Personalisation for Adult eLearning - an AHS Approach

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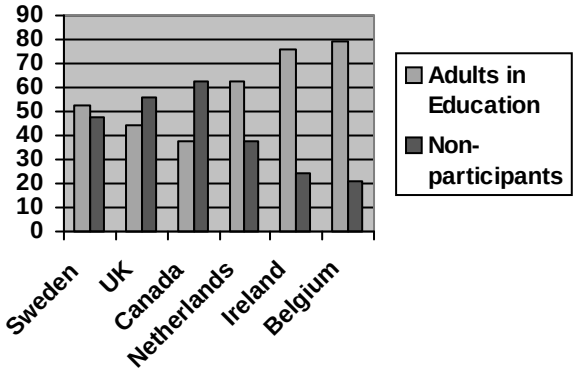
ABSTRACT

This paper focuses on research into the development of adult personalised eLearning using Adaptive Hypermedia Technology. The theories underlying the approach taken in this paper include the theory of Andragogy by Malcolm Knowles (1980) and Learning Styles theory by David Kolb (1984). The solution proposed in the paper extends the use of next generation Adaptive Hypermedia Systems (AHS). The paper first outlines key problems in adult education and investigates the appropriateness of AHS based systems in tackling these challenges. The paper then proposes a model for supporting dynamic personalised adult eLearning and describes its design and implementation. Finally, the paper concludes with an analysis of the proposed approach and presents key responses from the user community within the project.

1. Introduction

Recent trends in the European education system show an increasing number of adults returning to courses for reasons of personal or professional development. Over the last decade more than 75% of the adult population of Ireland have participated in some form of adult education, through training at work, evening seminars or third level courses.



PERCENTAGE OF POPULATION AGED 16 - 65 PARTICIPATING IN ADULT EDUCATION AND TRAINING (OCED AND STATISTICS CANADA, 1995 AND 1997)

However, just over one third of this percentage of adult learners were seen to abandon their respective courses after just a few weeks. Such drop out rates have been linked to the lack the environmental factors recommended by Malcolm Knowles. (Rodgers 1989). Such factors include Learner Involvement, Ownership of Content, Motivation, and Self-Directed Learning (Knowles, 1970).

AHS are providing a new and exciting approach to creating and supporting personalised eLearning courses (Brusilovsky *et al* 2003). Emerging trends suggest a strong link between personalization of eLearning and adult education.

2. Objective

AHS are beginning to mature, and boast advantages such as personalization of content, individualization of the learning process, and high levels of learner control (Brusilovsky *et al* 1996). Based on this the key question to emerge was whether or not AHS could deliver the key factors required for successful adult education (Brusilovsky, 1996).

AHS can provide several forms of adaptation, namely adaptive navigation, structural adaptation, adaptive presentation and historical adaptation.

- Adaptive navigation aims to guide the learner through the system by altering the structure presented to the learner according to the individual learner characteristics. Four main types of adaptive navigation are *direct guidance* (i.e. displays the best node for the learner to visit), *sorting* (links into order of most relevance), *hiding* (hiding links of irrelevant pages e.g. of pages which have concepts not yet covered by the learner), and *annotation* (augments the links with a comment which inform the user more about the link).
- Structural adaptation attempts to give the student a spatial representation of the Hyperspace environment. This representation is based on the learner model and is hoped to

provide the student with a sense of position within the learning environment.

- Adaptive presentation attempts to alter the way content is visually displayed to the learner based on the learner model.
- Historical adaptation includes trails or footprints through the system, landmarks made by the learning and progression cues provided by the system. All of these can be customized to suit a particular learner.

Although we identify four methods of adaptation, there are many "axes" over which these four methods can be applied, e.g. the learners course aims, previous learning experiences or motivation factors. Each axis upon which the adaptation is based can be controlled and changed at any given time by the learner.

In this paper we focus on adaptative navigation and personalisation of content.

In the design section, we will have a closer look at exactly how the content is altered in line with the above adaptation techniques.

3. Adult Learning

The process of adult education is often referred to as Andragogy, a term made common language by Malcolm Knowles during the late 1970's and 1980's. Andragogy is defined as "the art and science of helping adults to learn" (Knowles 1980).

Through his work Knowles uncovered what he believed to be the five major hypotheses on which the adult education process is based. These are as follows:

The need to know - Adult learners are a lot less passive than children and as such require valid reasons for what, how and why something needs to be learned.

Learner self-concept - Knowles believed that adults are extremely self-directed and require high levels of input into their curriculum if successful learning is to take place. Such input along with responsibility for decisions on aspects of the learning process create a sense of involvement and ownership of content, which are two of the necessary environmental factors required for successful learning (Knowles 1970).

Role of learner's experience - Adults return to the educational process with a huge amount of experience. Any education process including adults must allow for the incorporation of this experience into the learning process. Neglecting the previous experience of adult learners can lead to resentment on the part of the learner while recognition of same leads to a successful learning environment.

Readiness to learn. - Adults need to be highly motivated and need to have a readiness to learn for learning to take place. This readiness can come in several forms but is mainly characterized by a developmental phase in the person's life. Such phases are perfect opportunities for learning and can lead to high levels of motivation.

Orientation to learning - As a person gets older they begin to seek information that they can utilize in the near future and not at a later stage as with our standard education process. In this way, adults are often said to be problem-centered as opposed to subject-centered in childhood as previously defined by Lindeman (1989).

In pursuit of the perfect learning process for adult learning, Knowles also uncovered what he believes to be essential environmental factors necessary for successful adult education. These include a comfortable learning environment which allows freedom of expression, acceptance of differences, learner involvement in goal setting, shared responsibility for planning and operating a learning experience and active participation in the learning process (Knowles, 1970).

4 Learning Styles

David Kolb (1984) states that four main processes are used in learning. Concrete Experience (CE) comes from learning through direct involvement in a new experience. Reflective Observation (RO) describes learning through watching others or through thinking about our own experience or those of others. Abstract Conceptualisation (AC) is learning by creating concepts and theories to describe and explain our observations, and finally Active Experimentation (AE) is learning that uses the theories and concepts we have derived to solve problems and make decisions.

5 AHS

As learning has become more learner-centered, digital technologies have also become increasingly personalized (Sharples 2000). Hothi *et al* (1998) believe that AHS have the potential to break through traditional educational barriers by allowing the tailoring of applications to specific user needs and requirements.

According to Piderit *et al* (2002) adult learning reaches its plateau when the delivery technique is perfectly aligned with the requirements and roles of the 'Why', 'What', 'Where' and 'Who' of the overall education process. Piderit also proposes that the combined interaction between educator and learner through content and execution method is dynamic and non-repeatable and as such provides the uniqueness of the moment of learning. AHS creates a situation where these dynamic factors can be catered for and incorporated into the learning process.

Standard AHS contain two models, namely a Content Model and a Learner Model. The content model, in simplistic terms, holds the content to be taught in the form of small chunks known as Learning Objects (LO) which are normally between 2 and 15 minutes in engagement duration. LO's are made up of 2 elements; learning content and metadata, with the latter providing the details that can be used during selection and adaptation. Metadata tags facilitate rapid updating, searching and management of content by filtering and selecting only the relevant content for a given purpose (Longmire 2000).

The learner model contains all collected data regarding the learner. Exactly what this data covers varies from AHS to AHS but is typically captured by means of questionnaires, quizzes, user usage and other performance indicators. The use of LO's provides an excellent opportunity for the learner to apply their own meanings and context to the information at hand. There are three types of learner model namely; the *Stereotype Model*, where the performance of the system depends on the categorization of the learner (e.g. novice or advanced); the *Overlay Model*, where the basis for the system performance is student knowledge which is updated as the learner progresses through the content, and the *Combination Model* which is simply a combination of the previous two models.

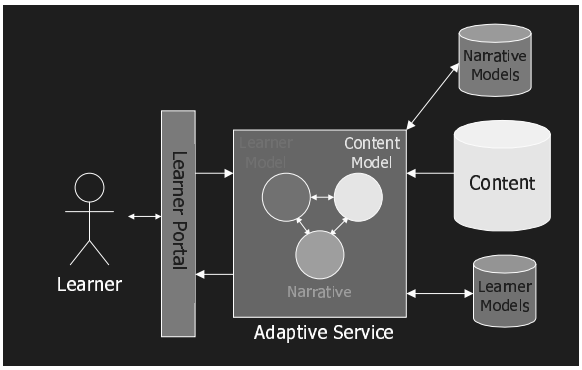
The Knowledge and Data Engineering Group in Trinity College Dublin have developed an AHS which contains a learner model, a learning object model and a narrative model.

The narrative model is a description of how the Learner model and concepts contained within the content model should be interpreted. A key factor of the narrative model is that it makes no direct reference to the actual learning content but rather references concepts which can be mapped down to specific LO's. This interaction is made possible by the use of meta-data. The narrative embodies the pedagogical strategy by which the learner will experience the content, for example discovery based learning or a case study.

Each Learning Object has its own set of 'meta-data', which provides a comprehensive description of the learning object. The narrative model is developed to outline the main points and concepts in the content and the various ways in which they can be provided to the learner. An adaptive engine is used to reconcile the content descriptions in the narrative to the content learning object metadata description and the learner model.

For this project the learner, content and narrative models were all modified to incorporate and allow for adult learning factors. The adaptive engine, which will be described in the design section, was not altered.

6 Design



Simplistic view of Multi-Model AHS System, which the artefact is built upon

The Learner Model

The learner model is populated through two learner presentation controls. The first learner control is in the form of a "Rebuild Scope" questionnaire. This control aims to evaluate the learner's particular learning needs and requirements in the form of motivation, previous knowledge of the subject matter and their course aims.

As previously mentioned, adult learner's environmental factors include learner involvement in goal setting along with shared responsibility for the learning experience (Knowles, 1970). The "Rebuild Scope" questionnaire caters for the learner's motivational factors for joining the course, their course aims and their previous experience of the subject matter. Research from this project uncovered 5 possible motivational factors common to adult education course, however to avoid ambiguity and

confusion on the part of the learner, these five were merged into three factors, namely *social* reasons, *work* reasons or *general interest*.

According to Knowles (1980) allowing high levels of learner input into the curriculum allows for a high sense of ownership of content, amongst other things. For the purpose of gauging the learner's individual course aims this questionnaire provides two possible levels of granularity within the content, namely a *general idea* of the main concepts or a *knowledge of specific concepts* covered in the course.

According to Brusilovsky (1996) both the learner's expectations with respect to a course and their knowledge about the subject being taught are very important. However, in terms of educational hypermedia a learner's previous knowledge should override their particular course aims. This conflict arises in the "Rebuild Scope" learner control where Question 2 covers the learner's course aims and Questions 3 to Question 6 inclusive cover the learner's previous experience. While both aspects of the learning environment are important, the learner model must be informed as to which one holds a higher ranking than the other for adaptation reasons.

Previous experience is a simple gauge of the learner's previous learning curve in relation to the chosen subject matter.

The second learner control is a "Rebuild Style" questionnaire. This control aims to define the learner's particular learning style to allow for further personalization of the content.

The Content Model

The Content model contains the LO's which are in turn grouped into Candidate Content Groups. The mechanism employed by the narrative to refer to content is to use an indirection whereby the narrative doesn't refer to the LO's directly, but to candidate content groups. Each candidate content group may consist of a minimum of one or a maximum of four LO's covering any aspect of the SQL course. For example - one LO is a summary of the main points contained in the section of the course, another LO is a list of exercises for the learner to complete to reinforce knowledge learned and a third LO is a list of extra reading on the topic. The decision as to which LO to deliver can be made at runtime based on the information contained in the Learner Model. This decision will be discussed in further detail in the implementation section.

The Narrative Model

The narrative model is a description of how the learner model and the content model should be interpreted to assemble a relevant, personalised and effective course (Conlan *et al* 2000). The narrative model for a course describes the rules, developed which govern the range and scope of personalised courses (Conlan *et al* 2002). The narrative model holds the possible ways based on a particular pedagogical model (e.g. case study) in which the concepts of the learning subject matter can be engaged by the student.

The narrative model contains the rules for adaptive display and navigation.

The Adaptive Engine

The adaptive engine reconciles the three models to compose the personalised course at run-time (Conlan *et al* 2002). Such dynamic construction of the learning experience is controlled by the learner via appropriate pedagogic instruments, e.g. indirect access to their learner model via both learner controls.

7 IMPLEMENTATION

The AHS artefact is built on XML (Extensible Markup Language). XML is the key technology to describe the models and it is the association and reconciliation of different XML elements in the models that is the responsibility of the adaptive engine.

In the learner model the XML document is made up of three sections namely, general tags, andragogical tags and technical tags. Within the 'andragogical' section the learners learning style and motivational factors are stored as seen below.

Based on the results of the learner style control the learner model is populated with the results of each of the four sections. These values are then used to 'plot' the learner as explained later in this section.

Also within in the 'andragogical' section, the learner's motivational reasoning is stored for use during adaptation. This aspect is explained in further detail later in this paper also.

Example of XML contained in Learner Model

```
<?xml version="1.0"?>
<pagelet>
  <general>
    <id>051000</id>
    <title>Objectives for Data Types Module</title>
    <keywords>data, types, NULL</keywords>
    <description>outlines what will be looked at in
    the data types module</description>
    <language>en</language>
  </general>
  <andragogical>
    <learningstyle type="kolb">
    <AC>6</AC>
    <CE>3</CE>
    <RO>6</RO>
    <AE>2</AE>
  </learningstyle>
  <motivation>
    <factor>general</factor>
    </motivation>
  </andragogical>
  <technical>
    <location>mod051-000.html</location>
    <format></format>
    <requirements>none</requirements>
    <size>242</size>
  </technical>
</pagelet>
```

In order to provide the high level of adaptivity and reuse the LO's are of fine granularity. To indicate this we use the term paglet to refer to the piece of eLearning content represented as a LO. The andragogical section of each LO contains a set of values as follows:

```
<AC>5</AC>
<CE>4</CE>
<RO>7</RO>
<AE>2</AE>
```

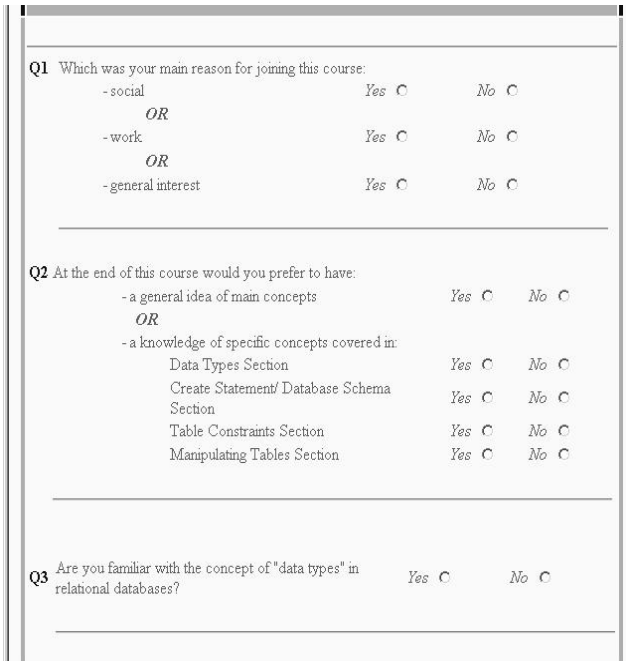
similar to those contained in the learner model. Each paglet is contained in one candidate content group either on its own or with a group of paglets providing the same competency to the learner. The adaptive engine compares the values in learner models to the values of each paglet in a given candidate content group and displays the 'best' paglet to the learner.

Example of XML contained in Narrative Model

```
<?xml version="1.0"?>
<candidategroup>
  <general>
    <identifier>cgmod052-001</identifier>
  </general>
  <members>
    <member>mod052-001</member>
    <member>mod052-001a</member>
    <member>mod052-001b</member>
  </members>
  <educational>
    <adaptivity>
      <adaptivitytype name="competencies.taught">
          <set type="ALL">
            <candidate>
              <langstring
              lang="en">db.datatypes.explanation
              </langstring>
            </candidate>
          </set>
      </adaptivitytype>
    </adaptivity>
  </educational>
</candidategroup>
```

The artefact provides run-time adaptation to the learner's particular motivation, course aims, previous experience and learning style.

The input for models comes in the learner's responses to the learner control questionnaires. As previously mentioned the "Rebuild Scope" questionnaire is displayed first and consists of 6 questions as follows:



Q1 Which was your main reason for joining this course:

- social — Yes ○ No ○

OR

- work — Yes ○ No ○

OR

- general interest — Yes ○ No ○

Q2 At the end of this course would you prefer to have:

- a general idea of main concepts — Yes ○ No ○

OR

- a knowledge of specific concepts covered in:
  - Data Types Section — Yes ○ No ○
  - Create Statement/ Database Schema Section — Yes ○ No ○
  - Table Constraints Section — Yes ○ No ○
  - Manipulating Tables Section — Yes ○ No ○

Q3 Are you familiar with the concept of "data types" in relational databases? Yes ○ No ○

One example of how each of the learners responses is mapped into the adaptation of the content to their particular needs can be seen in the form of Adaptative navigation depending on the learners answer to Question 2 along with Question 3. If the learner chooses the general option in question 2, and indicates later on in the questionnaire that he/she is familiar with data types (as put forward by question 3), the content displayed to the learner will only continue the predefined 'general' concepts in the remaining three topics only.

The "Rebuild Style" learner control consists of 18 questions. Questions 1 to 9 inclusive of the style questionnaire are set to define whether the learner favors Active Experimentation (learning which uses the theories and concepts we have derived to solve problems and make decisions) or Reflective Observation (learning through watching others or through thinking about our own experience or those of others) during learning. The first option of each question (in the form of a radio button) has a value of AE with the second option having a value of RO. When each question is answered the learner model should be populated with the related chosen option. At this stage it should be noted that in order to plot the learner on an x and y axis, each AE option chosen must have a value of minus1, with each RO value having a value of plus 1. At the end of the first 9 questions, the learner model should save both values. Please note that it is highly unusual for a learner to choose all 9 AE values and no RO values. It is more likely that the result will be 6:3 in favor of AC or 2:7 in favour of RO. The learner model for a individual learner should now look as follows:

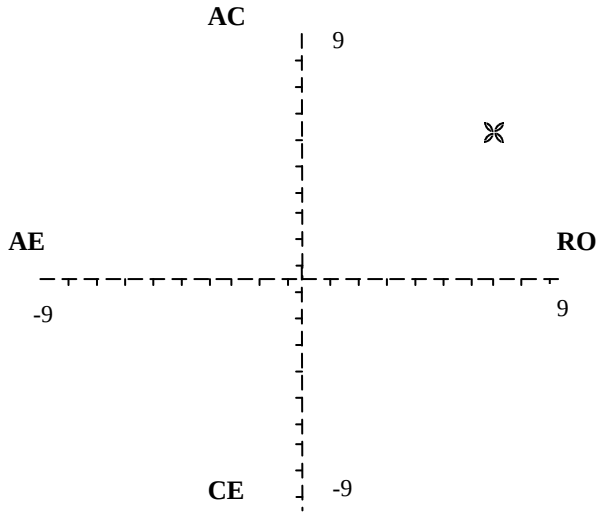
<AE> = -2
<RO> = 7

The higher of the two values provides the x co-ordinate for the learner, although both values need to be saved in the learner model for reasons of content adaptation

Questions 10 to 18 inclusive of the learning style questionnaire work on the corresponding idea of defining whether the learner uses the process of Abstract Conceptualisation (learning by creating concepts and theories to describe and explain our observations) or Concrete Experience (learning through direct involvement in a new experience) during learning. This comparison provides the y axis on the learning style below. For these questions the first option is AC with the second option being CE. For these questions each AC option would has a value of plus 1 with the CE option having a value of minus 1.

Again, the higher of the two values is used and becomes the y co-ordinate for plotting the learner. However, at the end of the second set of questions, the learner model should look as follows:

<AE> = -2
<RO> = 7
<AC> = 6
<CE> = -3



As previously explained, the andragogical section of each paglet contains four learning style values. During adaptation, the narrative model compares the above learner values with each of the paglets in the candidate content group and displays the 'best' pagelet to each individual learner.

8 TESTING AND TRIALLING

The artefact was tested on a group of 8 people ranging in ages from 23 to 40. Each learner completed the SQL course content and its given features without any interference from the author. Upon completion of same, they were asked to complete a feedback questionnaire which included questions varying from how easy the "Scope" and "Style" questionnaires were to understand and their relevance in the learners opinion to a quantative ranking of each of the adaptive features of the course.

9 AHS AND ADULT LEARNING

For evaluation purposes, the various aspects of the AHS were compared directly against environmental factors as recommended by Knowles.

The AHS allows the learner to assume a high level of control over the learning environment and content, which makes it very appealing to adult learners and also keeps it in line with the learner's self-concept as recommended by Knowles. Not only can the system be set up initially to cater to the learner's individual needs and wants but it can be altered at any given time by the learner.

As previously explained Question 3 - Question 6 inclusive of the "Rebuild Scope" learner personalisation control are created specifically for inputting and monitoring the learner's experience.

Motivation by nature is difficult to create and maintain during the learning process. The motivation which occurs during adult learning often comes in the form of the learner's readiness to learn. Although the AHS does monitor the learner's main reason for taking the course it does not claim to motivate the learner directly. It is hoped that the provision of a highly personalised course which adapts to the individual learners requirements would create sufficient motivation to encourage the learner to complete the course.

In light of adult learners being problem centered, the AHS provides exercises at the end of each topic section to allow the learner to put the knowledge learned into practice. This also allows the learner to see the possible real-life uses and implications of content.

Learning situations in which the adult learner feels free to express their opinion and views are more commonly referred to as a "comfortable" learning environment. eLearning environments often cater for such expression through the use of chat-rooms and discussion boards. The AHS does not contain a chat-room for the purposes of this report. However, for adults who enjoy learning new topics at their own pace their concept of a comfortable learning environment is somewhat different. Such learners are catered for in the AHS.

As with the learners self-concept mentioned previously, the learner is provided with high levels of control and input into their learning experience. Such control is intended to fulfill the learner's requirement to actively participate in their own personal learning experience.

Finally, the AHS does not explicitly explain to the learner the reason that each topic should be learned, even though adult learners often seek this information. However, for adults completing the course for reasons of career advancement it was hoped that they would be conscious of completing the full course in order to get a good return on investment of their time and energy.

Trailing of the system is ongoing and further more detailed feedback and conclusions are expected.

10 CONCLUSION

Initial feedback from this project shows the following conclusions:

The AHS did succeed in its aim to provide for personalisation of content in line with adult education learning factors as it adapts content to the learner's motivation factors, course aims, previous experience and orientation to learning and also allows for active participation.

Along with the above environmental factors, the AHS also successfully adapts to the learner's learning style through the use of the learner "Rebuild Style" control and the values added to each piece of content by the adaptive engine.

As with most systems, the AHS does have some elements lacking. Specifically, in terms of the elements of adult education certain factors such as the learner's need to know were not incorporated. Also, although recognition is given to the inclusion of motivation factors in the adult learning process the AHS does not contain any feature which particularly addresses this aspect of the adult learning process.

The artefact is currently undergoing testing which will be completed by 1st May 2003. It is hoped that the artefact shows enough potential through this testing and trailing to provide a solid basis for future work. Such work will be in the form of the integration of a revised system into a year-long trial which aims to develop a successful basis for adult eLearning courses in the future
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References:

Brusilovsky, P., Kommers, P., Streitz, N.: Multimedia, Hypermedia and Virtual Reality, 1996, Springer-Verlang Berlin Heidelberg, Germany

Brusilovsky, P., Wade, V.: From Learning Objects to Adaptive Content Services for Web-based Education, 2003

Brusilovsky, P.: Methods and techniques for adaptive hypermedia, User modeling and User-adapted Interaction, 1996

Brusilovsky, P.: User Modeling and User-Adapted Interaction 6, 1996

Conlan, O., Wade, V., Bruen, C., Gargan, M.: Multi-Model, Metadata Driven Approach to Adaptive Hypermedia Services for Personalised eLearning, 2000, http://www.tcd.ie/CLT

Conlan, O., Wade, V.: Novel Components for supporting Adaptivity in Education Systems - Model-based Integration Approach, 2002, http://www.acm.org/sigs/sigmm/MM2000ep/conlan/#btlm

Hothi, J., Hall, W.: Applying Adaptive Hypermedia in Education, 1998 http:www.ld.ics.uci.edu.pub/kanderso/ht98demos/hothi.html

Knowles, M.: The Modern Practice of Adult Education: From Pedagogy to Andragogy, 1970, Cambridge Book Company

Knowles, M.: The Modern Practice of Adult Education: From Pedagogy to Andragogy. 1980, New Jersey: Cambridge/Prentice Hall Regents.

Kolb, D.: Experimental Learning: Experience as the source of learning and development, 1984, New Jersey, Prentice Hall

Lindeman, E.: The Meaning of Adult Education, 1989, Norman, University of Oklahoma, USA

Longmire, W.: *A Primer on Learning Objects*, 2000 http://www.learningcircuits.org/mar2000/primer.html

Piderit, G., Quijano, L: What are the main techniques used in Adult Education, 2002, http:fcis.oise.utoronto.ca/~daniel_schuguruensky/faqs/qaindex.html

Rogers, J.: Adults Learning, 1989, Harmondsworth; Penguin

Sharples, M.: The Design of Personal Mobile Technologies for Lifelong Learning, Computers and Education, 2000