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On systemic perspective and the strategies in E-learning: inquiries in linear algebra

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Abstract

There is presented a teaching experience described by means of some theoretic elements of the Ontosemiotic Approach. We propose a series of problem-situations of exploration type which require an integral approach to *intra*-mathematical inquires, with investigation objectives, which involve applications of theore*tical constructions and methods* on the junctions in standard courses, in another environment. Our strategy is to design a *series of theoretical questions,* which lead to research activity, and to carry the students toward systemic perspective of mathematical practices through the practices of unitary perspective. We consider the Ontosemiotic Approach as an adequate theoretical framework which allows us to analyse the learning process in the e-modality of Linear Algebra course in order to arrange the activities so that the students would achieve the deeper comprehension of the most important concepts and their mutual relations.

1. Introduction

The most important ideas in linear algebra course to be learned by students are related to the concepts of vector (linear) spaces and linear transformations, which presents certain difficulties due to the abstract nature of the matter.

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Here we describe a series of activities which will allow the students to achieve the deeper comprehension of the most important concepts and their mutual relations.

1.1. Preliminary consideration of problems in the linear algebra course

Analyzing lists of problems in linear algebra courses and th**e** results in recent researches in mathematics education, we noted that there is a lack of problems which would require creative applications of the methods and technics traditionally taught in these courses. It is rather difficult to find the problems which would indicate the direction of applications of the theoretical facts beyond the themes covered in standard courses, as well as such sort of problems which would involve interdisciplinary considerations. Here we propose some tasks of exploration type which require an integral approach to intra-mathematical inquires with investigation objectives that involve applications of theoretical constructions and methods on the junctions in standard courses at the undergraduate level.

1.2. Towards intra and extra-mathematical applications within standard themes of linear algebra courses

In linear algebra courses, students should be familiarized with some operational methods related to vector (linear) spaces and linear transformations. We suggest some preliminary problem-situations of extra or intra-mathematical applications at the early stages of the course, in order to involve students in the mathematical activities of "personal cognitions" and to draw their attention to an alternative point of view on the same mathematical situation. For example, traditionally the matrices appear as a useful tool to represent linear transformations of vector spaces, nevertheless some sets of matrices may be treated in another environment, where the underlying geometry, topology and analytical methods should be involved.

We propose the implementation of the Forum scenery in order to involve all participants of e-modality course into the discursive practice of problem-situations concerned to the variety of characteristics of linear transformations corresponding to symmetric matrices and to antisymmetric ones which are most important in applications to mechanics, as well the orthogonal and unimodular matrices which describe geometric transformations used in applications (especially in the computer 3D Vision). We consider pertinent an implementation of Web2 technologies such as a WebQuest, which is considered as an inquiry-oriented lesson format, as well as Forum of general discussion of fundamental concepts.

2. Theoretical Framework

We consider the Theory of Ontosemiotic Approach as an adequate framework which allows us to analyze the learning process in the e-modality of Linear Algebra course in order to arrange the activities so that the students would achieve the deeper comprehension of the most important concepts and their mutual relations.

2.1. Theoretical background of the Ontosemiotic Approach

The Ontosemiotic Approach (OSA), considered as a unified framework to the study of the cognitive and instructional phenomena, emphasizes the role of mathematical activity which is modeled in terms of systems of practices (operative and discursive, oriented to problems solution), configurations of primary objects and processes (Godino, Font, Wilhelmi & De Castro, 2009; Font, Planas & Godino, 2010). In the process of realization of these practices there participate different types of *primary objects* (problems, language, arguments, concepts, propositions and procedures), which are organized in epistemic or cognitive configurations (depending on whether the institutional o personal level is taken into considerations), which in turn produce others mathematical objects of higher level complexity. The problem-situations promote and contextualize the mathematical activity; languages (symbols, notations and graphics) represent the other entities and serve as tools for action; arguments justify the procedures, meanwhile propositions relate the concepts. On the other hand the objects that appear in mathematical activity and those, of more complex nature, which emerge from these practices, depend on the "language game" (Wittgenstein, 1953) in which they participate and might be considered from the five facets of dualities proposed in OSA. It is important to take into account that choosing some entity into consideration as a primary one is rather