Learning styles, Personalisation and Adaptable e-Learning

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Abstract

Common Learning Management Systems (for example Moodle [1] and Blackboard [2]) are limited in the amount of personalisation that they can offer the learner. They are used widely and do offer a number of tools for instructors to enable them to create and manage courses, however, they do not allow for the learner to have a unique personalised learning experience. The e-Learning platform iLearn offers personalisation for the learner in a number of ways and one way is to offer the specific learning material to the learner based on the learner's learning style. Learning styles and how we learn is a vast research area. Brusilovsky and Millan [3] state that learning styles are typically defined as the way people prefer to learn. Examples of commonly used learning styles are Kolb Learning Styles Theory [4], Felder and Silverman Index of Learning Styles [5], VARK [6] and Honey and Mumford Index of Learning Styles [7] and many research projects (SMILE [8], INSPIRE [9], iWeaver [10] amongst others) attempt to incorporate these learning styles into adaptive e-Learning systems. This paper describes how learning styles are currently being used within the area of adaptive e-Learning. The paper then gives an overview of the iLearn project and also how iLearn is using the VARK learning style to enhance the platform's personalisation and adaptability for the learner. This research also describes the system's design and how the learning style is incorporated into the system design and semantic framework within the learner's profile.

1.0 Background: e-Learning Theories and LearningStyles

There has been an on-going debate on how to develop the instructional design theory in order to provide a much richer learning environment for learners. The three main schools of thought have had a large impact in learning and instructional design and these are Behaviourism, Cognitivism and Constructivism. The Behaviourism approach (Skinner [11] and Watson [12]) is one that sees the mind as a "black box" that responds to a stimulus. The Cognitivism approach deals with the information processing habits of the learner and that the "black box" should be opened and understood. In the Contructivism approach (Dewey [13], Montessori [14], and Piaget [15] amongst others) the learners interact with the environment and then construct their own knowledge based on that interaction.

Many learning styles have been developed to allow for learners to be categorised into a specific learner type. This learner type can then be used to provide the learner with suitable learning material thus possibly enhancing their overall potential for learning. Some of the most well know learning styles are Myers-Briggs Type Indicator [16], Multiple intelligences [17], Kolb Learning Styles Theory, Felder and Silverman Index of Learning Styles and Honey and Mumford Index of Learning Styles, VARK and Dunn and Dunn [18]. Sampson and Karagiannidis [19] state that learning styles have been at the centre of controversy for several decades now and that there is still little agreement about what learning styles really are.

Coffield et al [20] give a very detailed evaluation of common learning styles and they categorise them according to their theoretical importance. In particular, they identify the five families of learning styles which are described here with examples:

1. Constitutionally-based including VAKT (visual, auditory, kinaesthetic, tactile): e.g. Dunn and Dunn [and VARK
2. Cognitive structure including patterns of ability: e.g. Multiple Intelligences
3. A relatively stable personality type: e.g. Myers Briggs Type
4. Flexibly stable learning preferences: e.g. Kolb learning styles theory, Felder and Silverman and Honey and Mumford
5. Learning approaches, strategies, orientations and conceptions of learning: e.g. Vermunt [21]

It was found during this research project that a number of adaptive e-learning system research projects have used learning styles to adapt their learning environment to the user. It was found that some projects using learning styles and the learning styles they use are:

- ACE [22], Carmona [23] and CAMELEON [24] use the Felder Silverman's Index of Learning styles
- INSPIRE and SMILE uses the Honey and Mumford model
- iWeaver uses the Dunn and Dunn Model

6. APeLS [25] use the VARK, Kolb, Honey and Mumford models

It was found in previous research undertaken on these e-Learning projects found that the main purpose for using the learning styles was to adapt the content presentation to the learner. It was also found that some systems (for example Aha! [26] and MANIC [27]) develop this further and propose systems that provide mechanisms for inferring learner's preferences.

Brusilovsky and Millan [3] state that there are no proven recipes for the application of learning styles within adaptive systems and they also state that it is still unclear which aspects of learning style are worth modelling, and what can be done differently for users with different styles. So it seems that despite all of the attempted current adaptive learning systems research there is still a long way to go with this research area.

2.0 iLearn: the e-Learning platform overview

The e-learning platform iLearn [28] is an ontology based system that will provide relevant learning resources as a personalised bespoke e-learning package for the learner based on their pedagogical needs. The package provided to the learner will be made up of digital assets including text-based, video, audio or podcast. The digital assets could be either a learning object or an assessment object.

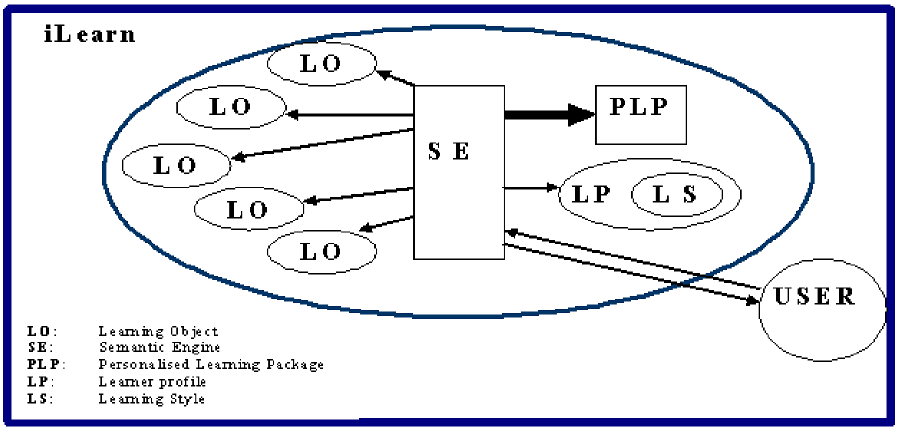

Figure 1: The iLearn semantic processing engine

The e-learning platform iLearn [is currently being developed using semantic web technologies and these include XML [29], RDF [30] and web ontology language (OWL) [31]. In particular, these technologies will be used to add meaning and reasoning to the semantic processing engine. The semantic processing engine will manage and generate the personalisation for the specific learner. This semantic personalisation engine will be able to interact with the learner to determine their learner style and subject preferences and it will also interact with the learning objects (Flash, Video, Audio, PP Presentation or Text) and then will develop a personalised e-learning package designed around the learner's specific requirements.

i-Learn contains a learner profile which is made up of a variety of learner-specific information. The learner-specific details for the profile have been defined as:

- The type of learner based on the learner's learning style
- The actual learning goal of the learner.
- The behaviour of the learner (including what type of material they are viewing and how?)

Figure 1 shows the iLearn semantic processing engine in more detail. It clearly shows that it is at the heart of the system and that it interacts with the learning objects, the user, the learner profile (containing the learning style type) and then generates the personalised learning package.

3.0 The learning style model

Learning styles were evaluated for this project and VARK was selected for iLearn's learner profile due to the fact that it seemed at the time of research to be the most concise tool and had the most relevant questions. It also does not contain too many questions and this is thought to be an advantage as generally learners may not be willing to spend prolonged time answering questionnaires. One other main reason why VARK was selected was due to the fact that it was found that this learning style compared to the others can also be clearly mapped to the type of learning material.

The VARK learning style will be used to provide the relevant material for the learner based on their learner type and Table 1 shows how the VARK learning style will be used and represented within iLearn. Fleming's actual recommendations for the appropriate study strategies are also shown in this table and the corresponding learning objects represented within iLearn. Table 1 also shows that the multi-modal learner type will be represented within iLearn by a mix of the learning object types.

VARK Learning Style	**Fleming's recommendations of study strategies**	**Learning objects to be presented in iLearn**
Visual	Pictures, video, posters, slides, flowcharts, graphs, diagrams	Video Vodcast PP slides
Aural	Discuss topics and ideas, remember stories, jokes etc.	PP Slides with audio Multimedia Podcast
Read/Write	Lists, headings, dictionaries, definitions, text books, manuals	PP Slides Text documents
Kinesthetic	Interested in doing, practical, real relevant	Multimedia interactivity
Multimodal	Mix of the above learning styles and learning objects	

Table 1: VARK learning style representation within iLearn

It is important to note, however, that the VARK learning style has been selected for testing and development purposes, however, it is intended that the learning style could be changed according to the user's and instructor's requirements. One proposal is that the iLearn system will eventually be adaptable enough that the developer will be able to use a chosen learning style.

4.0 iLearn system design and semantic framework

During the initial design stage for the project, the classes and their relationships for the iLearn system were developed. These classes show what data will be held within the system, the relationships and structure for the system. The iLearn class model (shown in Figure 2) shows the main classes and their relationships. The main classes found in the system are Person, Instructor, Learner, Learning_Package, Learning_Object_Group, Learning_Object, Learning_Material, Assessment_Material, User_Profile, Learning_StyleCat and Learning_Style. These classes and their relationships will now be discussed in further detail.

The Person class has subclasses of Instructor and Learner and both instructors and learners are users of the system. The instructor can add and manage the learning objects. The learner will be able to generate the learning package and the learner will also have a user profile holding details specifically to their own requirements (including details about their learning style).

The relationships between the learning object and the learning package are that the learning package is the generated personalised package that the learner can create specific to their pedagogical needs and this is made up of a number of groups of learning objects which can in turn be made up of a number of learning and assessment materials. The learner will be presented with groups of learning objects and will be able to decide which learning objects they want the learning package to be made up of. The purpose of this will be to enable the goal of the platform which is to provide the learner with a personalised bespoke learning package – the learner therefore will be provided with a choice of learning objects which can then become the bespoke learning package.

An example of this is that the learner may wish to learn basic Java programming and they may have the visual learning style category. The processing engine will therefore be able to search for all suitable basic Java learning object groups (containing learning or assessment materials) based on the learner's specific learning category (e.g. file types may be video, vodcast or presentation slides) and provide the learner with a selection of these learning objects. The learner can then select the required learning or object groups and these will then be put together within a learning package for the learner.

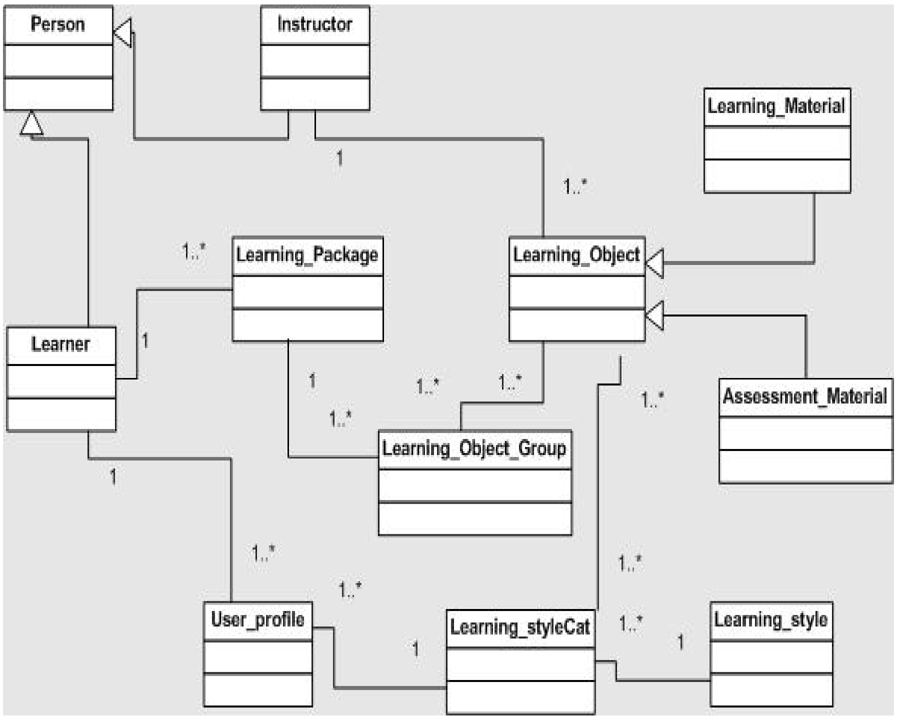

Figure 2: The iLearn class diagram

The class diagram also shows that the learning style has a number of categories associated with it and that each learning style category has preferred learning object type(s).

As initially we are using the VARK learning style then these categories are Visual, Aural, Read/Write, Kinesthetic and Multimodal.

This model has been implemented within the ontology development tool Protégé [32] and the initial semantic rules for the framework have been set. Figure 3 shows the iLearn classes and subclasses in Protégé.

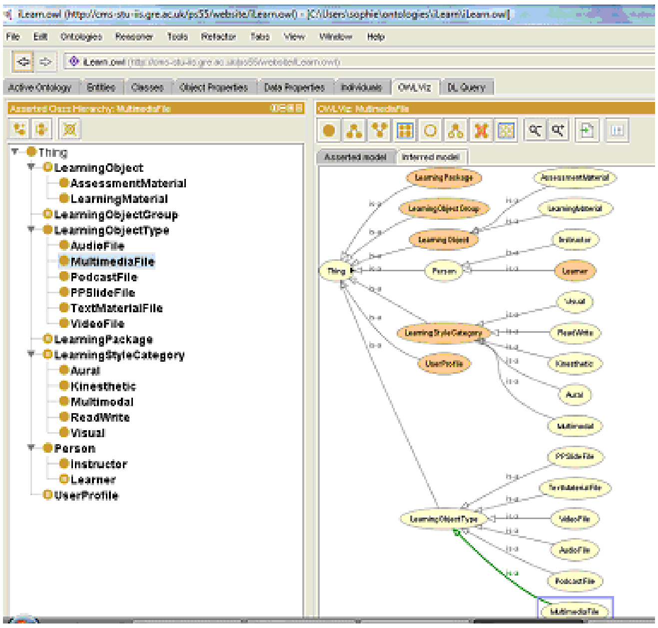

Figure 3: Protégé classes and visual representation of classes and subclasses

The next stage of the design was to devise the semantic rules for the system. These rules are developed in order to be able to allow for the inference rules to be set within the system. For example, if the user has a learning style category of Visual then the system can infer that the preferred file type are video, vodcast or presentation slides. So far the following semantic rules have been created and so therefore they have become part of the initial semantic framework for the system.

- all class and sub-class level siblings are disjoint
- if a class has some Learning_Object_Group then this class must be a Learning_Package
- if a class has some Learning_Object then that class must be a Learning_Object_Group
- if a class has one prefersFileType Learning_Object_Type then the class must be a Learning_Object class
- if a class has a user_Profile then the class must be a learner
- if a class has exactly one Learning_Style_Category then the class must be a User_Profile

Also the rules set for the learning style categories are:

- Aural type has prefersFileType only AudioFile and PPSlideFile and PodcastFile
- Kinesthetic has prefersFileType only MultimediaFile

- Multimodal has prefersFileType only AudioFile and MultimediaFile and PPSlideFile and PodcastFile and TextMaterialFile and VideoFile
- ReadWrite has prefersFileType only PPSlideFile and TextMaterialFile
- Visual has prefersFileType only PPSlideFile and PodcastFile and Video

These rules are used in order to provide the semantic framework for the system. The flow chart in Figure 4 shows how the learner and the learner's profile interact with the semantic processing engine. It shows that the user first completes the learning style questionnaire and the result of the questionnaire will be stored within the learner profile. The learner will also be able to add some learning specific information into the profile. The learner then requests the personalised learning package and the semantic engine will process the rules and provide the user with a selection of learning object groups. The learner can then select which learning object groups they require and the personalised learning package will be presented to the learner containing these learning object groups.

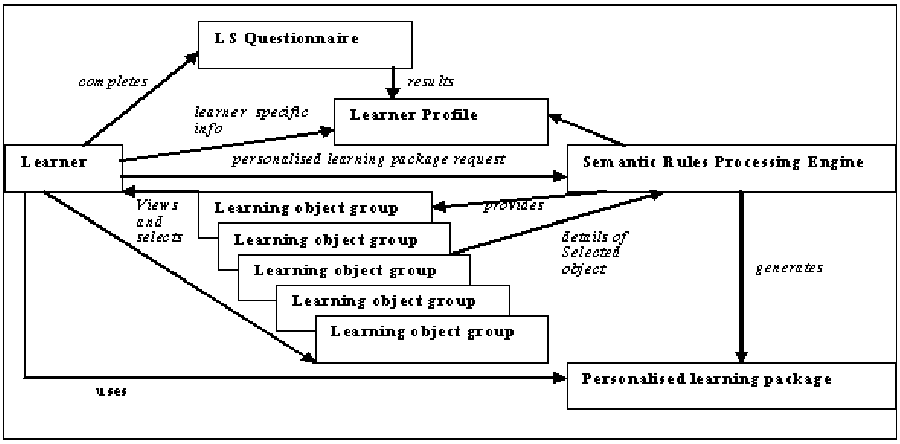

Figure 4: iLearn: the learner interaction flow chart

Note that the iLearn platform is being developed to be generic and both the learning style used and the specific learning fields are flexible and interchangeable. The VARK learning style has been selected for testing purposes, however, it is intended that the learning style could be changed according to the user's requirements.

5.0 Conclusion and further work

Although Learning Management Systems such as Moodle and Blackboard have many practical uses and are commonly used they do not offer much for a learner who wishes to have a personalised experience. With this in mind, it was decided to undertake the development of the e-Learning platform iLearn which allows for personalisation for the learner, specifically personalisation based around the learner's learning style. iLearn attempts to address the issues found with the limited personalisation within common Learning Management Systems.

Learning styles that are currently being used for adaptive personalisation within e-learning are Felder Silverman's Index of learning styles, Honey and Mumford learning style, the Dunn and Dunn Model, VARK and Kolb. Currently they are being used in a number of different projects (SMILE, INSPIRE, iWeaver amongst others) however there is no real standards and rules that are available when using them within adaptive e-Learning.

The iLearn project has chosen to add the Learning Style personalisation based initially on Fleming's VARK Learning style. This learning style offers a suitable questionnaire tools which can be integrated into the iLearn system. One main reason why iLearn is using VARK is because it is a tool which results can be clearly mapped to the preferred learning object.

This paper shows how the VARK learning style has been incorporated into the iLearn system design and thus shows how it will be used to provide the relevant material for the learner based on their learner type. One next step for the development is to develop the metadata. It is proposed that the metadata will be defined using some of the categories as defined by Ahmed [33] which are annotation (side notes added to a document for a specific purpose), resource based metadata (specific document properties and their values), subject based metadata (refers to data that represents subjects and their inter-relationships) and also the structural mappings (refers to cross-referencing documents).

The final implemented iLearn platform intends to address the issues found with the limited personalisation within common Learning Management Systems and intends to provide the learner with a personalised learning experience. The system is proposed to be generic and will have the capacity for developers to add their own categories in order to classify future types of learning objects. The system is also intended to not be subject specific so therefore it should be adaptable to cover many different fields of learning.

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