

The Effects Of 4C-ID Model Approach on Acquisition and Transfer of Knowledge About Electric Circuits

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ABSTRACT

This paper reports the first results of an experimental research, carried out in a private school with 9th grade students, where the 4C/ID-model was used for teaching and learning electric circuits. The authors describe the principles and features of the instructional model, that is suitability for the teaching and learning of complex knowledge and skills and yet their permeability to develop digital educational resources and learning environments. The authors analyse the preliminary experimental results in terms of students' performance (both reproduction and learning transfer), mental effort and instructional efficiency. They also suggest clues to future research.

KEYWORDS

4C/ID-Model, Digital Educational Resources, Electric Circuits, Instructional Design, Learning Environments, Multimedia Educational Messages

INTRODUCTION

In this paper we present the firsts results of a research based on the 4C/ID-model (Four Components – Instructional Design Model), suitable for complex learning, developed by van Merriënboer and colleagues in the 90s (van Merriënboer, 1997), that corresponds to an extended version of the article “Applying the 4C-ID Model to the Design of a Digital Educational Resource for Teaching Electric Circuits: Effects on Student Achievement” presented at the IDEE 2014 workshop (Melo & Miranda, 2014). Despite of the existence of other instructional design models, the 4C/ID-model acquire a high formulism level evidencing as a suitable model to teach complex skills, as it is most of the learning that takes place at school and professional training. Moreover, this model is very susceptible to the development of digital educational resources and multimedia learning environments that are increasingly used in education and vocational training.

We will consider the design of a digital resource for teaching and learning electric circuits based on this model and the main results achieved with its application to students in the 9th year of schooling, following an experimental research design.

The main objective of this study is to compare the effects of two instruction approaches in reproduction and transfer tasks, perceived cognitive load and instructional efficiency.

Science aims to achieve several goals, including replicating results and innovating. The innovative dimension of this article is the application of the 4C-ID model to the basic levels of education, since until now it has been used in university and professional training.

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THE 4C/ID-MODEL BACKGROUND

As refers Anderson (1983), a model is an application of a theory to a particular phenomenon. A theory is a precise deductive system, more general than a model. Often theories are grouped into frameworks and a framework is a general set of concepts for understanding a domain, but is not sufficiently organized to constitute a theory; from the same framework we can deduct various predictive theories.

The 4C/ID-model was developed based on some general principles of Instructional Design & Technology (ID&T or ID) (Reiser, 2001), where we emphasize the influence of the ADDIE model and the work of Robert Gagné (Gagné, 1975, 1984, 1985) and more recent theories, as the cognitive theory of multimedia learning, developed by Richard Mayer and collaborators (Mayer, Heiser & Lonn, 2001; Mayer & Moreno, 2003; Mayer, 2005) and the cognitive load theory, established by John Sweller and colleagues (Sweller, van Merriënboer & Paas, 1988; Chandler & Sweller, 1991; Sweller, Ayres & Kayuga, 2011). All these theories can be integrated into the information processing framework, where memory (associated to other cognitive processes) is the basis and the result of the cognitive activity that occurs during learning. All these theories and models can be included in the cognitive framework. There are others two frameworks: the behaviourist and the constructivist frameworks, each of which has given rise to theories and instructional models (Reiser, 2001; Wilson & Cole, 2001).

As emphasize Wilson, Jonassen, and Cole (1993), ID as a discipline rests on the twin foundations of (1) a systems design model for managing the instructional development process (like de ADDIE model) and (2) theories that specify what high-quality instruction should look like (Reigeluth, 1983, 1987).

Like others ID models, the 4C/ID-model gives a great importance to the learning tasks (Child, 2004). They are the core of the instructional process, which consists of five steps: Analysis, Design, Development, Implementation and Evaluation – ADDIE (Branson, Rayner, Cox, Furman, King & Hannum, 1975). However, learning tasks in 4C/ID-model are integral and real tasks that the learners or professionals must perform. This is a major difference of this model when compared to other models that, in most cases, divide the overall learning tasks into subtasks of easier achievement. Most of the ID' models use a bottom-up strategy, considering that much of the knowledge and skills are better learned by means of associative processes. It is the case of Programmed Learning by Skinner (Skinner, 1954, 1968).

But we know that it is not always so (van Merriënboer, 1997; Sweller et. al., 2011; Wertheimer, 1945). The basic skills training and the development of automatisms are essential to the performance of many activities but these should be part of the task as a whole. We think that some of the transfer problems expressed by students come from the way they were taught (Miranda, 2005) and one of these problems lies on the lack of prescription, training and practice (which is often one of the problems of the constructivist models) or the segmentation of tasks proposed by behavioural models (Skinner, 1968). We think that the cognitive approach or framework and its theories and models, mainly the 4C/ID-model, combined the best of both worlds.

The Multimedia Learning Theory

The use of the 4C/ID-model in the design of digital learning environments follows the assumptions of the multimedia learning theory developed by Richard Mayer, which posits that humans learn better from words and images than just words – the multimedia principle (Mayer, 2005; Paivio, 2006a, 2006b). However, in order to promote meaningful learning it is necessary that multimedia messages are designed from the way the human mind works, i.e. how it handles this type of information. The theory is based on three assumptions and five cognitive processes, derived from the results of experimental research done in the field of cognitive psychology. The three assumptions are: (1) the human system information processing included double channels for the processing of visual/pictorial and auditory/verbal (the assumption of dual channels) (Baddeley, 1997); (2) each one of the channels

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