Implementación de circuitos eléctricos para facilitar el aprendizaje de sistemas algebraicos lineales

Implementation of electrical circuits to facilitate the learning of linear algebraic systems

Implementação de circuitos elétricos para facilitar a aprendizagem de sistemas algébricos lineares

DOI: http://dx.doi.org/10.23913/ride.v7i14.272

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Resumen

La enseñanza de los sistemas algebraicos lineales, así como sus técnicas de solución, constituyen un eslabón importante en el desarrollo profesional de los alumnos de ingeniería y áreas afines, sin embargo, la asimilación de conceptos se ve afectada por la falta de vinculación entre la teoría y la práctica, de modo que gran parte de los estudiantes muestran con frecuencia poco interés en la explicación de los temas y esto da como resultado un bajo desempeño académico. Este trabajo presenta una propuesta de enseñanza de sistemas algebraicos lineales, en donde se verifican los resultados a través de simulación electrónica e implementación física de circuitos eléctricos para estudiantes de ingeniería.

Palabras clave: enseñanza, aprendizaje, sistemas lineales, circuitos eléctricos.

Abstract

The teaching of the linear algebraic systems, as well as its solution techniques, constitute an important link in the professional development of students in engineering and related fields, however, the assimilation of concepts is affected by the lack of connection between theory and practice, so that much of the students often show little interest in the explanation of the issues and this gives as a result a poor academic performance. This paper presents a proposal of teaching of linear algebraic systems, where the results are verified through electronic simulation and physical implementation of electric circuits for engineering students.

Key words: teaching, learning, linear systems, electrical circuits.

Resumo

O ensino de sistemas algébricos lineares e suas técnicas de solução, são um elo importante no desenvolvimento profissional dos estudantes das áreas de engenharia e afins, no entanto, a assimilação de conceitos é afetada pela falta de ligação entre a teoria e prática, de modo que a maior parte dos alunos muitas vezes mostram pouco interesse em explicar as questões e isso resulta em mau desempenho escolar. Este artigo apresenta um ensinamento proposta de sistemas algébricos lineares, onde os resultados são verificados por meio de simulação e implementação física circuitos eletrônicos para estudantes de engenharia.

Palavras-chave: ensino, aprendizagem, sistemas lineares, circuitos eléctricos.

Fecha Recepción: Junio 2016 **Fecha Aceptación:** Diciembre 2016

Introduction

With the course of the years, the teaching-learning process has undergone major changes, competency-based model has reached great acceptance in recent decades, taking as a basis the scheme conceptual, procedural and attitudinal, and in this sense, that to achieve a holistic student development, it is essential to lay the foundations for a comprehensive knowledge, based on the interaction of theory and practice, using the appropriate methods that facilitate the understanding and assimilation of concepts and techniques (SEP, 2016).

There are different degrees and subjects where it is necessary to solve linear algebraic systems, since the balance of chemical systems, to complex Electrical, Computer and Communication Engineering (ECCE) systems (2016). So wide and varied is the number of applications where these systems are established, that its teaching is set out a core part in the academic development of the students, allowing them to assimilate the concepts to handle them later with skill, and proceed to more complex problem solving.

the Technological University of Altamira (UTA by its name in Spanish) and the Ciudad Madero Technological Institute (ITCM by its name in Spanish), being part of the institutions of higher technological education in Mexico, they have degrees in their programs of study including management of resistors and power supplies, as seen in the areas of Electrical and Electronic Engineering (ITCM, 2016), as well as in Mechatronics and Renewable Energy (UTA, 2016); in which electrical circuits are an important aspect, because they present an ideal scenario for the implementation of linear algebraic systems (CGUTyP, 2016) (DGEST, 2016).

On the other hand, is important to the consideration of an appropriate method of teaching and learning, allowing students not only machining processes, but give real meaning to the solutions.

The understanding of the meaning of linear algebraic systems and its solution, is a problem not only conceptual character, but interaction with the physical world. Concepts and forms of mathematical language (with its symbolic and universal character), allow at last instance, the description of various phenomena physical, completely real and tangible, which are explained through the laws that govern the universe. Based on observations made to various degrees the

ITCM and UTA students, was found that, in general, presented various problems for the solution of linear algebraic systems of order three or higher, but even more, for the extraction of such systems in the real world or the interpretation of its meaning.

Thus, it was necessary to address this link between theory and practice, for students to verify the results through real electrical circuits, with the support of appropriate tools.

Taking all this as a background, it was proposed as a general objective to design a method that would allow students to understand the meaning of linear algebraic systems, while in particular, the configuration elements were analyzed for the implementation of a real physical system characterized by Such systems. Appropriate measurement instruments were also established that were applied to the experimental and control groups in the development of the experimental methodology. Finally, it was proposed to apply and evaluate the effects produced by the proposed method on the students' academic performance when working with the implementation of linear algebraic systems.

Theoretical fundament

The methods of educational institutions that are based on the characterization, operation and purely theoretical modeling of different systems present radical differences to models based on practice; Theorists who synthesize their work in the text only, try to articulate the fundamental laws of memory, which at university level usually allows the student to assimilate only the mechanical repetition of concepts without meaning for him, and That the link that unites them with the practice is disjointed. Even at the present time, residues of these schemes are found in an important amount of elements designed with the purpose of improving the academic skills; On the other hand, a considerable number of teachers who use their own knowledge and bet on making popular techniques that have the potential to improve the assimilation of knowledge through mental processes (Gardner, 2005). On the other hand, it should be noted that multiple intelligences play an important role in the development of knowledge, so that the more senses become involved in the learning process, the more meaningful will be (Gamon, 2008).

There is a marked tendency on the part of professors of university mathematics for the management of complex and little didactic algorithms, which move away from the practical and simple examples that arouse the interest of the students. When the problems are purely theoretical, they pose scenarios whose meaning is not understood or deciphered by the student; however, the correlation between theoretical mathematics and the physical phenomena present in practice, form an important step in the assimilation of concepts, Also generate interest in most students (Tahan, 2009).

Many people think vehemently, that mathematics are uninteresting, complicated, arid and even cold, but there are people who consider them to be very useful and interesting, it is finally a matter of optics, the point is that mathematical relations Exist in the natural world and human beings are immersed in them, which is an undeniable certainty, which can be used by the mathematics teacher to invite those who have a negative concept of this important science, a scenario that offers the Possibility of changing their perspective by consciously recognizing their presence everywhere, verifying in this way, their application in the real world (De la Peña, 2004).

According to Stewart (2012), mathematics is alive and present in the world around us, a reality that manifests itself relentlessly through 17 equations that changed the world, which include from the Pythagorean Theorem that Is present in the right triangles, to the Chaos Theory that models the changing population of living creatures when there are limits on available resources. All this, reveals a reality that can be used by the teacher, to make the pupil grow in his interest in mathematics and its relationship with nature.

On the other hand, the analysis of electrical circuits, is the first course based on calculations and procedures that relates the theory directly to the practice, in the courses of Electrical Engineering, Electronics and Mechatronics. Such courses typically examine basic elements, such as resistors, capacitors, and inductors, which, in steady state, represent complex linear algebraic systems, introducing students to theorems such as transforming sources and overlapping, mesh and nodal analysis, among others . Courses are often complemented by laboratory experiences where students gain experience with basic equipment such as Direct Current (DC) power supplies, digital multimeters, function generators and oscilloscopes, where they examine simple electrical circuits (Becker , 2014).

There is a large and growing literature that deals with the teaching process of such courses, and perhaps the most common theme in most of this literature is the need to help students develop a conceptual understanding of electrical circuits and their linkage With the mathematical modeling of them (Gokhale, 1995). There is also emerging evidence of attempts to remove traditional teaching in these courses in an effort to promote the development of the understanding of intangible concepts among students (Yadav, 2011).

In the teaching of electrical circuits, there is information that reveals that many students are little less than inspired by such courses, given that the student is obliged to learn various laws and methods of analysis, as well as to memorize a large number of formulas, without having Made an effort to gain conceptual understanding (Lawanto, 2012).

The active participation in the development of laboratory practices, combined with appropriate computational tools that allow the modeling and solution of linear algebraic systems, allows the student to reach a higher degree of understanding of the fundamental concepts, by verifying the solutions obtained both manual As computationally, and compare them with the actual values indicated in the electric meters. Active participation is important, since there is sufficient evidence that the complement of theoretical classes with active learning strategies, leads the student to retention of knowledge and increase of knowledge, through scientific processes and discovery, so that this Type of learning is beneficial and superior if compared to traditional purely theoretical methods (Becker, 2014).

Methodology

First, the appropriate characteristics of the proposed teaching-learning method were identified, with the aim of improving students' understanding of concepts and foundations. These elements are formed by a set of mechanisms inherent in the construction of knowledge, based on the relationship between theory and practice, all under a pleasant environment, where thoughts and stimulation through the involvement of the More sense, are the starting point for the holistic construction of knowledge (Chamorro, 2005).

All this resulted in the implementation of simple resistive circuits with DC voltage power supplies, which are represented by linear algebraic systems. The mechanism is that the student performs manually the calculations for the solution of the system, using the actual parameters of the circuit, and then compare the results obtained with those thrown by the measuring instruments in practice. Electronic simulation is also performed through some specialized software of electrical circuits, and in addition, the system is solved through a mathematics program.

The next step was to design an appropriate measurement instrument that would yield results that reflected students' academic performance in terms of concept understanding, modeling and solution of linear systems.

Within the degrees in electrical engineering, electronics and mechatronics, and during the delivery of the subjects where linear algebraic systems are handled, two groups of students were selected, one that received the traditional classes (control), and another Which was treated using the proposed teaching-learning method; Each group was 25 students, who were examined to measure their degree of assimilation of concepts and resolution of linear algebraic systems.

Finally, the instruments were applied to the two groups, just after seeing the contents in class, later the results were measured, which constituted a retention of knowledge in the short term; After two months and without prior notice, a second evaluation was applied and other results were found, which measured academic performance in the medium term. In each exam there were two sections, one focused exclusively on the assimilation of concepts, and the other focused on the modeling and solution of linear algebraic systems.

The evaluation elements addressed by the reagents used within the evaluation instruments are listed in Table 1.

Table 1. Elements evaluated by reagents.

Reactivo	Elemento evaluado
1-5	Asimilación de conceptos
5-10	Modelado de sistemas
10-15	Obtención de resultados
16-20	Interpretación y manejo de resultados

Discussion

One of the strengths of the study is that it showed that the proposed relationships not only allowed the student a better understanding of linear algebraic systems but also aroused his interest in relating the theory to operant reality and challenged him to face other problems Through his ability to translate equations into physical meanings, motivating his ingenuity and creativity, and thus developing in him important elements for his future professional activity.

One aspect worth emphasizing is that the study was applied to students from two different educational institutions, obtaining very similar results, although there were limitations in not being able to extend the research to all available students, because not all teachers Which provided the subjects related to the study were willing to participate.

As for areas of weakness, it is important to consider that as in any social study, there are inherent characteristics of each student, that can not be controlled by the investigator and that can cause some bias in the measurements, such as the condition Socioeconomics, previous knowledge, culture, motivation and socio-cultural formation, to mention a few. It is also important to have the right information technology, as well as with the appropriate laboratories, equipment and spaces so that research like this can be successfully carried out.

Conclusions

The results were satisfactory, since there was a significant increase in the assimilation of concepts and modeling of systems by the students of the experimentation group. The interaction with the measuring instruments in the physical implementation of the electrical circuits and the complementary contact with the software of electronic simulation and mathematics, motivated the interest of the students for the solution of the linear algebraic systems generated in the resistive circuits.

In the first evaluation, group "A" (which was the control group), obtained an acceptable score of 82 in terms of assimilation of concepts, while the second group obtained a score of 89 in the same category, so that no There was a noticeable difference, however, the results of the examination applied two months later, marked a difference of 24 points between the averages of both groups, so that group "A" forgot much of the concepts, while the "B "Almost maintained its performance.

Table 2 shows a summary of the results of the research, where the column "assimilation of short-term concepts" shows the result of the first section of the first examination applied. The column "assimilation of concepts in the medium term" shows the results of the first section of the second examination applied two months after the first in both groups.

The column "modeling and solution of short-term systems" establishes the results obtained in the second section of the first review, while the column "modeling and solution of systems in the medium term" reveals the results of the second section of the examination applied two months Then to the two groups. Row A shows the results obtained by the control group, while the B indicates the results obtained by the experimentation group.

Since the groups were made up of students with similar characteristics, the results obtained in the research imply that the proposed teaching-learning method was successful in the academic performance of the students.

Table 2. Averages of assessments applied per indicator in each group.

Grupo	**Indicadores de desempeño académico**			
	Asimilación de conceptos a corto plazo	Asimilación de conceptos a mediano plazo	Modelado y solución de sistemas a corto plazo	Modelado y solución de sistemas a mediano plazo
A (método tradicional)	82	62	61	43
B (método propuesto)	89	86	85	78

The greatest difference between the results obtained by the control and experimentation groups occurred in the medium-term modeling and solution of systems, which means that students who did not implement electrical circuits largely forgot the knowledge related to The resistive circuit modeling. On the other hand, the assimilation of the concepts in the short term showed the smallest difference between the groups, which was seven points, indicating that the proposed method does not immediately generate radical changes in the understanding of ideas and calculations Of linear systems.

In general, the results of the research resulted in an improvement of students in each of the proposed indicators, the implementation and modeling of resistive electrical circuits, accompanied by the appropriate use of electronic simulation software and mathematical solution of systems, allowed the holistic construction of knowledge.

For obvious reasons, it is not possible to control factors inherent in the nature of the groups involved, such as the previous knowledge of each student, their interpersonal relationships and social environment, as well as diverse factors inherent in human nature that prevent True experiment and to have an absolute control in the treatment of the variables. However, despite these circumstances, the results of the proposed method are academically encouraging.

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