5
	Notable	172	50.4	91	31.2
	Sufficient	65	19.1	118	40.2
	Insufficient	25	7.1	47	16.1

The results show that the proportion of cases that were correctly classified by the logistic models (see Table 2) was 87.8% ( $\chi^2 = 22.17, p = 0.00$ ) for the Developmental Psychology groups / lecture hall and 85.4% ( $\chi^2 = 26.85; p = 0.00$ ) for the Educational Psychology groups / lecture hall.

The Nagelkerke  $R^2$  statistic has oscillated in the estimation of the adjusted value between 0.08 for Developmental Psychology groups / lecture hall and 0.10 for Educational Psychology groups / lecture hall.

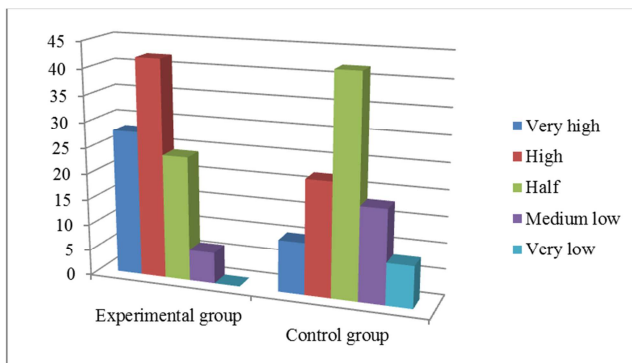
Based on the Odds Ratio (OR) values (see Table 2), the probability of students improving their performance in

Developmental Psychology and Educational Psychology subjects increases if they have previously studied conceptual maps, ranging between 85% For Developmental Psychology groups / classroom and 96% Educational Psychology groups / classroom. When both variables are introduced into the calculation, they both allow the making of correct estimates regarding the probability of a higher academic performance if the students have used interactive concept maps for their study, obtaining results of 82% and 92%, respectively, for each point of increase in the aforementioned variables.

**Table 2.** Logistic regression for the predictive probability that for a higher score after evaluation of theoretic contents, it is possible to predict the usage or not of interactive concept maps.

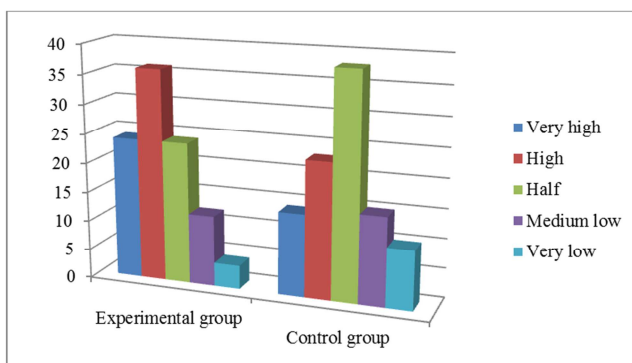
Variable		$\chi^2$	R <sup>2</sup>	B	E.T.	Wald	p	OR	I.C. 95%
Developmental Psychology Qualifications	Correctly Classified: 87.8%	22.17	0.08	-0.16	0.03	20.59	<.001	0.85	0.79-0.91
	Constant			-0.35	0.35	1.03	0.30	0.69	
Educational Psychology Qualifications	Correctly Classified: 85.4%	26.85	0.10	-0.03	0.00	24.45	<.001	0.96	0.95-0.97
	Constant			0.41	0.46	0.79	0.37	1.51	
All groups/ study halls	Developmental Psychology Qualifications	27.11	0.10	-0.06	0.01	24.71	<.001	0.82	0.81-0.86
	Educational Psychology Qualifications			-0.06	0.01	35.23	<.001	0.92	0.91-0.95
	Constant			0.08	0.40	0.04	0.83	1.08	

Finally, the results of the satisfaction survey show significant differences with respect to the percentage of students who were satisfied with the grade they obtained in relation to the effort they invested. Seventy percent (70%) of the students in the experimental group show High or Very High levels of satisfaction with respect to the results obtained after the objective test, while only 32% of the students in the control group are of the same opinion.



**Figure 1.** Level of satisfaction with the grade obtained in relation to the effort invested.

The same happens when students are questioned about their satisfaction with the development of the subject. Sixty percent (60%) of students in the experimental group claim to have a High or Very High level of satisfaction with the development of the subject. However, when questioning the control group with this same assertion only 37% of students affirm this same level of satisfaction.



**Figure 2.** Level of satisfaction with the development of the subject.

## 4. Discussion

Previous research [17] involved a study of characteristics that are very similar to those presented in the present study, since those researchers evaluated an experimental group of university students who made use of the CmapTools software with respect to a control group. The results are similar, since the authors conclude that the highest percentage of scores in the experimental group revolved around Remarkable or Outstanding, and that this result was higher than in the control group. It is noteworthy that the present study is not generating the only results that show that the use of an adequate study technique is linked to statistically significant improvements in academic performance, thus optimizing cognitive resources of students.

Previous research [18-19] concludes that, while student learning styles vary, they have little effect on academic performance. However, it can be assumed that this result is due to the fact that there has been no instruction in the type of technique used. In that, an adequate orientation of students in study techniques brings with it statistically significant improvements in academic performance and an optimization of their cognitive resources [20].

## 5. Conclusions

Currently in academia there seems to be a greater concern for content rather than for how that content is acquired. However, this is an important key to success. If individuals simply retain concepts and do not integrate the concepts into their cognitive structure, then information will disappear over time.

In this paper, the demonstration of the usefulness of using techniques that promote significant learning, aims at raising awareness in the educational community of the importance of teaching students from the outset, with various study techniques that will serve as scaffolding in the future, in order to build their knowledge.

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