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Exploring the relation between learning style models and preferred multimedia types

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A B S T R A C T

There are many adaptive learning systems that adapt learning materials to student properties, preferences, and activities. This study is focused on designing such a learning system by relating combinations of different learning styles to preferred types of multimedia materials. We explore a decision model aimed at proposing learning material of an appropriate multimedia type. This study includes 272 student participants. The resulting decision model shows that students prefer well-structured learning texts with color discrimination, and that the hemispheric learning style model is the most important criterion in deciding student preferences for different multimedia learning materials. To provide a more accurate and reliable model for recommending different multimedia types more learning style models must be combined. Kolb's classification and the VAK classification allow us to learn if students prefer an active role in the learning process, and what multimedia type they prefer.

1. Introduction

Computer-based multimedia learning environments support the idea that people learn better and more deeply when appropriate pictures (i.e., animations, video, static graphics) are added to text or narration (Mayer, 2001; Mayer & Moreno, 2002). Nowadays, there are numerous on-line adaptive learning systems that adapt courses (as sets of learning objects with multimedia materials) to student's needs (Cassidy, 2004; Coffield, Moseley, Hall, & Ecclestone, 2004).

One of the goals of an adaptive learning environment is to provide a virtual teacher for each student, because the learning "one teacher for one student" is the most effective (Woolf, 2009). This statement is based on the constructivist learning theory that supports the idea that knowledge is constructed by the student individually through his interactions with the learning environment (Rovai, 2004). Constructivist learning theory is based on the fact that students construct knowledge in their own way; it means that teachers cannot "transfer" their knowledge to students (Jonassen, 1991). It means that there is not a predefined learning path through selected learning materials as students can select learning resources by themselves, according to their preferences. If students pay too much attention to selecting the appropriate presentation of learning topics, too much attention can cause a student cognitive overload, which occurs when the total intended processing exceeds a student's available cognitive capacity (Mayer & Moreno, 2003). At the same time, inappropriate multimedia material can cause students a negative emotion (stress), which may result in an unchanged learning performance (Chen & Sun, 2012). To avoid cognitive overload and stress, the system may recommend appropriate learning materials and can guide students through the learning process, taking into account a student's preferences. Therefore, the system has to be familiar with the student's characteristics (Vogel-Walcutt, Gebrim, Bowers, Carper, & Nicholson, 2011).

A learning environment that takes over some of the teacher's tasks in "on-line learning" has to monitor student behavior in the process of learning in order to get information about his prior knowledge and learning style. The learning system can then, using gathered information, build student's model which is then used to support recommendations and adaptations of learning content for each individual student (Woolf, 2009).

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Some psychologists and neuroscientists have questioned if matching between learning styles and instructional methods has any effect on their learning (Stahl, 1999). Massa and Mayer (2006) claim that there was not strong support for the hypothesis that different types of learners (e.g. verbal and visual learners) should be given different kinds of multimedia instruction to improve learning.

In a constructivist learning environment, Mayer (2004) recommends involving methods of instruction that involve cognitive activity rather than behavioral activity, instructional guidance rather than pure discovery, and curricular focus rather than unstructured exploration. Mayer indicated that meaningful learning occurs when the learner strives to make sense of the presented material by selecting relevant incoming information. Plass, Kalyuga, and Leutner (2010) argue that individual differences in students could affect cognitive load if they influenced working memory, which is limited in capacity and duration (Spanjers, van Gog, Wouters, & van Merriënboer, 2012). Mayer and Moreno (2003) argue that reducing cognitive overload can involve redistributing essential processing, reducing incidental processing, or reducing representational holding. According to using adaptive learning environments in learning, we have already stated that if a student pays too much attention to the selection of appropriate multimedia material, it can lead to cognitive overload. For this reason, we design an adaptive learning environment with recommender systems in order to help students select suitable presentations of the learning topic, and thus reducing cognitive overload.

Regarding other researchers, adaptation of learning environments could be supported by a learning styles model, which is chosen as the most suitable for the selected learning topic (Akbulut & Cardak, 2012; Dağ & Geçer, 2009; Klašnja-Milićević, Vesin, Ivanović, & Budimac, 2011). In other words, the authors selected only one learning style model and then built a system using that model. In the previously cited papers it is not evident if the authors did any research in order to select the appropriate learning style model. The aim of this study is to discover if combining more learning style models helps to improve recommending appropriate multimedia materials. The results of this study will help us to design an adaptive learning environment based on the constructivist learning theory.

However, we suppose that some behavioral activities, e.g. selection of different types of multimedia, are determined by personal characteristics. Recommending a suitable choice of a multimedia type could result in increased learning, while assigning a multimedia type could lead to a higher cognitive load, resulting in reduced learning for low-ability learners (Plass, Chun, Mayer, & Leutner, 1998; Plass & Homer, 2002).

The question is how an adaptive learning system should select different multimedia types in order to adapt learning objects regardless of the learning topic.

This paper focuses on the design of a module for adapting learning objects to student needs which are based on the integration of more learning style models to be able to better describe student's preferences. Thus, we have the synergy of combining more learning style models that influence on the selection of multimedia types for the presentation of learning objects in the framework of an online learning environment.

There are many kinds of learning style models (e.g. Felder & Silverman, 1988, Honey & Mumford, 1982, Kolb, 1985, and Myers-Briggs, 1962), which provide very similar information about students, information processing, and information perception. Having consulted with psychologists, we chose four different learning style models in order to get four complementary views of students' learning preferences and characteristics (cognitive style, epistemic style, hemispheric style, and perceiving style). The second aim of our study is also to investigate possible dependencies between the used learning style models. By observing correlations and redundancies within their dimensions, we hope to reveal potential interactions between these models, which is a yet uninvestigated direction of research.

For our work, we selected Kolb's, Rancourt's, the hemispheric, and VAK learning style models, because the models identify a student's approach in problem solving situations, his cognitive mode, his way of thinking, and his dominant mode of perceiving information. Kolb's and VAK learning style models, which provide an overview about processing and perceiving new information in the learning process, are frequently used in the field of adaptive learning environment (Akbulut & Cardak, 2012). On the contrary, Rancourt's and hemispheric learning style models are less known. Rancourt's model is based on the differential utilization of the three modes of acquiring new knowledge: via senses (empirical mode); via thinking (rational mode); or via intuition (noetic mode) (Abdennur, 2009). On the hand, the hemispheric model reflects an application of hemispherical functioning of the brain into the process of learning. Consequently, a student with a left-hemispheric learning style prefers analyzing things, while the right-hemispheric student prefers experimenting and creative thinking (Reynolds, Kaltsounis, & Torrance, 1979). All four learning style models are briefly described in Section 4.

2. Motivation

There are very few recommender systems that are used in education (e.g. AnnForum (Chen & Persen, 2012) and Protus (Vesin, Ivanović, Klašnja-Milićević, & Budimac, 2013)). They recommend learning topics to the students in order to guide them toward the learning objects they should visit next. The systems were built according to the learning topic. Our goal is to design and develop an adaptive constructivist learning environment that can recommend learning objects for a computer science course in a secondary school (students aged 15–19 years). The system will be implemented as a web-application.

Due to the complexity of our system we have decided on a modular design. Fig. 1 shows the architecture of our adaptive learning system. The main system's components are:

- a module for registration of students that identifies their learning styles from the data collected by questionnaires,
- a module for recommending learning objects that are important students to achieve learning outcomes,
- a module for adapting learning objects according to learning styles, which are identified in the student's profile,
- a module for supporting the constructivist learning approach by recommending suitable learning activities.

In the initial phases of our development we focus on the selection of a suitable presentation mode of the selected learning objects. If we want to adapt the recommended learning objects to a particular student and provide efficient learning, the system should choose suitable multimedia types and learning activities independently of the learning topic. It means that the system needs information about the student's learning styles in a set of learning style models that can efficiently represent the student's profile.