Designing personalisation in LAMS

MuesserCemal Nat
School of Computing & Mathematical Sciences
University of Greenwich

Dr. Simon Walker
School of Education and Training
University of Greenwich

Dr. Liz Bacon
School of Computing & Mathematical Sciences
University of Greenwich

Prof. Mohammad Dastbaz
School of Computing & Technology
University of East London

Recent advances in technology have facilitated the use of e-learning in education and made personalisation possible in various ways. These developments have been supported by the widespread availability of learning management systems (LMS). In educational establishments an LMS is often only used to support the enhancement of classroom or lecture-based teaching, however it is increasingly being used to provide e-learning only courses (Kim, Jung, Lim, Kim, Noh, 2009).Most learning management systems place considerable emphasis on delivering and managing learning content but generally add little or no value to the learning process and its personalisation(Junqi, Zhengbing, Zongkai, Yumei, 2009).

In this paper, the authors will describe how personalisation is supported through a process of profiling individual learning styles using the Felder-Silverman framework and implemented through the Learning Activity Management System (LAMS).Whilst results are still to be analysed, the authors discuss the design of the subsequent learning system which will generate data and enable a comparison of students who followed a pathway based on the free-choice of learning materials with students who followed a pathway that incorporating structured 'personalised' learning materials based on the learners' predetermined learning style.

Keywords: Personalised e-learning, student profiling, LAMS, learning pathway, Felder and Silverman Learning Style Model.

Introduction

In the last decade information and communication technologies (ICT) and multimedia tools have reshaped learning and teaching methods. E-learning is one of the most promising outputs of these advanced technologies. The concept of e-learning has numerous definitions and interpretations. In this paper we adopt a definition of e-learning asthe use of internet technologies to provide and enhance students' learning anytime and anywhere. It promises to be a very efficient and effective educational method that has drawn growing attention from researchers (Wei & Yan, 2009). Ready made course or learning management system packages have been integrated into institutional provision to support classroom teaching and are used by tens of thousands of instructors and students at thousands of universities and colleges (Downes, 2005).

In January 2007, the British Government commissioned an expert working group to look at future learning spaces(2020 Vision, 2007).The "2020 Vision" report proposes an educational ambition for personalised learning and discuss such issues as teaching strategies to support personalised learning, how to utilise new technology to

realize personalised learning, and how to use the curriculum flexibly to increase personalised learning opportunities. The new labour government envisaged the personalisation agenda as a key to reforming and transforming public services, although in recent years, it lost its political appeal (Baker, 2008).However, the ability of ICT and the semantic web to capture, store and use individual data to enhance learning is still viewed as one way to better meet the needs of more people and itis now theoretically possible to deliver personalised learning based on individual students' needs and preferences. Different levels of personalisation in learning materials, and a personalized pathway through the materials can be developed with the aid ofexisting learning style models or monitoring students' behaviors in e-learning systems. Personalisation can also be achieved in interface design; modeling and identifying students who share the same or similar preferences supports collaboration with each other (Cemal Nat, Bacon & Dastbaz, 2009). Developing e-learning systems and improving the technologies and learning tools are the main focus of many researchers in e-learning today (Wei & Yan, 2009; Limongelli, Sampietro, Temperini, 2007).

From a pedagogical perspective, providing extended access to learning resources is an important issue. For example, Liu and Chen (2008)have developed a personalised e-learning system that can automatically select the learning contents and methods that are suitable for students' learning styles. The system also classifies students according to their learning styles to find common features and create a model that recognises new students and the classes they belong to. However, no consideration to generating a customized flow through the learning materials was attempted and only suggestions made for learning activities based on students' learning style preferences.

With the increasing trend towards e-learning, electronic activity management systems and 'learning pathway' concepts a new support structure for designing e-learning systems is required (Cao, Zhao & Wang, 2009).In this paper the authors will describe how the Learning Activity Management System (LAMS) has been used to support personalization by profiling students based on their learning styles.

The Felder & Silverman Learning Style Model (FSLSM) (1988) was selected as the preferred model to profile students and create personalised learning environment. It was formulated by Richard Felder and Linda Silverman (1988), and an instrument to test the model was developed by Richard Felder and Barbara Soloman in 1997.

The experiment was split into two parts. The first part provided structured 'personalised' learning based on predetermined learning styles using the FSLSM questionnaire. The second part allowed students to freely choose from the range of learning materials and activities. The experiment attempted to provide insights into a number of questions such as, (1) can personalised e-learning systems produce more effective learning outputs than non-personalised systems, (2) can methods like FSLSM help determine whether learning styles match what students do in actual practice and (3) are there better learning styles models more suited to the 21st digital age that can measure or help students' learning.

Both systems aim to provide complete and classroom independent e-learning environments. For the experiment, a group of university students studying 'Multimedia Games Design and Development' were randomly divided into two groups and invited to use one of two e-learning systems. System A provides a learning package based on their pre-determined learning styles. System B allows students to freely access any learning material and activity on the system. Both systems include exactly the same instructions, learning materials and activities, and both test the student's learning style using the Felder and Solomon questionnaire.

Use of LAMS

The Learning Activity Management System (LAMS) is an innovative type of LMS for designing, managing and delivering individual or collaborative learning activities. It can provide opportunities forconstructivist and social-constructivist learning by encouraging students to learn together and individually reflect with peers and tutors using collaborative tools such as mind mapping, asynchronous and synchronous discussion, quizzes, etc. LAMS can be used as a stand-alone e-learning system or in combination with other learning management systems such as, Moodle, Blackboard and Sakai.

A user-friendly highly visual authoring environment is one of the most important facilities of this software that allows instructional designers to establish learning pathways. Instructional designers drag and drop content or activity-related elements and join them together. A learning pathway can include a combination of activity related tools that may include, for example a self-assessment test, a mixture of collaborative learning tools such as mind mapping or chat and discussion forum, and wikis. In addition to existing activities, LAMS also allow plug-ins to be integrated to enable different services including Skype. LAMS has the potential to support personalisation at a technical level (the ability to change font size and color), and at the student level

(considering their experience and special needs), based on their learning style preference (Russell, Varga-Atkins & Roberts, 2005).

At the beginning of the personalised e-learning system used for this experiment, the FSLSM questionnaire (1997) is provided for students to identify their learning style. Two systems were developed, system (A) & (B). The resulting individual profile using system (A) is used to decide on the type of learning activity presented. The use of media is pivotal. For example, one LAMS pathway may include video-only content, whereas another might provide only text-based contents. In system A, students are not distracted by materials presented in a range of media formats – their only focus is on the materials that the system determines are most suitable for them. Multimedia resources are widely used to support students' learning. Using advanced technologies, instructors can prepare learning content in different formats including video, audio, image and text. Multimedia contents allow students to read, listen, watch, and study learning materials at a pace and time that suits their schedule and preferred mode of learning.Using well-designed multimedia, students can construct a more accurate and effective mental representation of information than they do from text alone. Humans have strong visual and auditory information processing capabilities and multimedia takes advantage of both capabilities at once (Mayer, 2003).Both systems (A) & (B) provide the facility to integrate different kind of media into learning sequences as well as providing the facility to include hyperlinks to open up external resources.

It could be argued that successful learning depends on students' engagement and motivation, which can be achieved by the use of various strategies and techniques. The pedagogic planner, Phoebe (2008) uses Benjamin Bloom's taxonomy to identify a range of tools that may be exploited for meeting desired cognitive learning outcomes. Pedagogical techniques that focus on providing activities for students to perform either in groups or as individuals can help them to create deeper and more effective learning. These include discussion or mind-mapping tools to help students to achieve levels of understanding throughout the cognitive process. They can use these tools to construct meanings by engaging in summarizing, classifying and describing activities. Furthermore, according to the Felder and Silverman's (1988) learning style model some students can learn better and retain the information longer by discussing or explaining it to others. LAMS provides the facility to integrate such tools into a learning pathway. The incorporation of collaborative and individual tools can be easily made through the authoring interface.

The supervision of students' learning activities and behaviors assist instructors to improve the learning quality and environment - tracking and recording students' activities is useful for feedback and adjustment, and revision of the curriculum (Yang, Yang, & Yan, 2009). Moreover, technologies used in LMS systems include user-tracking which makes it possible to figure out the goal of the user (Brusilovski 1996).A study on automatic student modeling for detecting learning style preferences demonstrated that the activities of the students in an e-learning environment can be utilized to obtain information about their learning styles (Graf, Viola &Kinshuk, 2007). In LAMS the facility to monitor learning activities and student's learning progress is an important LAMS records all student activity on the system and can allow instructors to see students' real-time progress, how they have responded in any particular activity, and whether they are interacting with other students.

"Applying" is one of the levels of students' cognitive process as defined in Bloom's Taxonomy(Forehand, 2005), which is based on a student's knowledge, and development of intellectual skills. It is about using or applying a concept in a given situation through its execution or implementation. It is important that students have experience applying whatever they learn to new problems and situations. For example, in a programming course, students need to write codes, execute them and see the results. When students *apply* the exercises provided, they can be given the chance to upload and submit their work for checking by a tutor within the LAMS system. Evaluations of LAMS in university environments in China indicated that LAMS has a profound impact on learners learning. Results showed 90% of learners are willing to discuss their ideas and complete their homework within LAMS (Jungi et. al, 2009).

In LAMS sequences can be saved and shared with other users on the same server, or exported to another server.

Profiling students using a learning style questionnaire

Learning requirements and preferences of each learner tend to be different (Liu, Gomez, Khan and Yen, 2007; Uden and Damiani, 2007). Some students may learn best by watching and listening, other by reading, and others by doing (Zapalska and Brozik, 2006; Cantoni, Cellario and Porta, 2004). Moreover, results from studies by Graf and Kinsuk (2007) demonstrated that matching learning materials and activities with students' learning style can make learning easier for them and improve the efficacy of learning. In our experiment, System A automatically selects and presents the learning contents and methods suitable for a student based on a profile of their learning styles. The FSLSM Model was designed to determine the most significant learning styles of

engineering students and assist instructors in realigning their teaching strategies in order to meet their students' learning needs(Felder and Silverman, 1988). It categorises students according to their preferred way ofprocessing, perceiving, getting and understanding of information. In parallel, it classifies instructional methods to address proposed learning stylesand distinguishes preferences in four dimensions, which are described below.

In the **Active** vs. **Reflective** dimension, learners are categorized according to their way of processing information. Active learners tend to retain and understand information best by doing something and prefer to discuss, work in groups, applying or explain things to others. Reflective learners prefer to think about concepts quietly first and to reflect on the material presented. They like to work alone. Also, when they stop periodically to review and think what they have read, and write short summaries of their reading, they retain the material more effectively.

The **Sensing** vs. **Intuitive** dimension distinguishes learners according to their perceptions of the learning materials. Sensing learners prefer to learn facts and study concrete learning materials. They often like solving problems with standard approaches and dislike complications. At the sensors end of the spectrum, students tend to be more practical and like doing hands-on work. They remember and understand information best if they see how it connects to the real world. Intuitive learners like discovering possibilities and relationships. Intuitors tend to be more innovative than sensors. They are more comfortable with abstractions.

The **Visual** vs. **Verbal** dimension categorizes learners according to the way that they prefer to get the information. Visual learners remember best what they see, such as pictures, diagrams and movies. They may use techniques such as highlighting to colour-code their notes to remember better. Verbal learners learn better from written and spoken explanations.

In the **Sequential** vs. **Global** dimension learners are characterized according to their understanding of information. Learners in this category prefer to learn in a linear way i.e. each step of learning follows logically from the previous one. In order to find solutions they tend to follow logical stepwise learning paths. In contrast to sequential learners, global learners tend to learn in large jumps, absorbing learning materials randomly and getting information suddenly. They can put things together once they see the bigger picture. They find connections between different areas and are interested in overviews, whereas sequential learners are more interested in the details.

Table 1:Felder and Silverman Learning Style Model

Felder andSilverman Learning Style Model		
Dimension	***Learning Style Preference***	***Definition***
Processing	**ACTIVE**	Doing something active with it: Discussing, applying or explaining it to others.
	REFLECTIVE	Prefer to think about it quietly first.
Perception	**SENSING**	Like learning facts.
	INTUITIVE	Prefer discovering possibilities and relationships
Input	**VISUAL**	Remember best what they see, pictures, diagrams, flow charts.
	VERBAL	Get more out of words: Written and spoken explanations.
Understanding	**SEQUENTIAL**	Gain understanding in linear steps, with each step following logically from the previous one.
	GLOBAL	Learn in large jumps, absorbing material almost randomly without seeing connections.

Reflection of learning styles

Felder and Silverman (1988) have also suggested mapping between teaching styles and students' learning styles. As e-learning didn't exist in 1988, learning style preferences and their corresponding teaching styles in classroom and e-learning have been reconstructed by the authors and are summarized in Table 2.

In our personalised e-learning system all dimensions of the learning style model were considered by adding the following features:

- Different types of learning support tools included for the provision of pedagogical support and encouraging students' information *processing.*
- Imaginative and practicaltypes of examples have been used for each part of the subject being studied in order to facilitate students' *perception* on learning materials.
- Video, audio, picture-based and text-based content presentations of each topic were provided to facilitate the students' way of *getting the information*.
- In order to encourage *understanding* of the subject, a sequential or free selection learning path was developed.

Table 2: Reflections of the FSLSM in classroom and on the system

Learning Style Preference		*Corresponding Teaching Style*		*Corresponding E-learning System Features*
Active	**Processing**	Active	**Student Participation**	**Learning Support Tools**
Reflective		Passive		
Sensing	**Perception**	Concrete	**Content**	**Subject Examples**
Intuitive		Abstract		
Visual	**Input**	Visual	**Presentation**	**Content Presentation**
Verbal		Verbal		
Sequential	**Understanding**	Sequential	**Perspective**	**Learning pathway**
Global		Global		

Design of the study

This study is based on the analysis of data resulting from two differently designed e-learning systems. In both systems computer science students study the subject of "how to import music and sound in flash files, and publishing a flash game". The difference is that one group will work in a personalised e-learning environment and the other group, in a non-personalised e-learning environment.

Students are provided with precisely the same learning materials related to the subject. The topic is divided into six sections, each section containing two different types of examples (practical and imaginative). Each section of the lesson could be delivered in one of four formats: video, audio, picture and text formats. In addition, students' are provided with code samples to download and run, as well as, supplementary exercises. Self-assessment tests are included in the learning pathways for each of the six sections of the subject. Both systems contain the same collaborative and individual tools. Just before finishing the learning session students are asked to complete an assessment test about the subject. They are also provided with e-mail support regarding the learning materials and technical problems as needed.

Design of the systems

Two different e-learning systems were developed using a Moodle and LAMS integration to answer our experiment questions. LAMS activity designs were embedded within Moodle courses and the studentswere divided into two groups on the Moodle course.

In system A, students were required to answer a learning-style questionnaire to identify their learning styles before they could start their learning session. They had to answer all the questions and complete the four main sections in the questionnaire representing the four learning style preferences outlined above. Questions were presented in four stages so that the students were not presented with too many questions in one go to facilitate their participation. The system then filters the learning resources for each student according to the results of the questionnaire in order to immediately present a personalised set of learning material. Before starting the learning

session, students are provided with the goals of the session to introduce and make them aware of what they will work through.

Each section of the questionnaire represents different dimensions of the FSLSM. In our system, the first dimension, which identifies active and reflective students, determines what kind of learning activities should be presented to the student. An example of this is as follows: if the student is an active type, then the system suggests students to use chat and discussion forum tools that allow them to collaborate and discuss learning materials with their friends. Moreover, students in this category can choose to use multi-user mind mapping tools to support their information processing. There are also additional exercises and code samples for students to download and try things out. The system will suggest that students in the reflective category take some time for thinking and note-taking tool to write summaries or generate a single user mind map tool to work alone or for reflecting on the information presented. Also, self-assessment tests are provided to give them an opportunity reflect on the material and check their acquired knowledge.

The second dimension categorizes students as sensing or intuitive and is used by the system for making decisions about presenting practical or imaginative examples of each topic. Practical-type examples displayed to students in the sensing category help them to find connections with the real world and learn the facts.Since, they tend to learn from examples rather than listening or reading course content, the number of examples available to assist the learners is increased for these students. These types of learners also, tend to like solving practical problems, therefore they have been provided with extra practical examples as well. Imaginative-type examples are provided to intuitive students to encourage their creativity and discover relationships between concepts .In contrast to sensing students, additional examples were not provided to intuitive students.

The third dimension determines a student's preference about the way of receiving information and helped the system to choose most suitable learning contents for each student. Video and picture-based learning contents are displayed to visual type students who can receive information easily from demonstrations and pictures. Verbal-type students are provided with audio and text contents as they are better at learning from spoken or written words.

The last sequential and global dimension is achieved by providing a customized learning pathway for each student. Sequential-type students gain understanding by working through the learning materials step by step, with each step following logically from the previous one. Therefore it is important for the system to create a sequential learning pathway for them. However, global-type students are allowed to choose their path freely as they absorb materials with random steps. They are also provided with a general subject overview to help them see the big picture.

Students need to complete all provided activities to finish the learning session and they can see their status as they work through on the progress bar. They are allowed to revisit completed activities however they cannot skip to activities that have not been attempted.

The system B appears initially to be similar to version A. At the start of the sequence students are required to answer the FSLSM questionnaire in the same four steps as outlined for system A. However, this system does not provide personalisation at any level of a student's learning. The students are presented with all available material for all topics in their lesson i.e. all video, audio, text and picture-based formats. In addition, each topic has two different types of examples: practical and imaginative. Students can choose to use either collaborative tools such as a discussion forum and chat, or individual tools like note-taking and a single-user mind map. All learning materials are provided for the student to choose from, so a student can work through the materials in any way they choose. However, the system will not let them to finish the learning session unless they have tackled some learning materials in all six sections.

At the end of both sequences, students given a chance to upload and submit their solutions to any of the practical exercises. Afterwards, before they finish their learning session they are provided an assessment test covering all six sections. The assessment test includes multiple-choice questions about each topic and they can are only allowed to attempt this test once.

Results from the experiment

Data from the experiment is still being analysed so it is too early to draw firm conclusions. The experiment was designed to investigate the effectiveness of a personalized learning environment on students' learning. Students were expected to study the subject and answer questions at the end of their learning session. All the actions from all the students on the system are recorded to gather more information about students and will be used to interpret in more detail whether the personalisation of learning materials and activities can ameliorate students' learning performance.

Another aim of the experiment is to analyze students' choice of learning materials in system B and compare these to the initial results from the learning style questionnaire to see if students' actions match with their pre-determined learning styles. The assumption is that students' behaviors can give relevant indication for identifying their learning styles. For example, Active-type students are expected to use a large number of discussion forum posts (begins a discussion, replies) and use of chat tool. Similarly Reflective-type students are expected to spend a longer time thinking and using the note-taking tool for writing summaries. Furthermore, the choice of video and picture-based contents will indicate Visual-type students and by contrast, the choice of audio and text-based contents will indicate Verbal-type students. Choice and time spent on practical-type examples will indicate the Sensing-type of learner. However, Intuitive types students are expected to choose and spend long time on imaginative-type examples. If students' prefer to study the subject in sequential steps they are expected to visit the learning materials in the provided order and they will categorised as Sequential-type students, however if they visit the materials in a random order they will categorised as Global-type.

According to some early observations, some students who started using the systems provided positive feedback. Generally, they found the system easy-to-use and helpful. Some written student comments are as follows:

About system A

- "This was a very useful insight into the future of E-learning. Truth be told, I didn't try my hardest to complete all the tasks but I believe, if this system was fully integrated into our learning schedule, it would be very useful particularly because it offers tailored learning."

About system B

- "It's very easy to use, pretty fun. I wouldn't mind using it again. Videos was awesome"
- "It is very educational. Please implement this in the future course."

Conclusion and future work

This paper introduced an approach to evaluating the effectiveness of personalised e-learning systems compared to non-personalised system. In the proposed method the Felder and Silverman Learning Style Model was used to analyse students' learning styles and, based upon a profile deliver personalised learning resources and tools. All four dimensions of the Felder and Silverman model havebeen used to provide a personalised environment including content presentation, learning support tools, example types and learning pathway levelsthroughthe LAMS learning environment. The use of LAMS accelerated the development of our e-learning system design and development providing enhanced capabilities and a user-friendly interfaces.

Furthermore, this study will provide further evidence about whether existing methods like FSLSM help determine whether learning styles match what students do in actual practice and if the models can measure or help students' learning.

Currently, the e-learning systems are still in use and experiments are still being run with students to assess the efficacy of the systems and gather more data. The main results and analyses will be undertaken shortly after all students have completed the experiment.

References

2020 Vision: Report of the Teaching and Learning in 2020 Review Group. http://publications.teachernet.gov.uk/default.aspx?PageFunction=productdetails&PageMode=publications&ProductId=DFES-04255-2006 [viewed 14 May 2010].

Baker, M. (2008). *Let's not get personal*.http://news.bbc.co.uk/1/hi/education/7741943.stm [viewed 20 May 2010].

Brusilovsky, P. (1996). *Methods and techniques of adaptive hypermedia.*User Modeling and User Adapted Interaction, (pp 87-129).http://www2.sis.pitt.edu/~peterb/papers/UMUAI96.pdf [viewed Feb 2010].

Cantoni, V., Cellario M. &Porta M. (2004). Perspectives and challenges in e-learning: towards natural interaction paradigms. *Journal of Visual Languages & Computing*, 15, 333-345.

Cao, X., Zhao, P. & Wang, X. (2009).*Study on Design and Development E-learning System Based on Learning Flow*. World Congress on Software Engineering, 2009, wcse, vol. 1, pp.367-371.

Cemal Nat, M., Bacon, L. &Dastbaz, M. (2009). Investigation on Student Modeling in Adaptive E-learning Systems. *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2009*, pp. 2420-2427.

Downes, S. (2005). *E-Learning 2.0.* Blog entry posted 17th October 2005. http://www.downes.ca/post/31741 [viewed 8 Jan 2009].
Felder, R.M. & Silverman, L. K. (1988). *Learning and teaching styles in engineering education.* Engineering Education, Vol. 78, No. 7, pp. 674–681.
Felder, R.M. and Soloman, B.A., (1997). *Index of Learning Styles questionnaire.* http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSpage.html [viewed 10 Feb 2010].
Forehand, M. (2005). Bloom's taxonomy: Original and revised. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology.*
Graf, S., &Kinshuk. (2007). Providing Adaptive courses in Learning Management Systerm with Respect to Learning Styles. In T. Bastiaens& S. Carliner (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education.* (pp. 2576-2583).
Yang, J., Yang H., & Yan, Li. (2009). *The Application and Practice of LAMS in Experimental Teaching of Modern Education Technology Course*. International conference on computer Science and Software Engineering. IEEE.
Junqi, W., Zhengbing, H., Zongkai, Y. & Yumei, L. (2009). *Effective Learning Activities Design with LAMS.*International Conference on Networks Security, Wireless Communications and Trusted Computing, 2009.
Kim, J., Jung, Y., Lim, Y., Kim, M. & Noh, S. (2009). An e-learning framework supporting personalization and collaboration. *Proceedings of the 3rd International Conference on Ubiquitous Information Management and Communication.*
Limongelli, C., Sampietro, G. &Temperini, M. (2007).*Configuration of Personalized e-Learning Courses in Moodle.* The IEEE Region 8 Eurocon 2007 International Conference.
Liu, M. & Chen, L. (2008). *Personalized Learning System Based on Solomon Learning Style*. Computer Science and Software Engineering, 2008 International Conference.
Liu, S., Gomez, J., Khan, B. & Yen, C. (2007).Toward a Learner-Oriented Community College Online Course Dropout Framework. *International Journal on E-Learning.*6(4), 519-542.
Mayer, R. E. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. *Learning and Instruction*, 13, 125-139.
Phoebe Pedagogic Planner (2008).http://phoebe-project.conted.ox.ac.uk [viewed 15 Jan 2010].
Russell, T., Varga-Atkins, T. & Roberts, D. (2005).*Learning Activity Management System Specialist Schools Trust pilot.* CRIPSAT, Centre for Lifelong Learning, University of Liverpool.http://www.becta.org.uk [viewed 10 Feb 2010].
Uden L. &Damiani E. (2007).*The future of E-Learning: E-Learning ecosystem* .Inaugural IEEE International Conference on Digital Ecosystems and Technologies (IEEE DEST 2007).
Wei, X. & Yan, J. (2009). *Learner Profile Design for Personalized E-learning Systems.* IEEE.
Zapalska, A. &Brozik, D. (2006). *Learning styles and online education.* Campus-Wide Information Systems, (23) 5, 325-335.

Please cite as: Nat, M; Walker, S; Bacon, L; Dastbaz, M. (2010). Designing personalisation in LAMS. *Proceedings of the 2010 European LAMS & Learning Design Conference* http://lams2010.lamsfoundation.org/papers.htm