

# USING LEARNING STYLES TO PERSONALIZE ONLINE LEARNING

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**Biography:** The author is a lecturer and a researcher at the Pedagogical University in Krakow, Poland. She also works at the Centre for Development of Distance and Permanent Education at Warsaw School of Economics, where she is responsible for the quality matters in e-learning. She has got a PhD in computer science and in her professional works tries to combine pedagogical approach to e-learning with possibilities of new technologies as well as artificial intelligence techniques. Her main research area is personalization in e-learning in its pedagogical and technological aspects. She presents the results of her research at numerous conferences and in scientific journals. She is a member of the editorial board of e-learning magazine E-mentor ([www.e-mentor.edu.pl](http://www.e-mentor.edu.pl)).

## Abstract

**Purpose** -The paper presents the results of research aimed at collecting the data necessary for preparing personalised content of e-learning courses. Its aim is to show how the information describing individual learning styles can be linked to the rules of creating tailored online courses.

**Methodology/design/approach** - The paper gives a brief explanation of how personalization is understood for the purpose of research carried out by the author and what are the psychological backgrounds of the applied approach. It presents also a KS-TIW questionnaire, based on Howard Gardner's multiple intelligence theory.

**Findings** - As it is not possible to define infinite number of different course models corresponding to every single learner the author describes a concept of defining several learner profiles which would represent various types of learning preferences.

**Practical implications** -The final part of the paper shows how the data concerning one's learning preferences can be transferred into particular type of learning content with special emphasis on a form of learning content delivery and type of activities planned for individual learner.

**Originality** -This research goes one step further than typical approach to personalization in e-learning, which is usually understood either by freedom of choosing the time and the place of learning or by adapting the layout of VLE to one's individual needs. Quite rarely the solutions offered in VLE's enable the learner to choose among the forms and methods the learning content is delivered.

**Keywords:** personalization, learning styles, e-learning, learning content

**Classification:** Research paper

## Introduction

In the last decades of the twentieth century it was a commonly held belief that introduction of computers into everyday school practice would change not only the way knowledge was delivered to students but also the way they absorbed and retained it. The expectation was that students would become more active and more creative participants in the educational process. Those unfulfilled expectations were transferred to e-learning, which seemed to give the learners more independence by allowing them to work on their own paths according to their individual arrangements (at least with regard to time and place of learning). However, the extent to which e-learning changes the way one learns in comparison to traditional on campus education is still unclear. In other words, does flexibility in time and place influence the way we learn? Do online students spend less time on learning? Is their knowledge obtained by the use of ICT broader, better structured and better adjusted to their needs? To their profession and position? Or to their expectations?

The extent to which e-learning is involved in educational systems varies significantly from one country to another but there are some common factors, which do not depend on the legal regulations, financial conditions or even on the access to computer labs and Internet in particular schools and countries. Those factors refer to pedagogical backgrounds of online education and therefore may be applied across the country borders and school levels. One such factor is personalization. The first section of this paper describes the concept of personalisation and how it could be understood and implemented in the context of e-learning. The next section presents the scope and the aim of research carried out by the author, followed by the description of a tool which can be used for gathering the personal data of learners and how this data can be interpreted for educational purposes. Finally, some useful suggestions on how to build a personalized online course are described.

### **Different Faces of Personalization in e-Learning**

There is a tendency to claim that personalization is an immanent feature of e-learning. The content placed on the e-learning platform, easily accessible from any place at any time, seems to fulfil individual needs of the learners. However, easy access to learning content does not ensure better results of teaching and learning. The results of a survey carried out at Warsaw School of Economics, where every semester up to 2000 students attend online lectures, have shown that there are no significant differences between the grades that student get in e-learning courses and in traditional on-campus classes (Dabrowski & Zajac, 2006). Although some students indicated in a survey that e-learning methods are more convenient for them as they do not require, for instance, making notes during the lecture, which they perceived as a factor influencing their concentration, there was no significant difference between the final exam scores of those taking online and on campus lectures.

One of the possible explanations is that accessibility of learning resources only makes the learning conditions more friendly and suitable, but the way of presenting learning material and performing learning activities remains the same for all learners, whereas in fact everyone has his or her own individual learning preferences (Felder, 1998). In the traditional classroom good teachers can monitor the behaviour of their students and change teaching methods, sometimes even on the spot, in order to get the best possible results. In a virtual learning environment (VLE) such adaptations are usually impossible. The purpose of the project undertaken by the author is to define different means of enabling the students to choose their own learning path. The aim of the research is also to establish conditions for creating versatile online courses adjusted to individual learner's needs – the courses that will enable them to achieve course objectives defined in a syllabus, but the way the particular learners will do that may be different.

Another commonly used means of personalization takes into account different levels of advancement of the users (e.g., ALATUS LCMS, 2003). There are two possible ways of fulfilling such a requirement. In the first approach learning content offered to all the learners remains the same but users are allowed to skip freely some parts of a course if they are already familiar with those pieces of information. The other approach requires preparing the learning content in such a way that various learning paths (corresponding to different levels of advancement) are possible and the learners can modify their own paths along the course by switching to more advanced topics or – just the opposite – trying to find some basic explanations if necessary. Usually, both of these ways involve automatically assessed tests, the results of which establish further steps. According to the results the learner can be unable to proceed to the next step of a course and is ‘forced’ to go back and revise some already passed sections. On the other hand, going to the upper level may be suggested if the results of tests show that the current level is too simple for that particular learner.

An interesting and a bit more sophisticated solution to that type of personalization was elaborated by the IBM research team that proposed the Dynamic Assembly Engine (Farell, Liburd, & Thomas 2003), which was built into the e-learning platform and allowed learners to decide whether they want to change the mode of further learning. More precisely, it gave the learners the opportunity to absorb only those pieces of information they actually need. Moreover, they could choose the form those pieces were presented in. It is plausible to argue that there is no better way to personalize learning than to give free choice to the learner. However, the pilot study led by the IBM research team indicated that some learners had spent too much time on making up their minds. In other words, they had not been able to decide which form was most suitable for them. The suggested explanation was that we rarely think about the way we obtain knowledge. We just do it. This means that although the learning process itself could have been optimized by better adjustment of learning content, the process of learning in this instance had not been more efficient because the amount of time spent on making appropriate decisions was quite large.

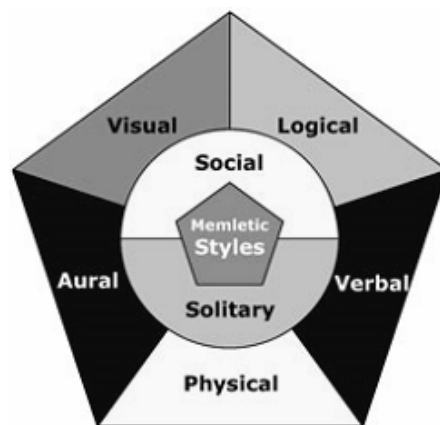
### **Psychological backgrounds of personalization**

As mentioned above, in classroom teaching a good teacher is able to differentiate and adapt learning methods to the current needs of the students. One way of doing so is to recognize the individual learning styles of the learners. This recognition can come from the teacher’s own experience, but it can also be supported by various inventories aimed at measuring learning styles according to the theory applied for establishing them. For instance, Felder (1998) says that when the background for classification is Carl Jung’s theory of personality types (extroverts, sensory, thinkers and judgers) 16 different learning styles are usually named and measured. Meyers-Briggs Type Indicator (MBTI - <http://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/>) and Paragon Learning Style Inventory (<http://www.oswego.edu/plsi/>) are the well known examples of inventories used for that purpose. Alternatively the Hermann Brain Dominance Instrument (HBDI - <http://www.hbdi.com/>) classifies learners’ preferences for thinking in four different modes based on the task-specialized functioning of the physical brain (left brain, cerebral, left brain, limbic, right brain, cerebral, right brain, limbic). Another well known type of learning styles indicator was elaborated by David Kolb (initialized in 1975 and continuously developed). The questionnaire allows one to distinguish four learning styles: diverging, assimilating, converging and accommodating. Those styles have been derived according to Kolb’s four

stage cycle (Kolb learning styles - <http://www.businessballs.com/kolblearningstyles.htm>)<sup>1</sup> of experiential learning that includes the following processes: concrete experience, reflective observation, abstract conceptualization and active experimentation.

A slightly different approach is presented in the Memletic Learning Styles Inventory elaborated by Sean Whiteley (<http://www.accelerated-learning-online.com/styles/default.asp>). Seven different learning styles are recognized by this inventory in accordance with seven types of intelligence indicated by Gardner in 1983: **verbal** (linguistic), **visual**, **aural**, **logical** and **physical** and with regard to our relations with others participants of learning **solitary** and **social** learning styles (see Figure 1).

Figure 1: Memletic learning styles



(Source: <http://www.learning-styles-online.com/overview/>)

However, while the outcome of a typical learning styles inventory is normally one dominating learning style (or, in some cases, two of them) Memletic LSI gives the information about the extent to what each of seven learning styles is used by a particular learner. Such indications are particularly important to e-learning as the learning content must be, for the most part, prepared in advance and is difficult to adapt “on the spot” according to learners’ needs. If the initial recognition of learning style, measured by applied learning styles inventory, was not precise (there can be many reasons for that) all learning throughout the course will be affected. An approach based on recognition of various learning styles helps to soften the consequences of such incorrect diagnosis.

The only problem that remains then is to prepare the appropriate content in a way that corresponds with indications of learning preferences described by the learning styles. This can be a significant obstacle because of the amount of work and time the preparation of such content requires. The same pieces of information should be presented in a text form in order to satisfy those who prefer verbal style, in a form of a video recording for those with dominating visual style or as an audio file for the learners with aural learning preferences. It would be also advisable to prepare additional graphs, flowcharts or tables where possible, for those who better absorb the knowledge presented in a structured and logical way. The same applies to course activities which should take into account both individual and group work. Such redundancy with regard to learning content obviously requires much more work and

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<sup>1</sup> a model of learning styles defined by Kolb can be found on a given website but LS Inventory itself is currently not available for free, it can be purchased from Hay Group ([http://www.haygroup.com/tl/Questionnaires\\_Workbooks/Kolb\\_Learning\\_Style\\_Inventory.aspx](http://www.haygroup.com/tl/Questionnaires_Workbooks/Kolb_Learning_Style_Inventory.aspx)) [7.02.2009]

time, but the effort put in it can be consumed in many various ways. This approach corresponds very well with the concept of RLO (Reusable Learning Objects), which is aimed at multiple use of the learning content stored in repositories of digital resources. This concept says that if learning content is divided into small learning objects stored in a repository then those objects can be linked and used in many different ways and therefore can serve as a “building material” for creating new courses. Such courses may differ in the level of advancement, for instance. In some courses particular group of learning objects can be used in an introductory part, whereas in the others the same pieces would constitute their main part. In the context of personalization different learning objects can be used in order to create personally tailored courses.

### **Research aims and scope**

The purpose of the research project described in this paper was to investigate the possibility of implementing personalization tools in a Virtual Learning Environment (VLE). The concept of personalization was based on Howard Gardner’s Multiple Intelligence Theory. Three separate steps/phases of the project can be distinguished. The first one – already completed – aimed at elaborating a tool for gathering the data about the learners’ individual preferences. In this phase some statistical analysis was performed with the use of data mining techniques.

The main goal of step two is to define the structure of a knowledge base (learning content repository), which could be used for personalization purposes. Such databases should fulfil three main requirements:

- the content must be divided into little “portions” called Learning Objects, which can be joined together in order to create a new online course;
- the same content should be stored in various forms (e.g., text, audio or video recording, graphic representation (table, flowchart));
- the way of combining different LOs must be defined.

The third step of research is aimed at implementing an intelligent steering algorithm in chosen LMS (Learning Management System). Its intelligence comes not only from the use of AI techniques but first of all from its ability to ‘learn’ and to generate the set of indications describing the needs of particular learners with regard to learning content, which should be prepared for them. The role of such an algorithm is to enable the system to interpret information concerning a learner’s preferences and to create a tailored online course corresponding with those preferences. In the pilot phase of research the algorithm will be implemented in a system used by the Warsaw School of Economics ([www.e-sgh.pl](http://www.e-sgh.pl)), but plans are to test the solution in conjunction with other e-learning platforms such as Moodle .

### **Collected data and its interpretation**

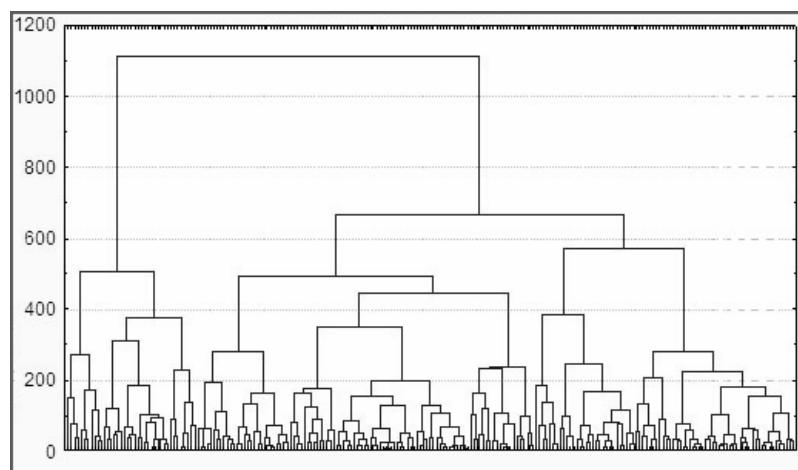
During the research study questionnaire data from 220 students was collected. There were two major groups of respondents: 160 people were university students; 60 others were upper secondary school students. The structure of the first group was composed in a way that it should represent various subjects of study and it covered such faculties as mathematics, informatics, Polish literature and linguistics, German language studies, political sciences and social science as well as the faculty of psychology and faculty of pedagogy. The students were mostly in the 6<sup>th</sup> term, some of them in the 4<sup>th</sup>. The secondary school group was more homogenous – all the students went to the same school. The purpose of including this group was to compare how the learning styles change with age and educational level. The diversity

of the first group was planned in order to check the dependence of learning styles on the subject.

Not surprisingly, despite many visible similarities among the students belonging to the same group (school or university class), every single set of data derived from a questionnaire was different. This is obviously a natural consequence of the fact that every one of us has his or her unique personality. But when we intend to reflect a reality in an artificial system we have to make some simplifications as such diversity cannot be practically accommodated. That is why the analysis of collected data was aimed at distinguishing a group of sample learners' profiles that would represent various individuals. For such a group the initial version of the steering algorithm can be prepared and tested. As no simple rules enable finding the subsets of learners represented by the same profile some artificial intelligence techniques were used. Actually a two step approach was undertaken. During the first phase cluster analysis was used in order to divide the population of 220 learners into several clusters. Each cluster would represent a different learning profile. As the number of possible clusters was unknown the agglomeration method was used. Various types of linkage and different possible metrics were tested. Figure 2 shows a sample cluster dendrogram illustrating clustering results by complete linkage and Euclidean metric (some other metrics like exponent metric, i.e., generalized Euclidean distance and Manhattan have also been tested).

The X axis in Figure 2 illustrates the objects: in this context they are the respondents. As can be seen some clusters of those objects can be distinguished. Their number depends on the level of clustering we choose, i.e. on the accuracy we allow while deciding whether two objects can be concerned as being similar or not. The measure of similarity in this context is a "distance" between the values describing two objects being compared. The smaller the distance the bigger is the number of groups (clusters). These clusters refer to various profiles of learners we try to distinguish and define in order to make the task finite. In this step of research the most important task, however, was to prepare a tool that would enable collecting the data about the learners and this tool will be described in the following section.

Figure 2: Cluster analysis of collected data – Euclidean metrics

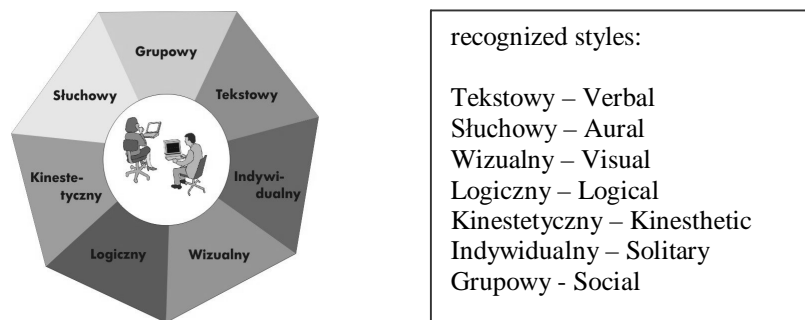


### KS-TIW Questionnaire

As already mentioned the most commonly used means of collecting data concerning user's profile is a questionnaire. Many such tools are in electronic version which can be quite easily included within the e-learning platform. For the purpose of the research described in

this paper a questionnaire based on Howard Gardner’s Multiple Intelligence theory and Memletics Learning Styles Inventory has been elaborated. The questionnaire has the acronym KS-TIW from its Polish name, which can be translated into English as Learning Styles Questionnaire based on Multiple Intelligences Theory. This is not simply a translation from the English version, but a model built on the same backgrounds. Learning styles are strongly dependent on cultural and educational context, which means that the questions must correspond with educational experience and the conditions one grew up in and therefore cannot be directly transferred from another environment. However the styles recognized by the questionnaire remained unchanged. Memletic inventory alike KS-TIW analyzes 7 styles linked to 7 intelligences indicated by H. Gardner.

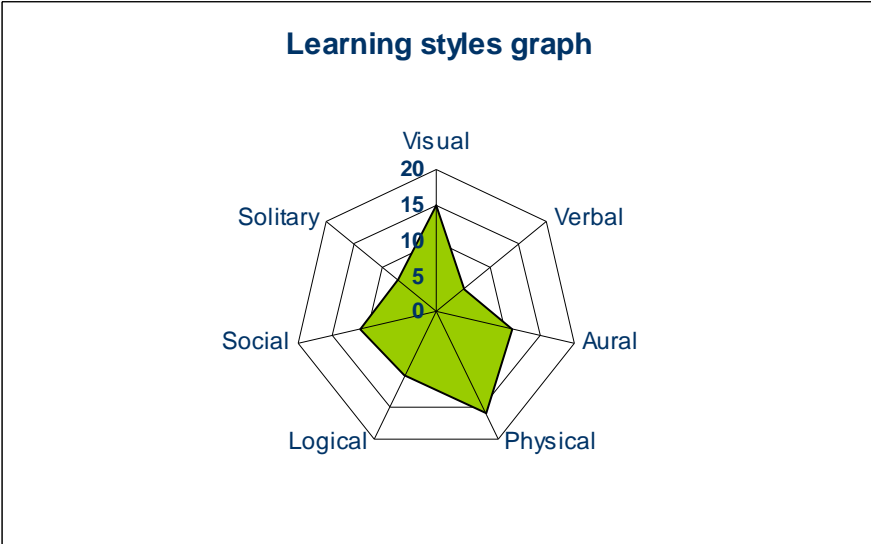
Figure 3: Learning styles recognized by KS-TIW questionnaire



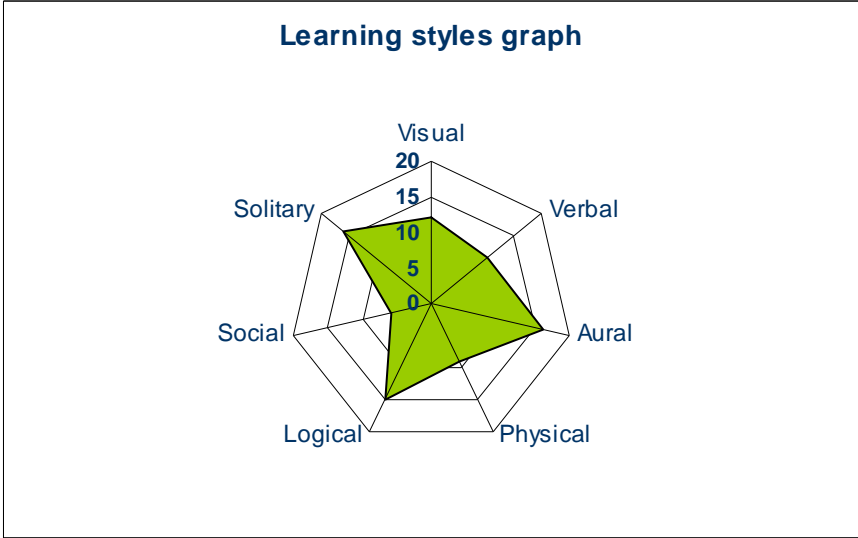
The questionnaire consists of 70 questions divided into 7 groups related to the 7 learning styles being recognized. Its role in the system is to elicit the information about possible learning styles of the potential learners. The maximum number of marks one can get for every single style is 20. That means each person is represented by the set of 7 values, ranged from 0 to 20, which illustrate the ‘involvement’ of every recognized learning style in one’s learning process. The results can also be presented in a graphic form. Figure 4 shows chosen graphs based on KS-TIW data. In Figure 4a we can spot the dominance of visual and physical learning styles. The first one indicates strong preferences to visual way of presenting the learning content, which may refer for instance to pictures or photographs. Also tables belong to visual form of presenting the data. As this person has quite a high value of Aural style those two styles together (visual and aural) can indicate the preference to absorb knowledge delivered as video recordings. The other really important learning style for this person is Physical, which means that this person prefers “learning by doing”. As the social dimension for this learner is a bit greater than solitary probably the group work will be more appropriate than individual studying. Figure 4b shows slightly different preferences – we can presume that although aural perception is also effective for this person more attention should be put into logical structure of learning content. In addition, for this person individual tasks are more suitable than group work.

Figure 4: Graphical visualization of learning styles

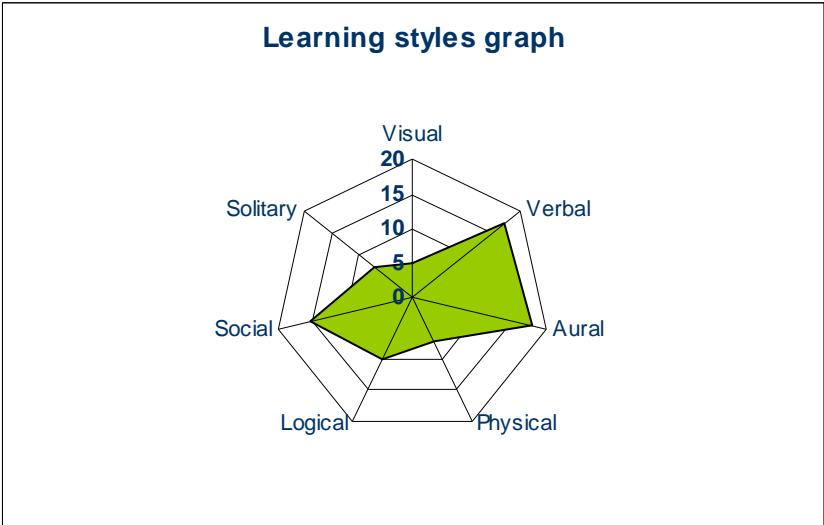
(a) dominance of visual and physical learning styles



(b) dominance of solitary, aural and logical learning styles



(c) dominance of social, aural and verbal learning styles



With regard to the styles of a person represented by Figure 4c one can spot that verbal delivery of knowledge (e.g. descriptions and explanations) both in written and in aural form are most important. Also the big difference between social and solitary styles implies the preference to group work and not individual tasks. The purpose of this brief analysis was to illustrate that information derived from learning styles individual profiles can be applied in construction of personalized courses.

### **Implications for Online Learning**

With regard to online courses learning styles can provide information on the form in which the learning content should be presented. A visual learning style implies the use of graphs, tables, illustrations and photos appropriately to the subject being taught. Video recordings will also be advisable in that case. The dominance of a verbal learning style indicates that the main means of presenting the information should be text – both written and as an audio recording. The logical learning style can be successfully supported by various tasks and problems to be solved. With regard to physical learning styles in online learning contexts, it may be valuable to use simulations to solve problems and to use some sort of educational games. All these indications must be combined with appropriate social inclinations. In other words the combination of logical and social styles may lead to the use of group work like case studies or project work, while logical and solitary styles may indicate that logical puzzles and crosswords are more advisable for that particular learner. These are only a few examples of possible combinations of content and activities linked together in an online course in order to make it better adjusted to one's individual needs. Needless to say, such approach requires considerable effort in preparing the learning content. More precise analysis of the possible structure of online courses in the context of personalization will be the subject of further research.

### **Technical Aspects of Preparing the Content of the Repository**

As indicated while presenting the scope of research, the repository of learning content that will be used by a personalised LMS should be prepared according to strictly defined rules. The most important among them is the requirement for the appropriate structure of data stored in the repository. This refers not only to the type, size and form of individual learning objects but also to the way the learning material is divided into little “bricks”. Actually both parts of this task may not be trivial and cannot be done automatically. Much more difficult, however, is a precise description of the sequence in which the individual objects appear in a course. Also, which of them can be combined or linked together and which of them imply the necessity of the others.

From a technical point of view some specifications already exist which can be applied for this purpose. For instance, the IEEE Learning Object Metadata (LOM) standard offers some commonly used items for description of typical learning objects grouped into several categories. Moreover, the IMS learning design specification allows adding to this description some pieces of necessary information concerning pedagogical aspects and learning objectives. And last but not least, the idea of RDF (Resource Description Framework) graphs proposed by W3C's Semantic Web working group seems to be very useful. It is based on a model of

entities and properties. Entities in this context are learning objects and the properties are their characteristics, attributes, aspects or relations to other entities.

An appropriate set of metadata built in accordance to these standards must describe all the learning objects stored in a repository that will be used as a knowledge base for the online learning system.

## Conclusions

The problem of personalization in online learning remains the focus of attention of many researchers nowadays. Various attempts have been undertaken but only some of the solutions are practically useful for teaching. Sophisticated web-based Adaptive Hypermedia systems as well as Intelligent Tutorial systems are often oriented on one type of task, for instance quizzes or assessments, and therefore cannot be used for other purposes (Brusilovsky, 2003). Moreover, their content is not shareable and this obstacle blocks their popularization. Also, according to Brusilovsky, some of them are adjusted to the needs of their authors and are not easily adaptive to learning conditions, other than those defined for a particular, experimental case.

In this paper another approach has been presented. The author and her colleagues from The Pedagogical University Krakow, Poland started to carry out research that would allow implementing some personalization tools directly in LMS already used at the university. Personalization is in this case based on learning styles theory and an appropriate questionnaire has been adapted to the virtual environment. Its role was to collect the data necessary to define the possible profiles of the learners. This phase of work has been already described in the paper and was the first part of the project. The other parts will be aimed at distinguishing possible elements of online courses with regard to their usefulness for personalization purposes. The last part should allow us to define the structure of Reusable Learning Objects and metadata that will describe them in order to enable their proper linking adequately in the structure of personalized e-learning course.

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