



Knowledge Of The Cognitive Structure Of Students Through Pathfinder Associative Networks Technique In The Context Of Pmate

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Abstract

CiberDidact Research Group, at the University of Extremadura (Spain) has been working in the knowledge of the student's cognitive structure in the mathematics.

Virtual environments, through which it holds and conveys the teaching, learning and assessment of mathematics education at different levels, are now a topic of interest that needs to be researched.

Within the Project Mathematics and Teaching, the University of Aveiro (Portugal), keeps developing a virtual environment based on the web, called PmatE (<http://www.pmate.ua.pt>). This is a resource formed by a "factory math tests" based on exercises or modular problems and a learning management system that monitors and records the activities and students' outcomes.

This research aimed to verify the educational possibilities of the learning environment PmatE, applied to conceptual teaching and learning of the four arithmetic operations, with students from year 4 of primary education.

PmatE environment was submitted to an evaluation in context, involving the participation of teachers and students in educational situations of resource use. This evaluation studied students and teachers' cognitive structures on the conceptual knowledge of arithmetic, by the technique of "Pathfinder Associative Networks", which supported the analysis and representation of cognitive networks, based on the "Theory of Nuclear Concepts, conceptual framework of this work.

Important conclusions were reached that reinforce the need for teachers to have useful tools to evaluate students' knowledge and effective forms to evaluate the quality of digital educational resources.

1 Introduction

The overall objective of this study was to determine how a digital learning resource (RED), the PmatE environment (<http://pmate2.ua.pt/pmate>), for teaching and learning of mathematics in primary education, is used in educational contexts, study quality and educational potential and to make recommendations to improve it.

In this study, we adopted a mixed evaluation model, consisting of descriptive evaluation, and evaluation in context and impact evaluation.

The evaluation was performed in context with the participation of five groups of teachers and students from the use and exploration of PmatE environment. The descriptive evaluation was based on the application of a survey online to all teachers users of this RED, and impact evaluation was based mainly on the analysis, by applying the technique of Pathfinder Associative Networks of Schvaneveldt [1] of cognitive structure of students in the fields of basic operations and their attitudes toward mathematics.

2 Theoretical Framework

One of the main weaknesses of current RED evaluation methodologies focused on teachers, focused on users or the quality of design, which generally do not consider the context of education as an evaluation criterion.

Another weakness is that these evaluation methods tend to focus on technical aspects rather than on the content and its application to a real environment in the educational goals and outcomes in terms of learning. An evaluation process, besides the quality of the content or aesthetic, must be able to measure what students learn as a result of the use of a resource or how their attitudes toward a subject, ultimately changing their cognitive structure.

To understand how to acquire and organize knowledge and how to characterize the cognitive structure is important to know one of the latest theories in this field, the Theory of Nuclear Concepts of Casas and Luengo [2, 3, 4]. The technique used in this theory, the Pathfinder Associative Networks, to create graphical representations of cognitive structure. The concepts are represented as nodes and relations between them as line segments of varying length according to their semantic proximity. This technique also helps to identify the key concepts around which students structure their knowledge and explore the evolution of their networks in a conceptual field. Also allows numerically quantify network characteristics such as coherence, complexity and similarity to other networks.

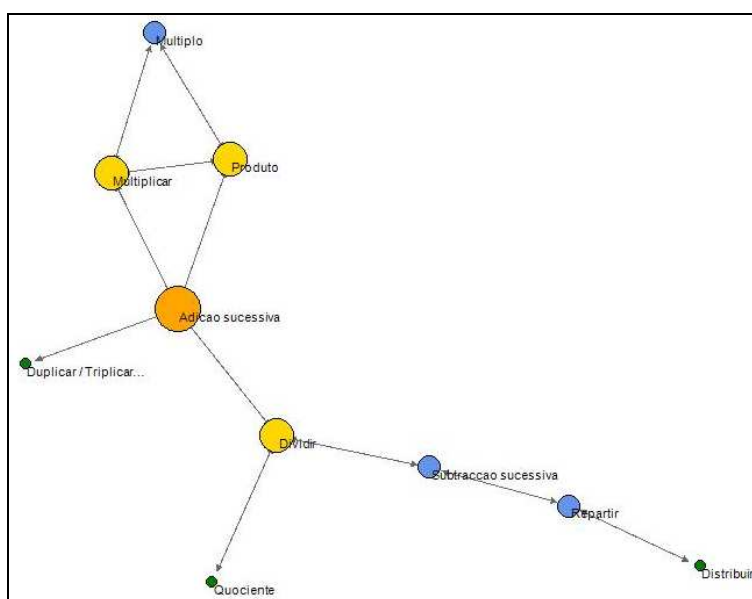


Fig. 1. Example of a Pathfinder network (multiplication and division) created from the technique Pathfinder Associative Networks

According to the Theory of Conceptual Fields of Vergnaud [5] a concept is not built from a single arithmetic type of situation, a situation is not dealt from a single concept, and construction and assimilation of all properties concepts and all aspects of a situation is a long process that extends throughout the years. According to this theory, the two main areas of the numeracy conceptual structures are additive and multiplicative structures.

A learning network of concepts related to these structures should enable the teacher to propose to students a wide range of situations that help develop the concepts involved in a conceptual field. The evaluation of the RED, should allow a check to what extent their use has contributed to improving the cognitive structure of students in that field.

3 Methodology

The research is organized in three dimensions. In the first two involved five groups of 4th grade of primary education (108 students). Four conducted educational activities PmatE environment. The other group (24 students), which served as a control group, did not develop any educational activity by in this environment.

Of all the groups collected data on their cognitive structure, both before and after the experience in the form of Pathfinder Associative Networks, attitude questionnaires and performance tests.

In the third area involved 76 teachers who were administered a survey evaluation.

3.1 Axis 1 - Conceptual domain of the basic operations

Tests will be done for consistency, similarity and complexity of the association networks obtained about the structure of additive and multiplicative structure.

Also made a comparative analysis between the results of the tests in the environment created PmatE and the results of national assessment test in mathematics.

3.2 Axis 2 - Attitudes of students towards mathematics

An analysis of students' attitude towards mathematics using the technique Pathfinder Associative Networks, studying in the representations obtained the key concepts, the concept neighboring terminals and Mathematics.

Also happened to the students a survey about their attitude toward mathematics before and after working with the environment PmatE.

3.3 Axis 3 - PmatE Environment Evaluation

We analyzed the results of a survey answered by 76 teachers users PmatE site about the quality criteria for use in educational contexts PmatE environment.

4 Results And Analysis

4.1 Axis 1 - Conceptual domain of the basic operations

Media	Class A	Class C	Class J	Class M	Class R
<i>Pretest</i>	0,352	0,381	0,298	0,120	0,552
<i>Posttest</i>	0,658	0,657	0,515	0,678	0,480

Table 1. Coherence of cognitive networks (average)

At the end of the educational intervention was an increase, statistically significant, the coherence (its value ranges between -1 and +1) of the cognitive networks of students, except students in the control class. This increase means that PmatE educational intervention may have contributed to a better conceptual understanding of the four basic operations..

Media	Class A	Class C	Class J	Class M	Class R
<i>Pretest</i>	6,787	4,067	7,240	3,841	4,120
<i>Posttest</i>	6,167	5,376	4,569	5,725	4,674

Table 2. Complexity of cognitive networks (average)

Observed a decrease in the complexity of networks (their value can range between 0 and 10), but this difference was not statistically significant.

Media	Class A	Class C	Class J	Class M	Class R
<i>Pretest</i>	0,176	0,172	0,118	0,182	0,143
<i>Posttest</i>	0,137	0,137	0,224	0,111	0,156

Table 3. Similarity of student-teacher cognitive networks (average)

The increase in similarity (values can range between 0 and 1) between the networks of students and teachers was not significant. We cannot say that after the educational intervention, students' networks tend to be more similar to those of their teachers.

Media	Class A	Class C	Class J	Class M	Class R
Pretest	4,72	4,18	3,92	4,50	4,48
Posttest	5,87	5,78	5,76	5,81	5,62

Table 4. PmatE test results (average)

The score of the students (ranging from 0 to 10) in PmatE tests increased after the educational intervention in all classes (including the kind of control). This increase was statistically significant, so we cannot say that is due solely to the use of PmatE environment.

The correlation of the variables related to the PmatE test and evaluation test (Pearson correlation of 0.674) tells us, with discretion, because it is a convenience sample, there is a direct relationship between the results obtained in the PmatE test and the results obtained by the students themselves in the national assessment test.

4.2 Axis 2 - Attitudes of students towards mathematics

As for the key concepts of networks of students, the most prominent in the post were those of "Satisfaction" and "Ease". Students also reduced the number of nuclear nodes of the concept "Fear".

4.3 Axis 3 - PmatE Environment Evaluation

According to teachers, the environment PmatE achieved positive results in the categories of teaching quality, technical quality, ease of use and overall value, and negative results in the management category. However, it requires changes at the level of training manuals, multimedia elements and integration with other operating systems and Internet browsers.

5 Conclusions

Pathfinder Associative Networks technique used in this study has great potential for the assessment of student knowledge. It is a simple, fast and effective way to identify the concepts about which students structure their knowledge and to explore and learn about the evolution of student learning.

As for the educational integration of PmatE environment for the population studied in this work, has shown that tests this context can be a useful tool for the diagnosis and assessment of student knowledge.

PmatE environment is shown as an effective tool for teaching and learning of mathematical concepts. The process followed in this research has allowed us to assess the quality and the educational potential of networked educational resources from a broader perspective and understanding.

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