UNIVERSITY OF BIRMINGHAM

University of Birmingham
Research at Birmingham

An Empirical Evaluation of Learning Style and Knowledge Level Adaptation

Alshammari, Mohammad; Anane, Rachid; Hendley, Robert J

Document Version
Peer reviewed version

[Link to publication on Research at Birmingham portal](#)

An Empirical Evaluation of Learning Style and Knowledge Level Adaptation

Mohammad Alshammari[1], Rachid Anane[2], Robert J. hendley[1]

[1]School of Computer Science, University of Birmingham, UK
{m.t.m.alshammari,r.j.hendley}@cs.bham.ac.uk
[2]Faculty of Engineering and Computing, Coventry University, UK
r.anane@coventry.ac.uk

Abstract. This paper presents an initial evaluation of different forms of adaptation based on learning style and knowledge level, which were implemented in an adaptive e-learning system. An experiment conducted in a learning context with 174 participants produced significant results in terms of learning gain. They indicate that adaptation based on both learning style and knowledge level yields significantly better learning gain than adaptation based on learning style only, and better than adaptation based on knowledge level only.

Keywords. Adaptivity · Learning style · Learner knowledge · Evaluation

One of the key characteristics of adaptive e-learning systems (AESs) is the provision of personalized services and the recommendation of learning material in the learning process. Although most AESs are based on learning style (LS) or on knowledge level (K) adaptation, the implementation of the adaptive process based on their combination presents a significant challenge. The lack of empirical research on LS and K adaptation is also a key issue in the deployment of AESs [1].

This paper is part of a broader investigation into adaptation based on LS and K in e-learning systems, and their empirical evaluation. An AES called AdaptLearn was designed and implemented to provide adaptation based on LS only, K only or on their combination [2, 3]. Adaptation is achieved through the manipulation of links to learning material on Computer Security, the application domain of the system. This involves the inclusion and generation of links to relevant material in a customized order, and the hiding or removal of links deemed unsuitable for the current level of the learner. It also provides adaptive guidance and offers recommendations and feedback to learners as they progress through their learning tasks.

An experimental evaluation of the impact of adaptation was carried out in terms of learning gain. This involved 174 participants in an academic learning environment. A pre-test and a post-test were used to measure the learning gain; each test contains 22 multiple-choice questions with five options. Learning gain was computed as follows:

Learning Gain = the score of the post-test – the score of the pre-test

Three independent variables/groups were established in the experiment. Group 1 involved the participants who interacted with a version of AdaptLearn which provides adaptation based on LS only. Group 2 involved the participants who interacted with a version which provides adaptation based on K only. Group 3 involved the participants who interacted with a version which provides adaptation based on the combination of LS and K. The experiment involved a number of stages: 1) access to AdaptLearn through an Internet browser and completion of the demographic data form and of the Index of Learning Style questionnaire [4]; 2) random assignment by the system of each participant to one of the experimental groups; 3) completion of a pre-test by each participant; 4) personalized study by the groups of the learning material on Computer Security; 5) completion of a post-test by each participant.

Table 1 presents the results of the learning gain variable for the experimental groups; they indicate that Group 3 had the highest mean value followed by Group 2 and then Group 1. According to the results, adaptation based on both LS and K in AdaptLearn yields significantly better learning gain than adaptation based on K only and better than LS only.

Table 1. One-way ANOVA results of learning gain relating to the experimental groups.

	N	Mean	SD	F(2,171)	Sig.
Group 1	58	53.50	18.92		
Group 2	58	64.74	18.94	22.89	< 0.0005
Group 3	58	75.48	14.18		

This experiment contributes to current research on adaptation by providing more evidence on learning gain when both the LS and K characteristics are integrated into an AES. Future research will involve a long-term evaluation with more participants and a larger set of learning resources. Different variables such as learner satisfaction, motivation, emotion and perceived usability of the system can be taken into account in future experiments.

References

1. Akbulut, Y., Cardak, C.S.: Adaptive educational hypermedia accommodating learning styles: A content analysis of publications from 2000 to 2011. Computers & Education. 58, 835–842 (2012).
2. Alshammari, M., Anane, R., Hendley, R.: Design and Usability Evaluation of Adaptive e-learning Systems Based on Learner Knowledge and Learning Style. In: Human-Computer Interaction--INTERACT 2015. pp. 584–591. Springer (2015).
3. Alshammari, M., Anane, R., Hendley, R.: An E-Learning Investigation into Learning Style Adaptivity. In: The 48th Hawaii International Conference on System Sciences (HICSS-48). pp. 11–20 (2015).
4. Felder, R.M., Spurlin, J.: Applications, reliability and validity of the index of learning styles. International Journal of Engineering Education. 21, 103–112 (2005).