Affective Tutoring System based on Extended Control-Value Emotional Agent and 3x5 RLO Matrix

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Abstract

The present research aims to present the general framework of an affective teaching system (affective tutoring system - ATS) oriented to engineering education. ATS system is equipped with an emotional agent inspired by the psycho-pedagogical researches of control-value theory that try to estimate the student's emotion during a reusable learning object (RLO), having as a stimulus the ability evaluated by means of item response theory. To present a lesson the RLO model was improved, being organized in a matrix form with five columns and three rows. Each objective of teaching is assigned to a RLO array. The five columns cover a theoretical concept, its properties, relationships between concepts, the involvement of the human factor in these relationships and conclusions. The three lines cover the following aspects of teaching: theoretical teaching of the five concepts from the columns, teaching practical examples or typical experiment for each column, and on the last line specific exercises that must be solved for each column separately. The RLO matrix object with three rows and five columns has also, besides teaching objective, verification tests associated to each element in the array. Evaluation of matrix tests is performed by item response theory, which links estimated student emotion with the type of teaching objective by Extended-Value Emotional Control Agent.

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1. Introduction

This paper is a research on computer-assisted learning systems. A computer-assisted learning system is a software process that assists a computer user in acquiring effectively knowledge in a given area. In the literature of computer-aided learning systems, it was found that learning is more effective if on the computer screen is displayed

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a human face, and determines: increasing motivation to learn [1], [2], active emotional involvement of the student [3], [4], [5] to sustain the motivation to learn.

The specialized work-related learning platforms define two types: ITS (intelligent tutoring system) and ATS (affective tutoring system). An ITS is a learning system based on advanced mathematical apparatus such as fuzzy logic, neural networks, stochastic systems, etc. It is a system that instructs the user in a specific domain. An ATS is an ITS which also has an emotional component that can improve learning process [6]. The concept of ATS involves both collecting the emotion (which has an affective time from seconds to 3 minutes) and collecting the mood (which may last from minutes to days or weeks). In the present work ATS will be limited to the collection of emotions. One of the important aspects of teaching ITS/ATS systems are emotional factors of the student user, such as boredom, pleasure, pride which are related to the human image from the computer screen [7], [8]. For the system of teaching ITS/ATS to be completely, humanoid face which we call in this work avatar-teacher must also contain a good quality dialogue, to intervene when teaching process is in deadlock, or has a high capacity of politeness [9], [10], [11], [12].

An ITS/ATS system has the following typical components [13]:

- **Domain module** – represents all structured information to be presented to students, and also tests. This information must be consistent with the pedagogic module.
- **Teaching module** - contains all teaching strategies tailored to a student, who are required to teach a certain lesson. (In the present work domain module and pedagogical module will form the same entity called domain module, abbreviated DM)
- **Student module** – represents the way how ITS platform has a certain image about the student at any time, containing information about the student, which may influence its capacity at a time of learning.
- **GUI module** - is the graphical user interface between the ITS platform its user. The platform from this study is equipped with a teacher-avatar called pedagogical agent in the literature.

2. **General description of the ATS system**

From the general description of an ATS/ITS platform-type presented in the introduction we considered four basic building blocks: domain module, pedagogical module, student module, and GUI module. Typical for SPE platforms is graphic module of gathering facial expressions, which is integrated into the GUI module. The experience that was been gained from research with ATS platform, led the unification of the pedagogical and domain module, resulting a new module called domain module that holds the collection of lessons and tests that are used in teaching, and also models of politely utterance formulas that avatar introduce each component of the DM in teaching process. The unification of the two modules within DM determines a more flexible and reusable learning objects (RLO), including classical or interactive types of teaching whose introduction to the user is done by politeness formulas. So, below is a general diagram of a tutoring system based on Extended -Value Emotional Control Agent and RLO 3x5 Matrix (Fig.1).

3. **Block diagram of 3x5 MRLO**

RLO is not a new approach to e-Learning field. RLO concept helps granular segmentation of individual and independent lessons, which are used for teaching. In the field of e-Learning teaching intelligent or affective/emotional platforms have various types of definitions for the concept of RLO. In this paper, we propose a new perspective for RLO and for the assigning of evaluation activity using Item Response Theory. In the literature the concept of RLO could be regarded as a limiting concept, which treats together theory, practical applications and numerical exercises. In order to develop a new method of independent assessment of students' knowledge in theory, practical examples and applicative exercises - we propose a matrix that divides the classical RLO vision on three dimensions: theory, examples and experiments, and exercises for each of the five specific categories - reusable information objects (RIO). The structure "3x5 MRLO" is shown in Figure 2 [14].
A lesson has teaching many objects and each to object is assigned a 3x5M RLO element-type. In this research, it have been adapted and renamed the five RIO elements as follows [14]:

The concept – an approach, an array of 3x5MORP ’s teaching objects.

The properties – presents the component characteristics of the concept.

The process – presents the dependency relations among concept and its components.

The procedure – the way how it can influence or change the relationship between the concept and its components.

The conclusion – is a synthetic structure of all four previous elements (concepts, properties, processes, procedures).

Information – content and directives - every object of teaching is structured as a sequence of:

a) Theory - presenting scientific support in the five categories of RIO.

b) Examples/Experiments – presents real cases and experimental cases for each of the five stages.

c) Exercises – practice presentation of numerical applications associated with five types of RIO.

General organization of DM is for a lesson, is like a matrix with number of columns equal to the number of objectives of the lesson, i.e. 4 lines (for the four types of teaching objects) [14]. Browse DM is performed by learning way, like the movement of a piece in a game of checkers, for each objective it is choosing one of the four types of teaching.

Completion of a 3x5MORP teaching object – type is performed line by line from left to right and from top to bottom. Moving from one field of the matrix to the next field is performed in accordance with the teaching strategy followed by ATS. For classical teaching just final testings are performed after the conclusion section. These tests are comprehensive of all five types of RIO. In traditional teaching it is considered that student can perform interrogative actions to ATS using collections of interrogative questions prepared in advance by the administrator of the platform. For interactive teaching it is used by switching between two consecutive fields on the same size of the three, a short test about current ORI, possibly combined with an interrogative action of the student. The option for the existence of
the student’s interrogative action belongs to platform administrator [13]. The four types of 3X5 MORP teaching objects are presented in [13] (Figure 3).

<table>
<thead>
<tr>
<th>RLO Theory</th>
<th>RLO Examples/Experiments</th>
<th>RLO Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Classical</td>
<td>Classical</td>
</tr>
<tr>
<td>Type 2</td>
<td>Classical</td>
<td>Interactive</td>
</tr>
<tr>
<td>Type 3</td>
<td>Classical</td>
<td>Interactive</td>
</tr>
<tr>
<td>Type 4</td>
<td>Classical</td>
<td>Interactive</td>
</tr>
</tbody>
</table>

Fig. 3. The meaning of the four types of teaching objects

4. Extended Control-Value Emotional Agent (ECVEA)

The purpose of this section is to present the steps for designing an emotional agent that act as a student module. The start of this research is the control – value theory of educational psychology [15], [16], which we will translate into a formalism based on fuzzy logic. This formalism will be called Extended Control –Value Emotional Agent, abbreviated ECVEA [17], [18]. ECVEA is a software process that will allow as input the student's learning ability and as output the emotional state encoded as a six-dimensional vector that defines the category I emotion according to Perrot’s approach [19]. To highlight the emotion of II /III category from Perrot’s approach ECVEA agent will build a statistical model that will highlight the difference between frustration or anger in the classroom, which cannot be achieved by any video camera (including Kinect), and will help the system to correct the separation between the two emotional states. For an efficient teaching process, the aim of the system is to avoid passive emotions (despair, frustration, boredom) and to stimulate student to have positive active states (joy, hope, relaxation, pride, gratitude) or negative affective states (sadness, shame, anger, anxiety) useful in teaching process [15], [16]. Thus ECVEA plays the role of Student Module.

5. Experiment

For this section we present first histograms dispersion models, small and medium that approximates uniform distributions, Gaussian and Dirac for the abilities of students (see Fig. 4). We conducted two experiments with ATS platform. The first didn’t display avatar and has operate more like an ITS, and the second has used the avatar in teaching – evaluation process and show that its dialogue and politeness improve the number of active facial expressions, captured by Kinect, and the number of positive estimated abilities of students.

For normal distribution case, it was approximated by a Gaussian distribution where the “bell-curve” central samples are approximately equal in size and side samples have negligible size compared to the first, the image approximating a rectangle. The Gaussian distribution is Gaussian bell-shaped, and in Dirac distribution case is used also a Gaussian bells where in the center is a high concentration of valuable samples and sides are negligible in size compared to the first.
6. Conclusions

This platform allows great flexibility of educational speech by using a system with high-level avatar that is controlled by an integrated management system in domain module and due to the new structure of lessons organized in 3x5RLOM – type matrix form and ECVEA emotional agent, the student being able to adapt to the learning process by the provided teaching and evaluation facilities.

References


