Detecting Learning Style through Biometric Technology for Mobile GBL

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ABSTRACT

Adaptive learning systems tailor content delivery to meet specific needs of the individual for improved learning-outcomes. Learning-styles and personalities are usually determined through the completion of questionnaires. There are a number of models available for this purpose including the Myer-Briggs Model (MBTI), the Big Five Model, and the Felder Silverman Learning-Style Model (FSLSM). Most models classify the student on a number of scales. Recently, a number of studies have investigated the possibility of determining an individual's learning-style directly through their interaction patterns when using a system. Automatic learning-style detection could play a significant role in the advancement of educational gaming through personalized learning environments. Biometric devices, such as accelerometers and eye-trackers, are now available for use with mobile devices. These provide an opportunity to move toward adaptive mobile gaming environments, giving potential to track learning-styles directly through avatar movement. This paper examines mobile learning (mLearning) with an emphasis on mobile game-based environments. Adaptive learning systems are introduced. The results of studies conducted to assess the potential of biometric devices as a means of automatically detecting students' learning-styles are discussed. The potential of this research for mobile game-based learning is outlined.

Keywords: Accelerometers, Adaptive Systems, Biometrics, eLearning, Eye-Tracking, Game Based Learning, Learning Style, mLearning, Mobile

INTRODUCTION

Individual learning-styles facilitate the provision of adaptive learning content to meet specific learner needs and allow for improved learning-outcomes. The main purpose of adaptive learning systems is the adjustment of the learning process to learners based on their fit within the scales of a learner model. These systems have, to date, relied on the use of questionnaires. This has proven to be a valuable means of data gathering for the development of such systems. However, this method of assessment can be time consuming, and intrusive for learners.

In recent years, there has been an increased research focused on automatic adaptation, based on a user’s behavior patterns when interacting with a system. Work conducted by
Spada et al. (2008) assessed the potential for using a student’s mouse movement patterns as a means of gathering user-data for the detection of learning-styles on the FSLSM (Felder Silverman Learning Style Model). Spada et al. (2008) were able to predict, with a high level of accuracy, a user’s learning-style on the Global / Sequential dimension of the model. Global learners generally acquire data in large leaps as opposed to Sequential learners who tend to learn in small steps. They achieved a correlation coefficient of $r=-0.8$ between the user’s score on the FSILS (Felder Solomon Index of Learning Style) and their vertical speed when interacting with the system.

As we move toward the development of intelligent adaptive systems for use in mobile learning environments, an alternative to the mouse is required.

Biometric technologies such as accelerometers and eye-trackers can potentially provide this alternative. The term biometrics is derived from the Greek words ‘bios’ and ‘metric’ which directly translate as life measurement. Biometrics can be broken into two main categories, physical biometrics and behavioral biometrics. The main focus of this research is behavioral biometrics, which has mainly been used to date for verification purposes. Biometrics in this regard are generally concerned with measuring the characteristics an individual acquires naturally over a time, and are usually based on the measurement of patterns (e.g., typing rhythm or gait).

**LEARNING-STATES**

Learning-styles have become a consideration in the development of adaptive learning systems. Learning-style has been defined as “the generalized differences in learning orientation based on the degree to which people emphasize the four modes of the learning process” (Kolb, 1999, p. 41), “the ways in which individuals begin to concentrate on, process, internalize, and retain new and difficult information” (Dunn & Griggs, 2003, pp. 81-86), and the characteristic strengths and preferences in the ways individuals take in and process information (Felder & Silverman, 1988).

Learning-styles reflect students’ preferences for acquiring retrieving and retaining information for learning purposes. A number of models are available for this purpose including the Myer-Briggs Model (Pittenger, 1993), The Big Five Model (Busato et al., 1999), the Dunn and Dunn Model (Dunn & Griggs, 2003), Kolb’s Model (Kolb, 1999) and the Felder Silverman Model (Felder & Silverman, 1988).

It should be noted that the popularity of learning-styles in recent years has led to the questioning by many researchers of their existence, validity, reliability and benefits. Reviews have been published by both Coffield et al. (2004) and Pashler et al. (2009). Coffield et al. (2004) do not dismiss learning-styles overall and acknowledge the benefits of learning-styles including “self-awareness and metacognition” (Coffield et al., 2004, p. 132), “a lexicon of learning for dialogue” (Coffield et al., 2004, p. 78), “a catalyst for the individual, organizational or even systematic change” (Coffield et al., 2004, p. 134). The research conducted by Pashler et al. (2009) is based on “the claim that presentation should mesh with the learner’s own proclivities” (Pashler et al., 2009, p. 108). Pashler et al. (2009) note that learning-style questionnaires give repeatable results and that the instruments are measuring ‘something’ rather than producing random figures.

Coffield et al.’s (2004) review directs most of the criticism at the limitations of traditional face-to-face instruction, due to the routine need for teachers to change their teaching style to meet the needs of different learning-styles within the classroom setting. eLearning systems have the potential to alleviate this burden through the “built in potential of offering individualized learning paths to students with little overhead for the teacher” (Popescue, 2008, p. 129).

While the relevance of learning-styles has been questioned, research does not dismiss the concept overall but indicates that its effectiveness can be limited in specific situations and set-
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