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# SPATIAL KNOWLEDGE EVOLUTION IN THE CIVIL ENGINEER TRAINING THROUGH THE GRAPHIC REPRESENTATION OF THE COGNITIVE MAP

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## BACKGROUND AND OBJECTIVES

The development of civil engineering quality works, supported on a suitable cartographic base, depends partly on the information received during the academic stage. Particularly, the graphic information which the future civil engineers get is basic to understand the territory through map interpretation.

The spatial knowledge may be due to the use of cartographic information or to its learning through the familiarization with town planning by travelling across. In both cases, this information is stored by people in a mental entity called cognitive map: the spatial knowledge about the territory which everyone stores in their mind.

Landmarks, paths, districts, nodes and edges are the principal elements which configure the cognitive image of a city by Kevin Lynch.

By using the information about the cognitive map stored by everyone, we suggest the production of a graphic test to evaluate the evolution of the spatial knowledge during the civil engineers academic training and everyone's relation with the most characteristic variables. This method allows us to determine the most important variable to store and to organize the spatial information. The cognitive map drawing by using true geographic references allows us to relate the spatial knowledge to reality and to analyze the distortion between both.

## APPROACH AND METHODS

This test is based on the representation of a route between two places well known by the students, as well as every landmark or node which will be necessary for a correct location at any point along the route. Every exercise, made individually by each student, will include some personal information: degree (X1), number of years living in the city object of the map (X2), sex (X3), age (X4), number of years enrolled in the Technical College (X5), their home town (X6), the use of cartography about the territory in which the route is located (X7) and the university year (X8).

Cartography – municipality contour and the landmarks among which the route must be evaluated- is used as help for the student to make the test and it leads us to establish relations between the reality and the mental information drawn in the test using a Geographic Information System (GIS).

The GIS analysis links directly the graphic test made by each student with the reality which the graphic test represents. It must be digitalized previously. The method used tries to find out which routes are within an area of influence around the real ones. On the other hand, we also try to analyze the distortion between the graphic test and the real route, measuring the distance between routes and landmarks in the drawing and the reality which they represent.

The record of the variables about every student allows us to study the effect that they have on the precision of the exercise. The statistical treatment of the variables is carried out by means of a multivariable analysis, specifically by doing a linear multiple regression which enables us to decide the most important variable in order to draw the spatial knowledge correctly. The precision of the test will be achieved by using the results of the GIS analysis with routes within an area of influence, as a categorical variable (0,1) which depends on the rest of variables for each student.

$$Route\ within\ an\ area\ of\ influence = a + \beta_1 \cdot X_1 + \beta_2 \cdot X_2 + \beta_3 \cdot X_3 + \beta_4 \cdot X_4 + \beta_5 \cdot X_5 + \beta_6 \cdot X_6 + \beta_7 \cdot$$

Statistical model from the variables of our study

## RESULTS

The statistical analysis establishes that the only independent variables which have enough predictive capacity to influence the statistical model are, in this order, the degree (X1) and the university year (X8).

The rest of the variables selected during the test design are rejected in spite of having been selected because they describe important parameters which fully describe the students who have made the test.

The goodness of fit of the statistical model through the independent variables “degree” and “university year” is expressed by the coefficient of determination R2, whose value is 0,154. This value means that the behaviour of the dependent variable is explained in a 15,4 % because of the independent variables. This means that the statistical model doesn’t explain adequately the reasons why one route is within an area of influence.

The GIS analysis is done using two criteria owing to the existence of two routes which the students draw, influenced by the means of transport which they usually use. One route has to do with the bus route that links the two landmarks in the template graphic test (route 2). The other route has to do with the shortest route by car (route 1)

Paying attention to these two criteria, we notice that the distance measured in route 2 has a smaller error than the distance measured in route 1.

With regard to the precision of the routes concerning the real ones, we observe an increase in the precision between the first university years up to the last ones for each degree and a light advantage of the Technical Engineer of Public Works degree over the Civil Engineer degree.

For the precision analysis in the position of landmarks and nodes, we divide the area around the route into three parts: part A, part B, and part C. The position precision of landmarks and nodes improves as we go into the historic city centre.