A personalized E-learning Interface

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***Abstract*—The student group is heterogeneous, and to reach the goals of individualization and differentiation it is necessary to fit e-learning to the different needs of the students. The article first defines the heterogeneity factors of the student group, and then describes how an e-learning system must have a personalized interface enabling different student views / access to learning objects and learning activities.**

I. INTRODUCTION

In a next generation e-learning system it must be possible to personalize the user interface. Being able to present an online learning environment which covers the heterogeneous needs of a student group when it comes to e.g. different intelligences, different intellectual levels, different cultural background, there is necessary that the system is able to have personalized views / interfaces.

A. Definition of a PLE

PLE (Personal Learning Environment) is suggested as the next-generation e-learning system. The question so far is however; - What is really a PLE? Johnson et al. describes how different persons have different understandings of the concept "PLE", from "empowering users of informal learning resources away from institutions" or "an extended portfolio" to "a superfluous accessory to the technologies of the desktop operating systems and the World Wide Web" [1]. The variety of interpretation illustrates how diffuse the concept still is.

Our definition of a PLE (Personal Learning Environment) is an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices.

II. THE HETEROGENEOUS STUDENT GROUP

The student group is not homogeneous, but heterogeneous. To be able to individualize and differentiate e-learning to a heterogeneous student group, it is necessary to find and describe the heterogeneity factors of the student group. We here focus on the theories of multiple intelligences [2], proficiency stages [3] and cultural dimensions [5] to describe the important heterogeneity factors in a heterogeneous student group. It is important that all these theories are considered together, not alone. A holistic approach is necessary when describing the heterogeneous student group, avoiding that smaller parts not are viewed as more important than necessary.

A. Multiple intelligences

Gardner's "Multiple intelligences" theory [2] provides a contribution to the discussion about who the learner is. In this theory he is defining eight different intelligences:

1. Visual / spatial intelligence: The ability to visualize and make mental maps. Persons using mind maps are using this intelligence.
2. Verbal / linguistic intelligence: The ability of reading, writing and communicating with words. This intelligence is well developed among writers, journalists, speakers etc.
3. Logical / mathematical intelligence: The ability of logical thinking, performing calculations and abstract thinking. Mathematicians, engineers and lawyers often have a well-developed logical / mathematical intelligence.
4. Bodily / kinesthetic intelligence: The ability of body coordination and conscious use of own body and hands, - an ability typically well developed among athletes, dancers, actors and craftsman.
5. Musical / rhythmic intelligence: The ability of singing, playing, composing and having a good musical ear, usually found among composers, conductors and musicians etc.
6. Interpersonal intelligence: The ability of understanding people and communicating, usually well developed among competent diplomats, charismatic leaders and among "persons that people like".
7. Intrapersonal intelligence: The ability of understanding our "self".
8. Naturalistic intelligence: The ability to recognize and classify elements / patterns of the natural world [2].

The idea is that all persons have eight intelligences, but that some intelligences are better developed than others. It is therefore possible to use the knowledge about a student's intelligences to let him/her feel mastering, but also to give adequate challenges to improve weak abilities. It will in the future be important for e-learning systems to offer a varied learning environment supporting different intelligences to provide individualized learning.

B. Proficiency stages

Dreyfus has another approach to the view of the heterogeneous student group. He makes a division between different stages for learners, and claims that students on different stages have different needs. The proficiency stages are:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise [3].

Despite different professional competences, there are some characteristics identifying a specific progress [4]. The "novice" needs models, rules and prescriptions, while

an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the learner not only sees what needs to be done, but also sees how to achieve his goal.

C. *Cultural dimensions*

The cultural dimension also needs to be considered when describing the student group. We may use Hofstede’s five cultural dimensions [5] in an attempt to describe the heterogeneous student group;

1. Power Distance Index: The extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.

2. Individualism vs. Collectivism: The degree to which individuals are integrated into groups.

3. Masculinity vs. Femininity: The distribution of roles between the genders.

4. Uncertainty Avoidance Index: A society's tolerance for uncertainty and ambiguity.

5. Long-term vs. Short-term Orientation: Thrift and perseverance versus respect for tradition, fulfilling social obligations, and protecting one's “face” [5].

III. Personalized views

A PLE must provide a student interface allowing customized views of the learning objects and learning activities. Examples of the students’ views of the learning objects and learning activities could be views based on:

- Themes.
- Time.
- Pedagogical methods.
- Media type / intelligence.
- Proficiency stages.
- Learning objective.
- Student productions of learning objects / learning activities.
- Ranking score.
- List of learning object recommended by the system based on behavior of previous students.
- Guided learning paths produced by teacher.
- (Free text) search.

Many LMS (Learning Management Systems) of today only allow one of these views, e.g. a theme structure of the content, or a chronologically structure of the course content. This is not sufficient if the learning environment should provide individualization and differentiation.

A. *Themes*

One student view in the user interface may be based on themes. This requires a user interface where learning objects / learning activities are accessible through a topic directory, with hierarchical structure of themes, e.g. in an “English as a second language” course.

Example “English as a second language”:

- Grammar
  - Nouns
  - Pronouns
  - Verbs
- History
- Culture
- Literature

B. *Time*

Time should be an additional student view. The system may present learning objects / activities chronologically, where the student sees the newest learning objects / learning activities first. A student view based on time is especially useful when the student wants to find the learning objects according to the course run and the course’s plan of progress throughout the semester.

C. *Pedagogical methods*

Learning objects and learning activities could also be accessible based on the pedagogical method used to reach the learning objective. This means that if a student has been working with a learning activity e.g. based on the pedagogical method “gaming”, s/he should also be able to choose other game learning activities.

We choose to use Heinich et al.’s categorization of pedagogical methods [6]:

1. Presentation: “In the presentation method, a source tells, dramatizes or otherwise disseminates information to students. It is a one-way communication controlled by the source, with no immediate response from or interaction with students. The source may be a textbook, an audiotape, a videotape, a film an instructor etc.”
2. Tutorials: “A tutor (in form of a person, computer, or special printed material) presents the content, poses a question or problem, requests a student's response, analyzes his / her response, supplies appropriate feedback, and provides practice until the student demonstrates a predetermined level of competency. Tutorial arrangements include instructor to student (e.g. Socratic dialog), student to student (e.g. tutoring or programmed tutoring), computer to student (e.g. computer assisted tutorial software), and print to student (e.g. branching programmed instruction). The pattern followed is that of branching programmed instruction, that is, information is presented in small units followed by a question or task. The computer analyzes the student’s response (compared with responses supplied by the designer) and gives appropriate feedback. A complicated network of branches can be programmed. The more alternatives available to the computer, the more adaptive the tutorial can be to individual differences.”
3. Demonstration: “In the demonstration method, students view a real or lifelike example of the skill or procedure to be learned. The objective may be for the student to imitate a physical performance or to adopt the attitudes or values exemplified by someone who serves as a role model.”
4. Discussion: “As a method, discussion involves the exchange of ideas and opinions among students or among students and teacher. It can be used at any stage of the instruction / learning process, and in small or large groups.”

5. Drill and Practice: “In drill and practice students are led through a series of practice exercises designed to increase fluency in a new skill or to refresh an existing one. Use of the method assumes that students previously have received some instruction on the concept, principle or procedure that is to be practiced… The drill and practice exercises should include feedback to reinforce correct responses and to remediate errors…”
6. Cooperative learning: “Students can learn cooperatively not only by discussing texts and viewing media but also by producing media.”
7. Game-based learning: “Gaming provides a playful environment in which students follow prescribed rules as they strive to attain a challenging goal. It is a highly motivating technique, especially for tedious and repetitive content. The game may involve one student or a group of students”.
8. Simulation: “Simulation involves students confronting a scaled-down version of a real-life situation… The simulation may involve participant dialog, manipulation of materials and equipment, or interaction with a computer”. [6]. There exist different types of simulations: physical, iterative, procedural and situational simulations [7] and all the different types can be useful in a learning situation.
9. Discovery: “The definition of discovery method: a teaching strategy that proceeds as follows: immersion in a real or contrived problem situation, development of hypothesis, testing of hypothesis, arrival at conclusion. The discovery method uses an inductive, or inquiry, approach to learning; it presents problems to be solved through trial and error or systematic approaches”.
10. Problem solving: “Problem solving involves placing students in the active role of being confronted with a problem situated in the real world. Students start with limited knowledge, but through peer collaboration and consultation they develop, explain, and defend a solution or position on the problem. Students must examine the data or information presented, clearly define the problem, perhaps state hypotheses, perform experiments, ten re-examine the data and generate a solution. The computer may present the problem, process the data, maintain a database, and provide feedback when appropriate.”[6].

D. Media type / intelligence

Examples of different media types are text, numbers, audio, video, illustrations etc. The student should be able to choose learning objects / activities based on media type. This means that the system should be able to present all the audio learning objects, the video learning objects, the textual learning objects and so on.

The multiple intelligences will demand different type of learning objects, e.g. the visual intelligence will demand presentations, mind maps, concept maps and graphics, while the kinesthetic intelligence will demand simulations and motion sensitive tools.

E. Proficiency stages

Based on Dreyfus’ theory of proficiency stages [3] described earlier, the system also must present learning objects / activities based on proficiency stage.

One student should be able to access the learning objects covering the novice stage if this is wanted, while another student should be able to access learning objects covering the proficiency stage.

F. Learning objective

The student should also be able to access learning objects based on type of learning objective. Different types of learning objectives could be found in the main categories knowledge (cognitive learning objectives), skill (psychomotor learning objectives) and attitude (affective learning objectives).

Based on well-know taxonomies there are also subtypes of learning objectives, that may be considered when producing a personalized student interface. Bloom’s taxonomy for the cognitive domain [8] has the following subtypes; knowledge, comprehension, application, analysis, synthesis and evaluation. Kratwohl’s taxonomy of the affective domain [9] has five subtypes: receive, response, value, organize values and internalize values and Dave’s taxonomy of the psychomotor domain’s subtypes are imitation, manipulation, precision, articulation, naturalization [10].

In addition it is possible to have one learning objective category called meta-learning. Meta-learning is the state of “being aware of and taking control of one’s own learning” [11].

G. Student productions of learning object / learning activity

It is important that the student in a learning situation not only has the consumer role, but also may have the producer role. The students often produce texts, web sites, mind maps etc. that also could be useful for other students. In an on campus learning environment the students share lecture notes etc. and the e-learning environment should also allow sharing of student productions. Because of validation of the learning objects’ quality, it must be obvious for the students what learning objects are student-made and what learning objects are produced by the teacher.

H. Ranking score

If the e-learning system allows the students to rank the learning objects / learning activities, it may also be possible to present the learning objects based on the ranking score, e.g. the learning objects with a high ranking score is presented before the learning objects with a low ranking score.

Based on ranking scores the e-learning system may recommend learning objects to a specific student, based on similar preferences of fellow student. If the student ranks a learning object high, the system presents learning objects that students with the same ranking score of the specific learning object also liked.

I. Learning object recommended by the system based on behavior of previous students

The system should also recommend learning objects based on the behavior of the students. The system may recommend a learning object to a student, based on earlier behavior and choices of fellow students.

J. *Guided learning paths*

In some cases it will be useful for the students to get access to the learning objects / activities presented as guided learning paths produced by the teacher. The learning path will be considered quality assured, since it is produced by the teacher.

K. *Free text search*

An additional way of access to the learning object / activities should also be the possibility of free text search.

IV. HCI SOLUTIONS

A. *Metadata*

Implementing the different student views described above requires a technological solution that save learning objects in such a manner that the learning object is saved one place but is retrievable in several semantic contexts. The student views described above also show that it is necessary to focus more on pedagogical metadata.

According to a LOM survey report [12] metadata elements describing the intellectual content (Keywords, Classification [with Purpose = Discipline]) and the characteristics of the resource as media and Internet files (Technical Format, Learning Resource Type) are well-utilized. Metadata elements which attempt to describe the resource as a software "object" or to associate with it an educational context or level are much less frequently used (e.g. Life-cycle.Version, Aggregation.Level, Semantic Density, Context).

B. *Manual vs automatic*

There is a division between manual and automatic access to learning objects and learning activities. There has during the last years been conducted a lot of research and development within "adaptive user interfaces", with an objective to provide user interfaces that automatically adapts based on user behavior.

There are also HCI (human-computer interaction) solutions, which will make it possible to achieve personalization based on manual principles (the user make the choices based on a user interface that presents data semantically), e.g topic maps and semantic web. Topic maps are an ISO standard - ISO/IEC 13250:2003. "A topic map is a technology for knowledge integration, describing concepts and their relations" [13].

A user-friendly, individualized and differentiated interface is an important feature of an e-learning system. Instead of presenting the learning objects and learning activities in one standard interface for all the students, an e-learning topic map could present "many roads to Rome", addressing the needs of the heterogeneous student group [14].

V. CONCLUSIONS

The article has presented how to define the heterogeneous student group, based on several theories like multiple intelligences [2], proficiency stages [3] and cultural dimensions [5]. A personalized user interface must take all the heterogeneity factors into account, and we have presented different student views that should be implemented to create a personal learning environment that offers individualization and differentiation to every individual student.

ACKNOWLEDGMENT

We thank the partners of the QUIS project (2005-06) QUIS – Quality, Interoperability and Standards in e-learning. EU-project under The eLEARNING programme, DG EAC/26/04.

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