



# The relationship between learning styles and cognitive traits – Getting additional information for improving student modelling

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## Abstract

Student modelling is an important process for adaptive virtual learning environments. Student models include a range of information about the learners such as their domain competence, learning style or cognitive traits. To be able to adapt to the learners' needs in an appropriate way, a reliable student model is necessary, but getting enough information about a learner is quite challenging. Therefore, mechanisms are needed to support the detection process of the required information. In this paper, we investigate the relationship between learning styles, in particular, those pertaining to the Felder–Silverman learning style model and working memory capacity, one of the cognitive traits included in the cognitive trait model. The identified relationship is derived from links between learning styles, cognitive styles, and working memory capacity which are based on studies from the literature. As a result, we demonstrate that learners with high working memory capacity tend to prefer a reflective, intuitive, and sequential learning style whereas learners with low working memory capacity tend to prefer an active, sensing, visual, and global learning style. This interaction can be used to improve the student model. Systems which are able to detect either only cognitive traits or only learning styles retrieve additional information through the identified relationship. Otherwise, for systems that already incorporate learning styles and cognitive traits, the interaction can be used to improve the detection process of both by including the additional information of a learning style into the detection process of cognitive traits and vice versa. This leads to a more reliable student model.

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## 1. Introduction

Student models (for example, see Brusilovsky, 1994) are essential to any adaptive virtual learning environments. These models contain information about learners such as personal data, domain competence, learning style and cognitive traits, and use this information to adapt to the learners' needs. An important task for such adaptive environments is to build a robust student model in order to be able to provide adaptivity in an appropriate way, but filling the student model with proper information about the learner is quite challenging.

The simplest approach to construct a student model is to ask a student for relevant data. However, this approach is not suitable for identifying accurate information for a number of components of a student model, such as cognitive traits, domain competence, and preferred learning styles. For example, the estimation of domain competence is subjective. To determine cognitive traits and learning styles, comprehensive tests or questionnaire-based surveys are the ordinary means used but these are time consuming and hardly definitive. An alternative approach to collect the information pertinent to a student model is to track the student's behaviour and responses and then make inferences about general domain competence, cognitive traits, and learning styles. The challenge of this approach is to identify and collect sufficient information to make reliable and useful inferences. To support the detection process of required information, it is beneficial to find mechanisms that use whatever information about the learner is already available to obtain as much reliable information as possible to build a more robust student model.

The aim of this paper is to demonstrate the relationship between the learning style and the cognitive traits of a learner. The identified relationship provides additional information which can be used to improve the detection process of both, the learning style and the cognitive traits, in an adaptive virtual learning environment.

To exemplify this relationship, we investigate the interaction of working memory capacity, one cognitive trait included in the cognitive trait model (Lin et al., 2003), with Felder–Silverman learning style model (Felder & Silverman, 1988). Both models as well as their possible implementation in adaptive virtual learning environments are described in the following section in more detail. In Section 3, we present the mapping between the Felder–Silverman learning style model and working memory capacity. This mapping is derived from links between learning styles, cognitive styles, and working memory capacity which are based on studies from the literature. Section 4 points out the results as well as the benefits of the identified relationship. Section 5 then concludes the paper.

## 2. Description of the learning style model and the cognitive trait model

In this section, two models – the Felder–Silverman learning style model (FSLSM) and the cognitive trait model (CTM) – are explained to provide background information for the current investigation. While several learning style theories exist in the literature, for

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