Continuous Evaluation of the Learning Process of Algebra Through a Semi-Automated Tool

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ABSTRACT

Personalized education is an issue that is being considered in the development of automated tools. Personalized education refers to the fact that students’ characteristics must be considered to determine the type of teaching or instructional design that must be provided to him/her. Within the area of intelligent tutorial systems (STI), student characteristics are handled within the student’s module and usually refer to the student’s skills, learning styles and prior knowledge of the subject of interest. The latter is closely related to the need to constantly assess the student, which is a process that is not easy to perform manually. However, several public schools in Mexico there is not the infrastructure necessary to be able to use automated tools, in each of the classrooms. This article is a proposal for a semi-automated tool for constant assessment.

KEYWORDS

Assessment, Gamification, Instructional Design, Tangible Interfaces

INTRODUCTION

It is not effective to assume that all learners will have to follow the same instructional model. All learners should not be advised to read the same material and with the same order (Chrysafiadi & Virvou, 2013). Provision of the same instructional conditions to all students can be pedagogically ineffective. In contrast, achieving learning goals can be more effective if pedagogical procedures are geared to comply with the pupils’ individual needs (Akbulut & Cardak, 2012). In various investigations, the authors agree that it is very important to identify the student’s characteristics, which in various studies are called the student’s model. For example, Rongmei and Lingling mention that the student’s model is the record of the learner’s basic information and cognitive state of information, which accurately, objectively and truly reflects the learner’s current level of knowledge and cognitive ability.

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(Rongmei & Lingling, 2009). On the other hand, in (Alsubait & Khamis, 2011), the authors state that among many characteristics that define the student’s model, there are characteristics that have a greater influence on the learning process such as:

- The student’s previous knowledge that determines the concepts that he can learn.
- Student’s skills and learning styles that determines the teaching approach that best suits him/her.
- Student’s emotions and motivations is another important characteristic that is usually forgotten in student modelling research.

Likewise, tailoring learning experiences to student needs can be accomplished with respect to several factors including intellectual ability, cognitive styles, learning styles, prior knowledge, anxiety, achievement motivation, and self-efficacy (Akbulut & Cardak, 2012).

In the mentioned works, the authors agree that one of the relevant characteristics in the student’s model is the detection of the prior knowledge that the student has on the subject to be taught or learnt. In looking at the importance of the detection of the students’ prior knowledge as pedagogical support, the authors can mention the theory of cognitive load (CLT). One of its effects, the reversal expertise, affirms that many experimental studies generated by the cognitive load theory demonstrated that instructional procedures and techniques that were effective for novice learners appeared to be detrimental for more experienced learners (Kalyuga, Rikers, & Paas, 2012). In contrast to experts, novices should achieve higher levels of learning performance with this additional material that is essential due to their level of expertise, compared to novices lacking the written explanation (Leppink, Broers, Imbos, van der Vleuten, & Berger, 2012), (Rey & Andreas, 2013).

The process of detecting prior knowledge is closely related to the constant evaluation of students, which leads to detecting the cognitive skills that the student has to solve problems, and in this research, focuses on problems of algebra. This evaluation is the one that will give the guidelines to determine the type of instructional design that should be provided to the student. However, the process of constant evaluation is not easy to perform manually, so personalized education requires automated tools, but at the same time, as mentioned in (Cuendet, Dehler-Zufferey, Ortoleva, & Dillenbourg, 2015), classrooms using computer technology today are the exception rather than the norm. This is not due to the lack of potential of computer technology for learning. And even though the digital age is so advanced around the world, in Mexico, where this research is carried out, the necessary conditions do not exist for any institution to use fully automated tools. Disadvantages such as poor infrastructure, lack of computers, and inadequate internet access, are some of the most common obstacles that do not allow most Mexican educational institutions to use automated techno-pedagogical strategies.

Typically, fully automated software applications use somewhat sophisticated hardware requirements for handling animations, graphics, and other features that make them attractive but also expensive. Therefore, there are still many opportunities to propose strategies supported by technology to help improve the teaching-learning process within the classroom. This paper describes the proposal of a semi-automated tool, which does not require sophisticated computers, cell phones or Internet access, making it a low-cost tool. This tool is very focused on supporting the teacher to carry out constant evaluations through games and challenges based on the resolution of problems of the subject in question, which, in principle, is related to algebra. The design of the tool is based on an iterative instructional design, related to problem solving and was implemented on an electronic card.

Likewise, when a tool that helps in the evaluation process is proposed, models that may be able to perform this task efficiently are required, models that, in some way, can simulate decision making, as a teacher does. For this reason, a model of fuzzy logic is proposed, which by using rubrics designed on the basis of an algebra teaching model called 3UV, and associated with Bloom’s Taxonomy, allows evaluating and classifying the student in solving algebra problems. Subsequently, an instructional design related to the management of various types of problems, based on another approach to CLT, called working examples, is proposed.
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