MOTIVATION AND LEARNING MODES: TOWARDS AN AUTOMATIC INTELLIGENT EVALUATION OF LEARNER MOTIVATION

Bourouaieh Douadi, Université 8 Mai 45, Algérie

Abstract

This paper presents an experimental learning environment to analyze research questions related to learner’s motivation. Three learning modes are available for the learners; all of them are about the same topic: designing entity-relationship data models. The first learning mode is a hypermedia, the second a set of navigable learning videos with an annotated timeline, and the third one is a graphical design environment offering a range of social activities including assessment of peers’ solutions. Our goal is to study the motivational aspects that come into play in different learning modes to design an intelligent system for automatic evaluation of the learner motivation. We are currently exploring the Hidden Markov Models (HMMs) from artificial intelligence techniques.

Keywords: Ill-Structured Domain, Artificial intelligence, Entity-relationship modeling, HMM, Interactive learning environment

1. Introduction

In recent years, interactive learning environments has evolved and spread out through the IT evolutions. The education styles have changed, now there is not older time and place limitations and the learner have several learning material sources with multiple interaction modes. In the other hand, the exclusively distant learner is isolated and hence can easily feel unmotivated. To face this problem, virtual learning environments offer a large set of learning strategies scaffolded with texts and explained images, as well as videos, animation, 3D and 2D simulations, socialization, etc. This technological profusion of learning tools has led to a cognitive demanding learning context, and the learner is faced with multi-modal learning channels and learning paths. The learner may choose to engage in a predefined linear order or he can go through learning material nodes according to his preferences and knowledge mastery level. Learner has to engage in self-regulated learning and is an active participant in his own learning (Moos, 2014).

One major issue in distance learning is the high dropout rates (Di Ramio, Wolverton, 2006; Chen, Jang, 2010), this issue is also a negative indicator for motivation (Chen, Jang, 2010). Chen indicates that, despite the importance of motivation in learning consequences, it has not received necessary attention in the research community. Motivation has been identified as a critical factor in human activities in general; for a complex cognitive function like learning it’s criticality has been identified in multiple works (Chen, Jang, 2010; Ibáñezb, Kloosb, 2013). Despite the enormous benefits of rich media environments and the self-regulated learning, learners are not always very motivated to use them. In this paper we present an experimental environment “ModaLearn” used to address some research questions related to learner motivation.
and engagement. We also explored an artificial intelligent technique aimed to approximate the learner motivation state, as a part of the learner model.

2. LEARNER MOTIVATION

Motivation is a common word used in the education field although there is no real consensus about how to define motivation (Kleinginna, 1981). Usually, the education research community adopts the definition stated by Houssaye that describes motivation as the forces that initiates and directs behavior (Blanca, 2013). Another, typically used definition of motivation (cited in Moos, 2014), states that motivation is the physiological processes involved in the direction, vigor, and persistence of behavior (Eccles, Wigfield, 2002). For the education field those two definition relate the behavior to learning processes, i.e. how engaged is the learner in his learning activities.

There is a common agreement about the impact of learner motivational levels in academic outcomes (Blanca, 2013) because motivated learners are likely to engage in proposed learning activities that will help them in better mastering the presented learning material or targeted knowledge. Also, the lack of motivation is correlated with low achievements (Jeamu et al., 2008).

3. KELLER’S ARCS MODEL OF MOTIVATION

Psychologists have presented multiple motivation models; the ARC model was developed, based on a compilation of most predominating theories, by Keller and presented in (Keller, 1987); the aim of the theory is to measure the individual motivational state levels. Four factors are identified as important in approaching the measure of the motivation construct:

The first component, attention, refers to the interest displayed by the learner towards the material/knowledge being taught. Grabbing learner attention is considered the most important component of the model. Consequently, strategies are employed in order to arouse and sustain the learner interest. The attention component is divided in three sub-categories: Perceptual arousal, inquiry arousal, and variability.

Relevance is the second component; it is related to the learner’s goals (present and future) and preferences. After grabbing learner attention, it has to be sustained by the content relevance. If the content or activities are not perceived as valuable by the learner, the motivation can decrease or be lost. An important issue for the relevance component is to connect the actual instructional environment with past experiences (Keller, 2008).

The third factor is confidence; this factor is about learner’s attitudes toward success. Levels of confidence are highly correlated with motivation and the amount of efforts made by the learner to reach his goals. In consequence, it is important that learning environments offer to student mechanisms to evaluate their chance of success.
4. Assessing Motivation

Measuring motivation is essential to assess the effectiveness of an instructional design or interactive learning environment. The Instructional Materials Motivation Survey (IMMS) was the instrument developed under the ARCS model (Keller, 1987) to measure learner’s motivation levels (Keller, 2010). This instrument is widely used in learner motivation studies as reported in Di Serio et al. (2013). The questionnaire is composed of 36 questions with 5-points Likert-scale items. Each question is related to one ARCS factor. The instrument is valid and reliable (Cronbach- α .96) (Keller, 2006).

Table 1 shows examples of IMMS questionnaire questions organized by factors (Keller, 2006) with examples of associated questions.

<table>
<thead>
<tr>
<th>Attention (Questions: 2, 8, 11, 12 (reverse), 15 (reverse), 17, 20, 22 (reverse), 24, 28, 29(reverse), 31 (reverse))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. There was something interesting at the beginning of this lesson that got my attention</td>
</tr>
<tr>
<td>11. The quality of the writing helped to hold my attention</td>
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<td>…</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Relevance (Questions: 6, 9,10, 16, 18, 23, 26 (reverse), 30, 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. There were stories, pictures, or examples that showed me how this material could be important to some people</td>
</tr>
<tr>
<td>16. The content of this material is relevant to my interests</td>
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<td>…</td>
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</tbody>
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<tr>
<th>Confidence (Questions: 1, 3 (reverse), 4, 7 (reverse), 13, 19 (reverse), 25, 34 (reverse), 35)</th>
</tr>
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<tbody>
<tr>
<td>4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson</td>
</tr>
<tr>
<td>25. After working on this lesson for awhile, I was confident that I would be able to pass a test on it</td>
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<td>…</td>
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<tr>
<th>Satisfaction (Questions: 5, 14, 21, 27, 32, 36)</th>
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<tbody>
<tr>
<td>14. I enjoyed this lesson so much that I would like to know more about this topic.</td>
</tr>
<tr>
<td>21. I really enjoyed studying this lesson.</td>
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<td>…</td>
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</tbody>
</table>

Table 1. IMMS Questionnaire outlines

The IMMS instrument is relevant in our research because we tend to use it to train and evaluate the accuracy of our HMM. Additionally, in order to address research questions about learner motivation towards different learning modes, we need to use the IMMS instrument. Additionally, IMMS can be used to analyze each factor independently from the others and hence can allow us to tackle richer research questions.

In this work we use IMMS to evaluate motivation levels of 2nd year university student towards three different learning modalities for the same topic of database entity relationships modeling.
5. Hidden Markov Models

In our work, we explore a possible way to automatically approach learner motivational levels from his activities within the learning environment. HMMs are one possible probabilistic technique issued from artificial intelligence field.

HMMs are statistical model with four components (Rabiner, 1989): states observations symbols, state transition probabilities distribution, observation symbol probability distribution, and initial state probability distribution. The HMM models can address three problems: The Evaluation Problem, the Decoding Problem, and the Learning Problem. Those models have been used in numerous application fields including educational one. Figure 1. presents an example of HMMs.

To automatically approximate the learner motivation state we heuristically built a set of initial HMMs and selected best ones that led us to one HMM that is responsive with the experiment results. Although our HMM showed a good performance within our data, there is no guarantee that it will predict the learner motivation state in other learning configuration or even in the same configuration but with other learners. Here, more tuning and experiments are needed.

Figure 1. HMM with three states

\[
\begin{align*}
A &= \begin{bmatrix} 1 & 2 & 3 \\ 1 \ 0.2 & 0.3 & 0.5 \\ 2 \ 0.1 & 0.2 & 0.1 \\ 3 \ 0.7 & 0.2 & 0.1 \end{bmatrix} \\
B &= \begin{bmatrix} 0.1 & 0.9 \\ 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix} \\
\Pi &= [0.1 \ 0.5 \ 0.4]
\end{align*}
\]
6. THE EXPERIMENTAL LEARNING ENVIRONMENT

ModaLearn propose different learning modalities about the same topic which is entity relationships modeling (ERM). The field of ERM was chosen because it involve complex problem solving activities and is an open ended problem, learners have difficulties in mastering this kind of knowledge (Connolly, Begg, 2006; Suraweera, Mitrovic, 2004) which involves creativity and is demanding a real motivated learners.

The first modality is a hypermedia, composed around an ER course with text, images, and navigable links. The learner can go along the course using links and can also consult examples of solved problems. An exercises section is also available. exercises, example, links are here to create richer learning environment than merely present one long course page, even if the single page is presenting the same content.

The second modality is an annotated set of videos describing different parts of ER modeling (see Figure 3.). Annotations help learners to navigate through video parts and directly access different sections of the course, as an example, learner can choose to go directly in the section explaining cardinalities and how to set them, or focus on the difference between relation instance and relation class. It was possible to embed videos in the hypermedia rich modality (first modality) but we choose not to use them in order to keep neat differences between modalities.
The third modality consists of a visual ER designing tool, it’s a graphical tool where learners can construct their solutions and send them back to a database. The tool is user-friendly interface with essential editing options (cancel, copy, paste, etc). When using the graphical tool, learners can consult the actual exercise text they are dealing with. When a learner finishes his solution, he can submit it. After posting, models became available to all learners from database. Each learner is able to view their peer models and assess them. This peer assessment activity was added to promote meta-cognitive skills and encourage learners to evaluate the solutions of their fellows. Exercises can be added by supervisor so they became instantly available for learners.
6.1 PRELIMINARY HMM OUTLINE

When using HMMs one has to design a model by choosing appropriate states and observations symbols. Then, set up state transitions probabilities and symbol observations probabilities. The next step is to train the HMM, the Baum-Welch algorithm is used (Rabiner, 1989). Training the HMM consist of finding the best set of state transition and emission probabilities explaining a given set of output sequence (observations). At this stage we obtain a useful tool for discovering hidden states from observations, ie. discovering learner's motivation levels from calculated indicators. The most likely explanation task, solved by the Viterbi algorithm, is used by feeding a sequence of observations to the HMM and get a sequence of hidden states (Rabiner, 1989).

Our first experimental HMM was composed of three states describing motivational states: Weak, Medium, and Strongly motivated. We choose as observation symbols a set of indicators calculated from learner interactions within the learning environment (the used modality). As examples of those indicators we can cite: time on page, number of actions in period of time, page return number, etc. indicators are not directly available as observable symbols, they have to be calculated from low level data.

We started with a heuristically posed set of probabilities for symbol observations and inter-states transitions, and then we adjusted the two sets of probabilities heuristically to get plausible motivational levels from observations. After that, we trained our model with simulated activities over each modality.

Despite the fact that our obtained HMM are presenting acceptable outputs (automatic evaluations of learner’s motivational levels) with simulated learners, we are aware that it should be refined using experimentation’s data.

7. THE PILOT STUDY

A pilot study was conducted within a master degree work in order to, essentially:

- Refine the design of the research protocol and assessing its feasibility.
- Debug the programs and enhance the interface of each modality.
- Get preliminary data to run appropriate statistical analysis methods.

In the pilot study we opted for a crossover design with a group of sixteen (n=16) student. Students where all from the computer science department of 08 Mai 45 Guelma University, Algeria. The research question for this work was about which modality is more motivating for learners. Participants where volunteers contacted personally by their fellow student (concerned with the master work). They responded to the IMMS questionnaire after each modality. The only statistical analysis done were descriptive ones, they were used for comparing mean scores for each question in the questionnaire.
8. Discussion and Conclusion

In this paper we presented a description of our current research topic. We designed an experimental interactive learning environment composed of three learning modalities: hypermedia course modality, annotated video modality, and the problem solving graphical tool. The ultimate goal of this setting is to explore research questions related to learner motivation levels. We adopted the Keller’s ARCS model theory of motivation and decided to use the IMMS questionnaire instrument to measure learner motivation in the different settings.

Also, another important part of our work consists of applying HMMs, from artificial intelligence techniques, to automatically assess learner’s levels of motivation. The main tasks concerned the design of the model by finding states and observation set, training, and tuning the HMM. The obtained model can be considered as a good first approximation, but we are aware that more refining is needed for a robust instrument.

The next step for our works is to run quasi-experimental studies to address motivation research questions for different learning settings.


Keller John M. (2008), *First principles of motivation to learn and e3-learning*, “Distance Education”, V. 29, n. 2, pp. 175-185 doi:10.1080/01587910802154970


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