Intelligent Information Technologies:
Concepts, Methodologies, Tools, and Applications

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Chapter 5.5
Using Emotional Intelligence in Personalized Adaptation

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ABSTRACT

The process of training and learning in Web-based and ubiquitous environments brings a new sense of adaptation. With the development of more sophisticated environments, the need for them to take into account the user's traits, as well as the user's devices on which the training is executed, has become an important issue in the domain of building novel training and learning environments. This chapter introduces an approach to the realization of personalized adaptation. According to the fact that we are dealing with the stereotypes of e-learners, having in mind emotional intelligence concepts to help in adaptation to the e-learners real needs and known preferences, we have called this system eQ. It stands for the using of the emotional intelligence concepts on the Web.

INSIDE CHAPTER

The process of training and learning in Web-based and ubiquitous environments brings a new sense of adaptation. With the development of more sophisticated environments, the need for them to take into account the user's traits, as well as a user's devices on which the training is executed, and to place them within the context of the training activities, has become an important issue in the domain of building novel training and learning environments. Personalized adaptation represents a key aspect in technology enhanced learning and training communities. Different users could have different learning needs and preferences, and they could have different knowledge levels, as well as different opportunities to use certain training methods related to the fact that both users and theirs labs are placed in physical world. The chapter presents an approach to the realization of personalized adaptation according

to the individual user's traits, such as: personality factors, cognitive factors, learning styles, and personality types (stereotypes) on one side, and user's devices on which the training is executed on the other side. At the same time, we are interested in how to manage teaching resources when the e-learners have different emotions, perceptions, and reactions. Because that we are dealing with the stereotypes of e-learners, having in mind emotional intelligence concepts to help in adaptation to the e-learners real needs and known preferences, we have named this system eQ, which stands for the using of emotional intelligence on the Web (electronic emotional intelligence). There are several key paradigms being used in the conceptual design of the eQ system: (1) this approach is based on using a multiagent system with the belief-design-intention agent rational model, (2) the eQ system is initially defined by considering component-based definition of the adaptive educational hypermedia system, (3) the eQ system uses the FOSP adaptive learning strategy, and (4) the main aim of the eQ system is to improve the adaptation processes in the Semantic Web and Grid environment.

INTRODUCTION

The history of learning can be followed back to ancient Greece, where Socrates used tutorial learning. Plato established one of the earliest known organized schools in Western civilization, the Academy in Athens, and further developed the form of live dialogue. Aristotle considered learning by doing as an efficient way of education. Already, in the 17th century Comenius wrote that learning has to be adjusted to the learner's abilities. Each person learns differently and needs to develop their own learning skills in their own way. Looking into the past we can see that ideas about how to learn are not new. However, what is new are the circumstances and opportunities. The existing school system is suitable for the industrial age, when manufacturing processes were performed in a routine way. The knowledge age demands higher skilled jobs based on critical thinking, creativity, collaboration, and interpretation abilities. Additionally, the percentage of "knowledge workers" is rapidly increasing and 50% of all employee skills become outdated in three to five years (Moe & Blodgett, 2000). Therefore, using only traditional methods cannot cover today's educational needs. Many relevant authorities have recognized the new demands on one hand and new potential on the other. In the following we mention some of them.

Peter Drucker sees new horizons. *"For the first time substantial and rapidly growing number of people have choices. For the first time, they will have to manage themselves. And society is totally unprepared for it."* He cites Plutarch in Drucker (1989), saying that education requires a focus on the strengths and talents of learners:

Any teacher of young artist—musicians, actors, painters—knows this. So does any teacher of young athletes. But schools do not do it. They focus instead on a learner's weaknesses. One cannot build performance on weaknesses, even corrected ones; one can build performance only on strengths. And these the schools traditionally ignore, in fact, consider more or less irrelevant. Strengths do not create problems—and schools are problem-focused.

Alfred Bork (2001) considers current and new paradigms concerning technology and learning. The current main learning paradigm, called *information transfer* or *classroom-teacher paradigm*, envisions the primary aim of learning as the acquisition of information. Its major auxiliary learning technology is the textbook. The author argues that we need much better learning for all and this learning has to be affordable for the individual and the world. Therefore, he predicts a future paradigm—*tutorial learning.* It sees learning as fully active, focusing on the student

as learner rather than on authority figures giving information. *Tutorial learning* refers to the type of learning that takes place between a highly skilled tutor and the student, or a small group of students. The main problem related to this form of learning was that there were few good tutors, and it is a very expensive way of learning. But what makes the difference now is the available technology to rebuild learning and make it more interactive, individualized, and adaptive. *"For the first time we have the possibility of educating everyone on earth to each person's full potential."*

Wayne Hodgins (2005) presents the grand vision of *meLearning* that will provide personalized learning experiences to every person on the planet every day. When the learner is ready, the "teacher" will appear.

Roger C. Schank (2002) revises the concept *intelligence*. In the past, education and intelligence was built on accumulation of facts and ability to cite opinions of others. Today in school, pupils learn how to answer instead of how to query. The easier it is to get information, the lower its value. But the value of good questions increases. In a scenario from the future, when an issue arises, one can easily get related opinions of relevant authorities in a preferred form. If it is not enough, one can discuss the problem with other (suitable) people (all over the world) who are just dealing with a similar issue or with currently available instructors. In the future, intelligence will mean ability to reach the boundaries of the knowledge base.

Each person learns differently and needs to develop own learning skills in his or her own way. This is a reason why we explore using *emotional intelligence* (eQ) in learning on the Web (Web-based learning).

The main technological challenges and requirements for the next generation Web and Grid systems can be fulfilled by using emerging technologies, such as:

- **The Semantic Web:** This represents the idea of having data on the Web defined and linked in a way that can be used for more effective discovery, automation, semantic integration, metadata annotation, and reuse across various applications (W3C, 2001).
- **The Semantic Grid:** This attempts to extend the Semantic Web approaches and solutions to take into account Grid characteristics.
- **Knowledge Grid:** This offers high-level tools and techniques for distributed knowledge extraction from data repositories on the Grid.
- **Adaptive Web systems:** These are able to adjust to different user requirements and to manage sources of heterogeneity.
- **Peer-to-peer (P2P) architecture:** This considers a set of protocols, a computing model, and a design philosophy for distributed, decentralized, and self-organizing systems.
- **Ubiquitous computing (pervasive computing):** This describes distributed computing devices, such as personal devices, wearable computers, and sensors in the environment,

Figure 1. The process for developing eQ online
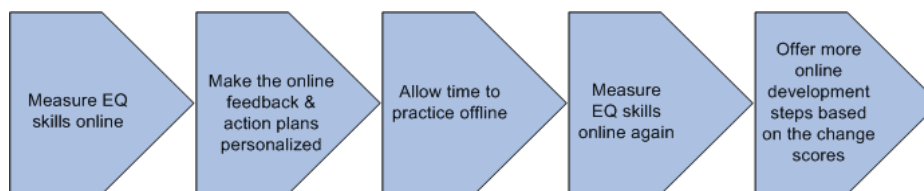
as well as the software and hardware infrastructures needed to support applications on these computing devices.

Adaptation represents an important factor in building intelligent educational systems, with the aim to facilitate learning processes and to improve the learning efficiency through adjustment to real user needs. On one side, there are methods and techniques of adaptive hypermedia (AH) systems, as well as user modelling and personalization/adaptation methods, such as Brusilovsky (2001, 2003):

- **"pre-Web" generation of AH systems:** They explore adaptive presentation and adaptive navigation support and are concentrate on modelling user knowledge and goals.
- **"Web" generation of AH systems:** They explore adaptive content selection and adaptive recommendation based on modelling user interests.
- *"*Mobile**" generation of AH systems:** They explore using of known adaptation technologies with the aim to adapt to both an individual user and a context of his/her work.

On the other side, there is an opportunity for using new technologies and standards, such as metadata, Semantic Web, Web services, Semantic Web services, as well as the Semantic Grid. Development of the Semantic Grid has led to new achievements, such as OWL (Web Ontology Language) for expressing ontologies in a way that supports interoperability between systems. A key motivation for the semantic interoperability is the need to assemble new applications, as well as new tools and equipment for cooperation in order to provide the requisite global behaviour, without manual intervention (De Roure & Hendler, 2004).

In this chapter, we explore the impact of using AH systems in the Semantic Grid environment with the aim to point out certain potentials in further learning on the Web, as well as to show the way to increase learning efficiency. The Semantic Grid must be able to interoperate with a large-scale spectrum of current and emerging hardware and software technologies, on one side, and with a different user's profiles on the other side. Different users prefer different presentation forms: some prefer multimedia contents (graphical material and hypertext documents, simulations, presentations); others use traditional web pages (questionnaires, exercises, research study).

Figure 2. An extension of the IEEE PAPI learner preference information (IEEE 1484.2.24)
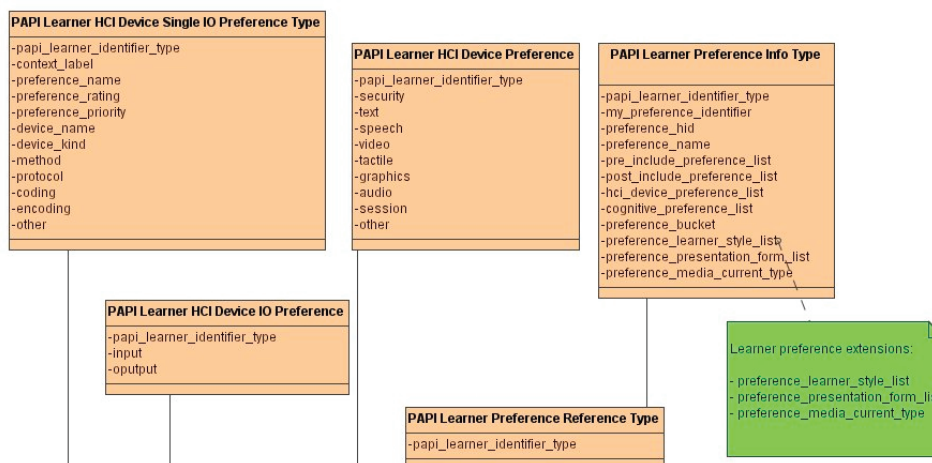
This chapter presents an approach to the realization of personalized adaptation according to the individual user's traits, such as: (1) personality factors, (2) cognitive factors, (3) learning style, and (4) personality types (stereotypes). Different users could have different learning needs and preferences, different knowledge levels, and different opportunities to use certain training methods and equipment.

The chapter first provides an overview of personalized adaptation and the adaptive educational hypermedia systems. In addition, this chapter explains the role of context, content, and adaptation management parts in building multiagent systems for personalized adaptation. Then, the key paradigms of the eQ agent system are discussed in detail. In the following section, implementation of our eQ agent system is presented. Chapter five explains fine art professional training, ACCADEMI@VINCIANA, and two examples of using eQ agent system in improving the adaptation process in the Semantic Web and Grid environment: (1) e-learner is a preschool child, and (2) e-learner is an expert in the domain of painting technologies. The last section contains some conclusion remarks.

USING PERSONALIZED ADAPTATION IN LEARNING

We can see certain similarities and parallels between the delivery processes in art and education, especially in their two forms, artefact and experience. This can illustrate the difference between learning objects and learning design, as well as the various degree of adaptation provided by different media.

In both areas artefacts are produced by authors—writers produce books, painters produce paintings, and composers produce compositions. On the other side, domain experts with pedagogical background write textbooks. These artefacts typically require active processing from their us-ers, interpretation, and usually a require a higher degree of imaginative involvement to integrate the message into their minds.

Another form of delivery is experience—books and scenarios are interpreted by actors in plays and movies, and musicians interpret compositions in concerts. Also, traditional (*objectivist*) teaching is based mostly on the interpretation of textbooks by teachers and trainers. In these cases, the audience's mental processing is usually more passive as some abstract dimensions of the original artefact become concrete and therefore do not need so much imagination to be activated; typically the interpretation is more unambiguous.

In both art and education there is a transformation process between the artefact and experience. In art it is controlled by directors or conductors during rehearsals. Teachers are educated how to interpret textbooks during their pedagogical study. In modern (*constructivist*) forms of teaching they overtake the mediator or guide role and the performers are learners themselves instead of teachers, resulting in a very active participation, possibly fully embedded in the learning experience (e.g., field trips).

Personalized adaptation represents a key aspect in technology enhanced learning and training communities. This implies the requirement of a reactive and decentralized platform that can make informed decisions about how to respond to changes of the user's preferences, device capability, enterprise policy, and many other environmental factors. Roughly speaking, the main aim of personalized adaptation is to support ubiquitous, decentralized, agent-based systems and devices for learning, training, and doing well in different environments.

Development of a sharable digital library of learning and training resources can be useful in various systems, such as computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. At the same time, there

Figure 3. An extension of the IEEE PAPI learner portfolio information (IEEE 1484.2.26)
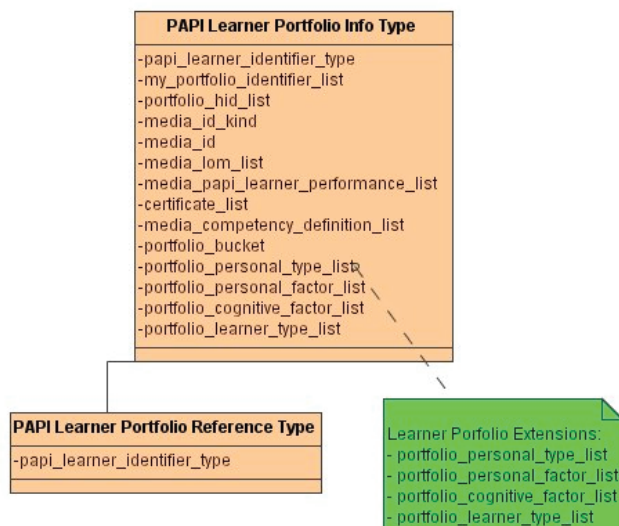
are different resources types, such as graphical material and hypertext documents, simulations, questionnaires, exercises, presentations, research study, experiments, and much more.

In this chapter, we propose using concepts of emotional intelligence (eQ) with the aim to achieve adaptivity in the domain that can be collectively referred to as a "context" in professional learning and training environments. More recently, the notion of eQ has attracted increased attention as one of the prerequisites for improving student's learning. Starting from the preliminary definition of eQ, originally proposed in Salovey and Mayer (2000), we describe eQ as *"a person's ability to understand learning emotions and to act appropriately based on this understanding."*

eQ represents an essential part of effective communication and adaptability, especially in the field of education, to support the user being more emotionally and socially intelligent, and to reduce negative behaviours. Web environment represents the perfect place to measure eQ skills and offer new suggestions for practicing these skills. The process for developing eQ online (Bradberry &

Greaves, 2003) is shown in Figure 1, as well as in context management part of Figure 5.

The Role of Context, Content, and Adaptation Management

Based on experience from the development of adaptive educational hypermedia authoring tools (Kravcik, Specht, & Oppermann, 2004), the authors suggest that an efficient AH system should contains the following three parts:
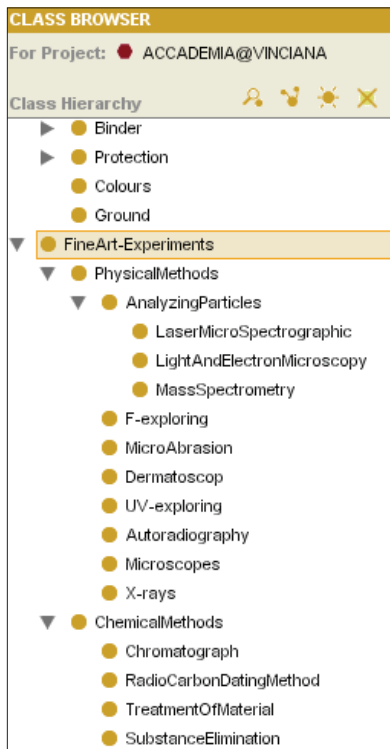
- Context management
- Content management
- Adaptation management

Some of the more significant roles of each of these parts are discussed.

Context Management

Context management includes user modelling, enabling reusability, and sharing of the user model by various adaptive applications and user devices.

Figure 4. One part of the domain ontology - AC-CADEMI@VINCIANA

In other words, context managers can be used to collect, collate, and process context information about users. The goal of this part is to design and implement a mechanism by which context information can be updated and distributed. Context management must be able to detect modification and addition of user's characteristics, and it must have location awareness module, as well as a component that provides data about enterprise policy (Robinson, 2000).

The approach represented here is based on modelling stereotypical models of user individual traits for adaptation. These individual traits include the following:

- Personality factors (extrovert, introvert)

- Cognitive factors (perceptual processing, phonological awareness, ability to maintain attentional focus)
- Learning styles (moving, touching, doing, auditory, visual)
- Personality types (conventional, social, investigative, artistic, realistic, and enterprising personality)
- Information about user's devices

All of these individual traits could be extracted by using specially designed psychological tests that perform multiagent systems represented as a distributed test-sensor system. The ontology for adaptation is made from context information about users, as well as about user's devices. This ontology is based on using the IEEE PAPI (Public and Private Information) Standard, which represents (IEEE PAPI, 2001):

A data interchange specification that describes learner information for communication among cooperating systems.

The IEEE PAPI Standard is extended to the parts that are related to the learner *preference information* (IEEE 1484.2.24), as well as the learner *portfolio information* (IEEE 1484.2.26) (shown in Figure 2, as well as Figure 3). These extensions are made with the aim of enabling using eQ concepts during the learning processes on the Web.

Content Management

The content management part maintains the domain model (learning objects with metadata, semantic concept networks/ontologies) and supports the authoring process (separation of content and layout, their reusability, semi-automatic annotation) (Kravcik, 2004). As an example of professional training domain, we have represented the ontology ACCADEMI@VINCIANA. This ontology involves solid team of experts from the

area of fine art conservation and restoration, as well as physics and chemistry. It has three main parts, with the knowledge supporting the following (Damjanovic, Kravcik, & Devedzic, 2005):

- Learning about fine art painting methods and materials (education: painting methods and materials, conservation treatments, preventive conservation strategies, restoration, reproduction)
- Training on fine art painting methods and materials (education, classical painting technology analysis, painting damage diagnosis)
- Art Fraud E-detection (author identification, original expertise, fraud detection)

The ontology ACCADEMI@VINCIANA has several dimensions concerning professional training's intentions. First, this ontology describes three fundamental painting components, as well as their role in the construction of painting. These components could be explained as follows: colours (represent main artistic instrumentation), ground (represents the base, the underlay of painting), and binder (represents an important factor to firm adherence of colours to the ground). Second, this ontology observes fundamental aspects for analyzing painting methods and techniques. These aspects can be considered as follows (Kraigher-Hozo, 1991):

- **Purpose and usage:** icon, miniature, illumination, altar painting,
- **Ground material:** stone, tree, glass, ivory, parchment, canvas, paper, cardboard,
- **Binder and colours:** chalk, carbon, aquarelle, pastel, tempera, oil, encaustic,
- **Painting tools:** quill, cane, brush, air brush, artistic knife, aerograph,
- **Painting methods and techniques:** proplasmos, glykasmos, verdaccio, puntegiaro, trattegiaro, fa presto, impasto, alla prima, collage, frottage.

Third, ACCADEMI@VINCIANA ontology can be divided into the following two categories of trainings (Kraigher-Hozo, 1991) (shown in Figure 4):

- Trainings made by using physical methods
- Trainings made by using chemical methods

Trainings made by using Physical Methods

This includes trainings that could be performed by using (Kraigher-Hozo, 1991):

- **Dermatoscope:** For non-invasive diagnosis
- **Micro abrasion equipments:** For drilling micron level holes, and cutting or marking fragile or otherwise difficult materials
- **Microscopes:** For histological analyzing of paintings
- **Exploring the nanostructures of painting materials with X-rays:** This method show solid results in uncovering fraud, as well as in exploring the way of building paintings
- **UV exploring:** It can be used to learn the process of building paintings up to the identification of original
- **Fluorescent microscope (F-exploring):** It can be used to explore homogeneity of varnish and other transparent layers
- **Analyzing particles (protons, neurons):** ESA (Emission Spectral Analyze) (laser), Laser micro spectrographic analysis, Light and electron microscopy (scanning), Mass spectrometry, DBA (*Debye-Scherrer* Analyze) (analyzing small particles);
- **Autoradiography:** It can be useful for microscopic fluorescent measurements.

Trainings made by using Chemical Methods

This includes trainings that could be performed by using (Kraigher-Hozo, 1991):

- Microchemistry approach with pigments identification, emission spectral analysis, the iodine probe, DBA …
- **Chromatograph:** Substance that reacts on certain components (for example, if the re-agent is protein, substance will be coloured red).
- **Exploring substance elimination:** Binders have different behaviours when they are heated in water (wax is smelted at 60ºC, oil at 160ºC).
- **Different treatments of certain material:** Burning samples, exposing samples to the rays of the sun or to the X-rays, high temperature, …

- **Radio carbon dating method:** One of the most widely used and best known absolute dating methods, based on the decay rate and half-time of C-14 (an unstable isotope of carbon).

All of these physical and chemical methods and devices could be used to explore and make artistic trainings with the aim to learn about painting methods and materials, as well as to explore and diagnose conservation strategies, originality, author identification, forgery, and much more (Damjanovic, Kravcik, & Devedzic, 2005).

Adaptation Management

Adaptation can be thought of as the behaviour of an entity in response to both changes in context management and needs in content management part. The adaptation manager could be used directly by an application that pushes relevant

Figure 5. Conceptual design of the eQ agent system
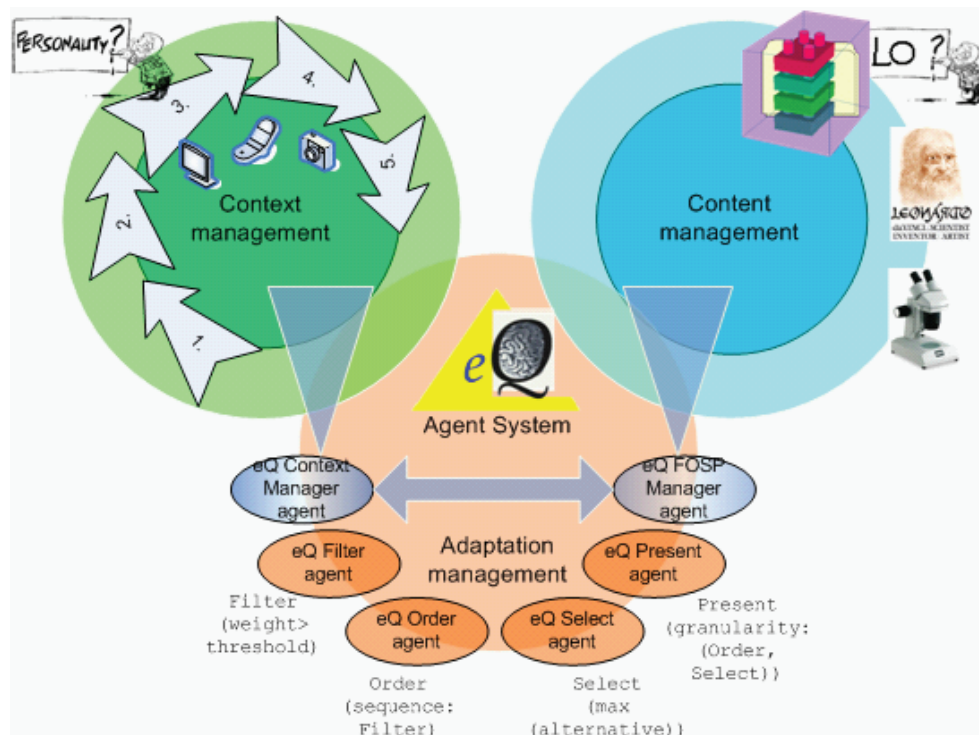
information to a user based on the user's stereo-type and the user's learning and training needs. In this chapter, the adaptation manager decides to modify presentation content by using the FOSP (filter-order-select-present) adaptive learning strategy (Kravcik, 2004) that will be discussed in detail.

Figure 5 shows the conceptual design of the eQ agent system (Damjanovic, Kravcik, & Devedzic, 2005). *Context management part* is related to the first level of personalized adaptation in which using eQ concepts are made. The process for developing eQ online includes the following:

1. Measure eQ skills online
2. Make the online feedback and action plans personalized
3. Allow time to practice offline
4. Measure eQ skills online again
5. Offer more online development steps based on the change scores

Content management part includes learning objects (LOs), semantic metadata about learning materials, and training devices. *Adaptation management part* consists of the eQ agent system, which performs the proposed FOSP adaptive strategy.

Adaptive Educational Hypermedia Systems

Development of the AH systems can be roughly divided into three generations of research (Brusi-lovsky, 2004):

- The first generation describes pre-Web hypertext and hypermedia (before 1996).
- The second generation is devoted to the Web-based AH systems (between 1996 and 2002).
- The third generation explores advanced developing technologies for "open corpus AH" and developing a component-based

Figure 6. Personality types (stereotypes)

architecture for assembling adaptive Web-based educational systems (since 2002).

Recently, the impacts of many technology trends in further development of the AH systems can be noticed. These impacts can be considered as developing comprehensive frameworks for adaptive Web-based education, developing more intelligent educational material by using learning object metadata (LOM), and exploring the ideas of the Semantic Web for content representation and resource discovery.

The main characteristics of the AH system is their ability of adaptation to the following (Brusilovsky, 2001):

- **User characteristics:** User goals/tasks, knowledge, background, hyperspace experiences, preferences, interests, and individual traits. When we consider learning processes, we should observe some pedagogical attributes of learners, such as: teaching style, interaction style, grade level, and mastery level.
- **User environment:** Encompasses all aspects of the user environment that are not related to the users themselves, such as location, computing platform, bandwidth, and so on. Environment variables specify search paths for files, directories for temporary files, ap-

plication-specific options, and other similar information.

The user characteristics might be determined by modelling users or by modelling groups of users with similar requirements (stereotypes). So, user models may be individual or stereotypical (Henze & Nejdl, 2003). In this chapter, we explore adaptation to the user's individual traits (personality factors, cognitive factors, learning styles, personality types). As it has been mentioned in Brusilovsky (2001), many researchers agree on the importance of modelling and using individual traits for adaptation, but there is little agreement on which features can and should be used, or how to use them.

One of the most popular kind of AH system is that one dedicated to the learning on the Web, known as the Adaptive Educational Hypermedia (AEH) system. Notable definitions of the AH, as well as AEH systems, could be mentioned:

AH system *(Brusilovsky, 1996): "By adaptive hypermedia systems we mean all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user."*

AEH system *(Henze & Nejdl, 2003): "An adaptive education hypermedia system is a quadruple."*

(DOCS, UM, OBS, AC)

$$(1)$$

Each component represented in (1) can be briefly described as follows (Henze & Nejdl, 2003):

- **DOCS** (**DOC**ument **S**pace): A finite set of first-order logic (FOL) sentences with constant symbols for describing documents (and knowledge concepts), and predicates for defining relations between these (and other) constant symbols.

- **UM** (**U**ser **M**odel): A finite set of FOL sentences with constant symbols for describing individual users (user groups), and user characteristics, as well as predicates and formulas for expressing whether a characteristic applies to the user.
- **OBS** (**OBS**ervation): A finite set of FOL sentences with constant symbols for describing observation, and predicates for relating users, documents/concepts, and observations.
- **AC** (**A**daptation **C**omponent): A finite set of FOL sentences with formulas for describing adaptive functionality (rules for adaptive functionality, rules for adaptive treatment)."

Our approach is based on modelling stereotypical models of user's individual traits for adaptation. We have used the *Jung/Briggs-Myers* typology of personality (Berens, 2002) in modelling the following basic personality types (stereotypes) (shown in Figure 6): (1) conventional personality, (2) social personality, (3) investigative personality, (4) artistic personality, (5) realistic personality, and (6) enterprising personality.

Individual traits can be extracted by using specially designed psychological tests. Moreover, several studies that have explored the use of individual traits in adaptation to the different user profiles (stereotypes) have concluded without finding any significant differences (Brusilovsky, 2001). As a possible solution, there is a need to have a certain relation between user traits on one side, and possible interface settings on the other side. It can be realized through building a repository of different metadata for adaptation that can be used, together with different catalogues of metadata, for education.

Current researches about the use of educational metadata are concentrated on applications of LOM standards (e.g., IEEE LOM). The main purpose of these standards is to improve reusability of LOs. LOM standards are supported by many LOs

repositories (e.g., ARIADNE). LOs repositories represent an important research topic, which is connected through peer-to-peer (P2P) networks (e.g., Edutella). ELENA project is a closely related system that tries to employ ontology-based reasoning in adaptive Web-based systems (Dolog, Henze, Nejdl, & Sintek, 2003). This system uses user model ontology, and its purpose is to improve the level of personalization when a user searches for LO in open hypermedia space. However, none of those systems have explored the potentials of emotional intelligence in the Semantic Web environment.

We can start from the above explained definition of AEH system (definition 1). We will consider an artistic personality type with an introverted perception, with the aim to suggest users (learners) in which online experiments they could participate. The adaptive dimension of the eQ agent system will be discussed in the upcoming subsections (Damjanovic, Kravcik, & Gasevic, 2005).

eQ System: Document Space (DOCS)

The document space consists of:

- A set of n atoms (n corresponds to the number of online experiments)
- A set of m atoms (m corresponds to the equipment needed to execute an online experiment)

$$OE_1, OE_2, .., OE_n, EQP_1, EQP_2, .., EQP_m$$
$$(2)$$

In addition, the document space includes a set of predicates about specific equipment requirements for doing an online experiment:

$$e\_request1(EQPi, EQPj) \text{ for certain } EQPi \neq EQPj$$
$$(3)$$

Sometimes, the online experiments can be finished in different ways and by using different equipment. This kind of dependence between online experiments and equipment needed can be expressed by the needEquipment predicate:

$$\forall OE \; \exists EQP \; needEquipment(OE, EQP)$$
$$(4)$$

The above constraint (definition 4) is useful in the Semantic Grid environment for resource sharing among dynamic collections of individuals, institutions, and Web resources.

eQ System: Observation (OBS)

eQ has one atom for the observation of the participation of users in certain online experiments. It is based on using the user psychological facts, called facts. In addition, eQ has a predicate observe:

$$observe(OE, P, facts) \text{ for certain } OE, P$$
$$(5)$$

P represents user (learner) personality type.

eQ System: User Model (UM)

User model represents an important part of any AEH system. User model models user features and user preferences, which can be described as follows (Henze & Nejdl, 2003):

- User features describe the ability of user to exploit some of the effects. For example, it is a user's knowledge and experience about the effects they consider.
- User preferences describe to what extent the user is eager to make use of some effects. For example, it is a user's subjective mark of the effects they prefer or dislike.

User model characterizes a learner and learner's knowledge/abilities, so the other systems can access and update this information in a standard way. Participation of users (learners)

in some online experiment can be convenient to the user when user personality type satisfies a set of psychological requests, such as: introverted, extroverted, and so on. For example, if we have an artistic personality with introverted perception, implying the usage of the keywords inner_world, ideas, images, memories, reflection, depth, then the rule for processing the above observation (definition 5) can be expressed in the following way:

$\forall OEi \ \forall Pj$
observe(OEi, Pj, inner_world) $\lor$
observe(OEi, Pj, ideas) $\lor$
observe(OEi, Pj, images) $\lor$
observe(OEi, Pj, memories) $\lor$
observe(OEi, Pj, reflection) $\lor$
observe(OEi, Pj, depth)

$\Rightarrow$ type(OEi, Pj, artistic_personality)

$$(6)$$

eQ System: Adaptation Component (AC)

People with artistic personality and introverted perception are energized when they are involved with the ideas, images, memories, and reactions that are a part of their inner world. Introverts often prefer solitary activities and feel comfortable being alone, or spending time with one or two others with whom they feel an affinity. Based on these facts, the eQ adaptation component uses certain defined symbols to represent a suggestion to the user in order for their participations in certain online experiments. In addition, eQ adaptation component uses some keywords for representing a proposal about instruments needed in doing the experiment.

Now, we can explain the use of the following predicates of the eQ adaptation component: use_instrument and suggest_participant.

$\forall OEi \ \forall Pj$

$\forall EQPk$ (observe(OEi, Pj, ideas)
$\Rightarrow$ type(OEi, Pj, artistic_personality)
$\Rightarrow$ EQPj e_request(EQPi, EQPj))
$\land \lnot$suggest_participant(Pj, OEi, big_experiment)

$\Rightarrow$ suggest_participant(Pj, OEi, small_experiment)

$$(7)$$

According to the fact about resource sharing on the Semantic Grid, we define a predicate called use_instrument:

$\forall OEi \ \exists EQPk$
$\forall Pj$ (observe(OEi, Pj, ideas)
$\Rightarrow$ type(OEi, Pj, artistic_personality)
$\Rightarrow$ EQPj e_request(EQPi, EQPj))
$\land \lnot$use_ instrument (Pj, OEi, manual)

$\Rightarrow$ use_ instrument (Pj, OEi, digital)

$$(8)$$

Summary and Implications

One of the key challenges in today's Web environment is the need to deal with data and knowledge resources that are distributed, heterogeneous, and dynamic, based on using effective open, distributed, and knowledge-based solutions. This knowledge-oriented and semantics-based approach to the Web brings new paradigms to exploit techniques and methodologies from intelligent software agents and Web services representing components of the social networking and interacting in a ubiquitous and pervasive manner. These challenges are addressed in the eQ agent system we have proposed for dealing with personalized adaptation in the Semantic Web and Grid learning and training environment, which will be presented in the next section.

THE KEY PARADIGMS OF THE EQ AGENT SYSTEM

E-learning and training should provide advanced knowledge sharing and collaboration between both user profiles and user needs. This means that e-learning courses and trainings can be as-

sembled dynamically from different repositories of LOs and tailored according to the user profiles and their learning needs.

In this chapter, we explore several key paradigms being used in conceptual design of proposed eQ agent system for personalized adaptation.

- First, this approach is based on using a multiagent system with the Belief-Desire-Intention (BDI) agent rational model.
- Second, this system is initially defined by considering the component-based definition of the AEH systems represented in Henze & Nejdl (2003).
- Third, this system uses the FOSP adaptive strategy proposed in Kravcik (2004).
- Finally, because we are dealing with the stereotypes of users, having in mind eQ concepts to help in adaptation to the user's real needs and known preferences, we have named this system eQ.

eQ stands for using eQ concepts on the Web, or using electronic eQ (Damjanovic, Kravcik, & Gasevic, 2005). In that way, we could determine the eQ agent system as a distributed test-sensor system, with the main aim to infer about user stereotypes, to recognize them, and to offer the personalized information and content wherever it happens, in online, offline, or virtual training labs.

eQ System: Multiagent System with the BDI Rational Model

Multiagent systems (MAS) are widely seen as the most promising technology for developing complex distributed software systems in the years to come. The most important reasons for using MAS when designing a system can be described as follows (Stone, 1997):

- Domains with different (possibly conflicting) goals and information, where MAS is needed to handle their interactions
- Having MAS could provide a method for parallel computation by assigning different tasks or abilities to different agents
- Full robustness of system and applications
- An easy way to add new agents (scalability)
- The modularity of MAS and simpler programming
- Exploring intelligence according to the need to deal with social interactions

eQ system represents MAS being developed to support a decentralized approach in both Web-oriented and ubiquitous environments. eQ uses embedded BDI rational model, in which the proposed FOSP adaptive learning strategy can be implemented. The BDI paradigm is based on the early philosophical work of Bratman regarding rational action theory (Bratman, 1987). Their primary contribution is the integration of the various aspects of BDI agent research, such as theoretical foundation from both a quantitative decision-theoretic perspective and a symbolic rational agency perspective, to the system implementation and building applications that are used as a practical BDI architecture.

eQ agents considers information about the user (user group), represented as instances from the ontology for adaptation, and according to the user stereotypes, user types (schoolchildren or experts), personality factors, cognitive factors, and learning styles, they find appropriate educational resources. Using the eQ agent system, personalized adaptation mechanisms pass by two phases: (1) personalized adaptation based on using contextual management, and (2) additional personalized adaptation based on using the proposed FOSP adaptive strategy.

eQ System: System Defined as an AEH System

A decentralized user model (UM) could be formed in continual following of the user's physical movements, as well as the user's history of preferences from the ontology for adaptation. For example, participation of user Pj in certain online training OEi could be done when the user's personality type satisfies a set of psychological requests, such as introverted, extroverted, and so forth An example is described in subsection 2.2.

eQ System: Using the FOSP Adaptive Strategy

Learning strategies represent techniques and methods that include techniques for accelerated learning, using certain environments for learning, graphic tools, emotional intelligence, and the other most widely implemented methods of helping learners to learn more successfully. These strategies are most successful when they are implemented and used in the collaborative learning environments in which each pair of learner/teacher is a part of a well-planned learning system. There must also be efficient methods of feeding that information back into the system so that there will be continued progress in teaching and learning. Nowadays, this process is well known as reusability of teaching resources that can be achieved at various levels. In addition, these strategies are most effective when they are applied in positive, supportive environments where there is recognition of the emotional, social, and physical needs of learners and where individual strengths are recognized, nurtured, and developed. This is one reason we explore use of eQ concepts in this chapter.

A novel method for specification of adaptation strategies in AH systems, which should support efficient collaborative authoring, is known as the FOSP method. The FOSP method is based on using a pattern identified in the adaptation process that consists of four operations (Kravcik, 2004):

1. Filter
2. Order
3. Select
4. Present

The main idea is to separate the partial results produced by different authors in such a way that they can be reused. FOSP method consists of the following three levels shown, in Figure 7:

Level 1 - Operations:
- Filter (selects just those components that have their weight greater than threshold)
- Order (sorts the selected components according to the sequence value)
- Select (chooses that one component with the highest alternative value)
- Present (displays the components, taking into account the granularity value)

Level 2 - Functions:
- Weight (the relevancy of the pedagogical role for the learning style)
- Sequence (the presentation order of the role for the learning style)
- Alternative (the relevancy of the media type for the learning style)
- Threshold (the threshold for the object display based on the learning style)
- Granularity (the max number of objects presented for the context)

Level 3 - Sets:
- role, style, media, and context

This can be explained in the following way (Kravcik, 2004):

When a teacher wants to teach a learner certain new knowledge or skill, he usually first decides what types of learning resources are suitable for the particular user, for example for one learner it can be a definition and an example, for another

a demonstration and an exercise. Then he should order the resources, that is decide whether to start with the definition or the example. Each learning resource can have alternative representations, so the teacher has to select the most suitable one—narrative explanation, image, animation, video, and so forth.

But, how to manage teaching resources when the learners have different emotions, perceptions, and reactions? In this chapter, we propose using the eQ agent system with the FOSP adaptation strategy, shown in Figure 7.

The aim of each of the above-mentioned levels in creating a flexible and ontology-powered agent system to support better adaptation and e-learning mechanisms will be discussed in detail. In order to explain the FOSP method, we define new document space that includes the sets of the following atoms (Damjanovic, Kravcik, & Gasevic, 2005):

- A set of r atoms (the pedagogical role of the object [e.g., definition, example, demonstration]),
- A set of t atoms (the media type [e.g., text, image, audio, video, animation]),
- A set of c atoms (the usage context [e.g., multimedia desktop, mobile device]):

$$R_1, R_2, .., R_r, MT_1, MT_2, .., MT_t, UC_1, UC_2, .., UC_c$$
$$(2')$$

All of these atoms explained in (2') can be associated with those ones that are explained in (2). Further, the document space includes a set of predicates about media type and usage context need in e-learning (definitions 3' and 3'' can be also associated with predicate e_request1 explained in definition 3):

$$e\_request2(MT_k, MT_l) \text{ for certain } MT_k \neq MT_l$$
$$(3')$$
$$e\_request3(UC_e, UC_f) \text{ for certain } UC_e \neq UC_f$$
$$(3'')$$

Apart from the above explained pedagogical role, media type, and usage context, FOSP method considers one more type—the learner learning style (e.g., intuitive, sensitive, active, reflective). It can be represented as a set of l atoms (l corresponds to the learning style) (shown in 2''):

$$L_1, L_2, .., L_l$$
$$(2'')$$

Learning style can be: (1) haptic (moving, touching, and doing), (2) auditory (sound, music), and (3) visual (learning from pictures). Learning style is a subset of the learner personality type. At the same time, one personality type can use more learning styles. For example, if we have an artistic personality with introverted perception, the main motivation factor of this personality is in relation to her/his creativity. So, an artistic personality can use auditory or visual learning style. Now, the definition 6 can be extended in the following way:

Figure 7. Introduction of the eQ agent system into the FOSP method
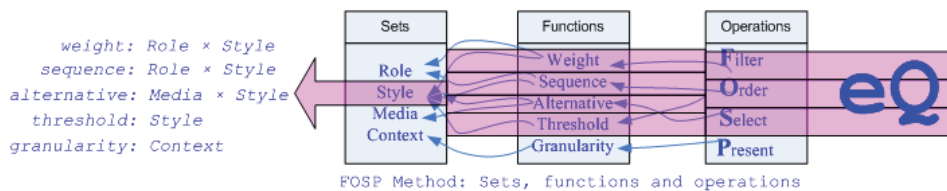
∀Pj ∃Ll
observe_deep(observe, Ll, sound) ∨
observe_deep(observe, Ll, music)

⇒ person(observe, Li, auditory)

(6')

The definition 5 can be expressed in the following way:

observe_deep(OE, P, L, facts_style)
  for certain OE, P, L

(5')

This definition can be substituted with the following:

observe_deep(observe, L, facts_style)
  for certain OE, P, L

(5'')

Based on the adaptive strategy proposed in Kravcik (2004) we explain the FOSP functions (Damjanovic, Kravcik, & Gasevic, 2005):

• The weight function—it represents the relevancy of the pedagogical role for the learning style:

weight: Role × Style → Integer

(9)

∀R ∀L
observe_deep(R, observe, L, facts_style)
⇒ weight(R, L, Relevancy)

(10)

• The sequence function—it defines the presentation order of the role for the learning style:

sequence: Role × Style → Integer

(11)

∀R ∀L
observe_deep(R, observe, L, facts_style)
⇒ sequence(R, L, Order)

(12)

• The alternative function—it expresses the relevancy of the media type for the learning style:

alternative: Media × Style → Integer

(13)

∀MT ∀L
observe_deep(MT, observe, L, facts_style)
⇒ alternative(MT, L, MT_Relevancy)

(14)

• The threshold function—it sets the threshold for the object display based on the learning style:

threshold: Style → Integer

(15)

∀UC ∀L
observe_deep(UC, observe, L, facts_style)
⇒ threshold(UC, L, threshold_set)

(16)

• The granularity function—it specifies the max number of objects presented for the context:

granularity: Context → Integer

(17)

∀UC ∀L
observe_deep(UC, observe, L, facts_style)
⇒ granularity(R, L, max_number)

(18)

eQ System: New Adaptation Component

Specification of adaptation strategy by using the FOSP method consists of the following operations (Damjanovic, Kravcik, & Gasevic, 2005):

• Filter—for the current object it selects just those components that have their weight greater than threshold:

$\forall R \ \forall L \ \text{observe\_deep}(R, \text{observe}, L, \text{facts\_style})$
$\Rightarrow \text{weight}(R, L, \text{Relevancy})$
$> (\forall UC \ \forall L \ \text{observe\_deep}(UC, \text{observe}, L, \text{facts\_style})$
$\Rightarrow \text{threshold}(UC, L, \text{threshold\_set}))$
$\Rightarrow \text{Filter}(\text{component})$

(19)

- Order—this sorts the selected components according to the sequence value:

  $\forall R \ \forall L \ \text{observe\_deep}(R, \text{observe}, L, \text{facts\_style})$
  $\Rightarrow \text{sequence}(R, L, \text{Order})$
  $\Rightarrow \text{Order}(\text{component})$

  (20)

- Select—from the alternative components it chooses the one with the highest alternative value:

  $\forall MT \ \forall L \ \text{observe\_deep}(MT, \text{observe}, L, \text{facts\_style})$
  $\Rightarrow \text{alternative}(MT, L, \text{MT\_Relevancy})$
  $\wedge \text{max}(\text{alternative})$
  $\Rightarrow \text{Select}(\text{component})$

  (21)

- Present—it displays the components, taking into account the granularity value:

  $\forall UC \ \forall L$
  $\text{observe\_deep}(UC, \text{observe}, L, \text{facts\_style})$
  $\Rightarrow \text{granularity}(R, L, \text{max\_number})$
  $\Rightarrow \text{Present}(\text{component})$

  (22)

Summary

In practice, defining a pedagogic strategy for learners with a certain learning style means the instruction designer needs to specify the functional values of weight, sequence, alternative, threshold, and granularity for different types of LOs (i.e., content objects) (Kravcik, 2004). But it is not necessary to define all values. If no value is specified, a default one will be applied: 0 for weight, the minimum value for threshold and the maximum one for granularity. This approach is compliant with the established standards and recommendations, including the adaptive hypermedia application model (AHAM) reference model for adaptive hypermedia. Specification of adaptation strategies separating the content, declarative, and procedural knowledge in adaptive courses is quite natural, and similar approaches have been successfully applied in related areas, for instance in electronic documents generally.

IMPLEMENTATION OF THE EQ AGENT SYSTEM

Nowadays, there are different agent's methodologies and frameworks based on using the BDI rational model, such as JACK, Jason, Nuin, Jam, 3APL, SPARK, Gaia, and Jadex. Each of these methodologies/frameworks considers different types of goals: *query, perform, achieve, maintain, cease, avoid, optimize, test, preserve*. We have chosen to use the Jadex platform, which supports reasoning by exploiting the BDI model, and is realized as an extension to the widely used JADE middleware platform (Braubach, Pokahr, & Lamersdorf, 2004). Jadex supports the development of rational agents on top of the FIPA-compliant JADE platform, and supports *achieve, maintain, query,* and *perform* goal types (Braubach, Pokahr, Moldt, & Lamersdorf, 2004).

The Jadex BDI model considers three types of attitudes of agent rational behaviours: (1) belief (goals), (2) desire, and (3) intention. Beliefs represent the information about agent's internal, as well as external states, and provide domain-dependent abstraction of entities. The motivational attitudes of agents are captured by goals, which represent a central concept of the Jadex BDI architecture. And, last but not least, plans are the means by which agents achieve their goals.

All triggering events and beliefs must be specified in the agent definition file (ADF), whose role is to let the agents know what kind of event they must handle. Figure 8 shows one part of the eQ agent system's belief base defined in the ADF.

Figure 8. ADF belief-base

```
<beliefs>
<!-- FILTER agent -->
<beliefref name="eQFAgent" class="String"
    exported="true"><abstract/>
</beliefref>      <!-- ... -->   </beliefs>
<goals>
<!-- Perform filter operations -->
<performgoal name="filter_op" exported="true">
<dropcondition> $beliefbase.mission </dropcondition>
</performgoal> <!-- ... -->   </goals>
<plans>
<!-- Filter operation -->
<plan name="weight"> <body>new FilterPlan()</body>
<trigger> <goal ref="filter_op"/> </trigger>
</plan> <!-- ... -->   </plans>
```

All important agent startup properties, such as an agent name, agent implementation class, packages, and others, are possible to define in the ADF.

FINE ART PROFESSIONAL TRAINING: ACCADEMI@VINCIANA

The main idea presented here is to implement a novel art academy based on using the Semantic Web and Grid possibilities, on one side, and better personalized adaptation methods based on using eQ concepts with the proposed adaptation strategy, on the other side.

Personalized Adaptation in Fine Art Professional Training

When the user starts application for fine art professional training and learning, this application automatically recognizes both user's individual traits and user's devices on which this application is executed (Damjanovic, Kravcik, & Devedzic, 2005). All information about the user's characteristics is contained within the ontology for adaptation (context information), extracted by distributed personality test-sensors. An eQ Context Manager Agent finds all context facts about observed user and sends these results to the eQ FOSP Manager Agent, with the aim to perform personalized adaptation and to present adapted content information to the user. eQ Context Manager Agent has a location awareness module whose role is to support changes in the user's device attribute values. For example, the user starts using training application on the laptop, and then migrates to a PDA. This means that the content information has to be additionally adapted, and the eQ FOSP Manager Agent has to perform some kind of filtering which shrinks the images to a size that fits nicely on the screen of the PDA.

All points of the considered eQ agent system, which uses the FOSP method for personalized adaptation, are shown in Figure 9. Levels one and two can be directly implemented through the eQ BDI reasoning engine, as shown in Figure 9. This means all triggering events and beliefs must be specified in the Agent Definition File (ADF), whose role is to let the agents know what kinds of events they must handle.

Figure 9. eQ Agent System uses three levels of the FOSP method: Operations, functions, and sets
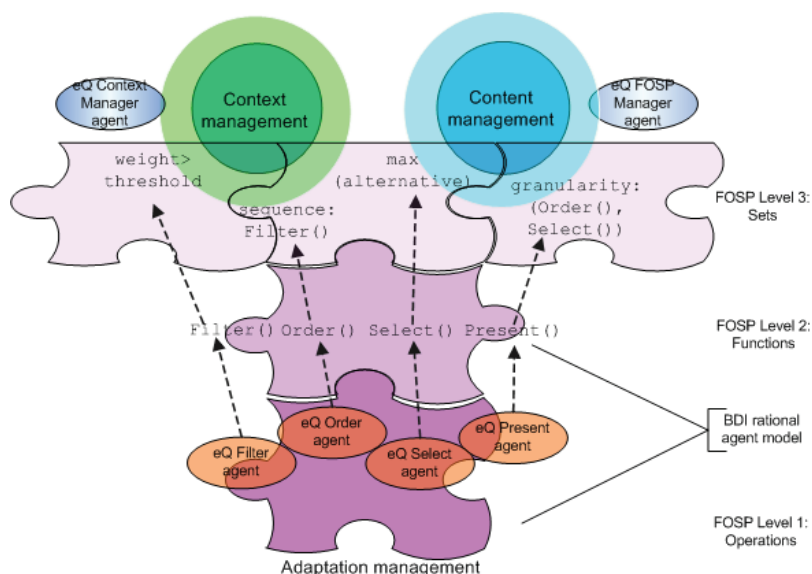
Practical Results

We represent two examples of using the eQ agent system for improving the adaptation processes in the Semantic Web and Grid environment: (1) e-learner is a preschool child, and (2) e-learner is an expert in the domain of painting technologies. The main difference between both of these learner's profiles represents their ability to organize and use knowledge. Experts have a notable level of experience and knowledge, different from beginners (preschool child). Knowledge and experience of experts can be distinguished in the way they have organized knowledge, as well as the way they represent and interpret information about their environment. According to the way in which the knowledge is organized, experts remember information, infer about certain facts and categories from the organized knowledge, and solve different problems by using existing knowledge.

User identification means considering a huge number of criteria and characteristics from the ontology for personalized adaptation. In order to explain as simply as possible the role of the eQ agent system in achieving better personalized adaptation, we consider minimum criteria required from the FOSP adaptation method. That means joining both the ontology for personalized adaptation and the domain ontology - ACCADEMI@ VINCIANA, based on finding the pair of values, such as: (1) learning style – style, (2) learner type – role, (3) media type – media, (4) presentation form – form. The eQ BDI agent rational mechanism executes the FOSP adaptation method based on using all of these pairs of values from ontologies. As a result, different e-learners get adapted and personalized educational contents.

Firstly, we can define the FOSP Level 3 (Sets) for both examples (shown in Table 1).

The FOSP adaptive strategy is executed based on using the definitions (9 – 22). If we suppose that there are the following educational resources from the domain ontology ACCADEMI@VINCIANA, such as (1) *techniques*, (2) *materials*, (3) *fundamentals*, and (4) *experiments*, then the

Table 1. Learner's characteristics at the FOSP Level 3 – Sets

Attribute name	A) e-learner is a preschool child		B) e-learner is an expert	
	Instance value - Ontology for adaptation	**Instance value - Domain ontology**	**Instance value - Ontology for adaptation**	**Instance value - Domain ontology**
Learner type (LT)	Beginner	Preschool child	Expert	Expert
Learning style (LS)	Visual	Visual	Visual	Video; Audio; Speech; Text
Media type (MT)	Computer	Computer	Computer; PDA; online experiments	Computer; PDA; online experiments
Presentation form (PF)	Video	Video	Video	Video; online experiments; docs + pictures

Table 2. Characteristics of the educational resources

Instance name	A) e-Learner is a preschool child			B) e-Learner is an expert		
	Learner type (Role)	**Learning style**	**Media type**	**Learner type (Role)**	**Learning style**	**Media type**
Techniques	Beginner (5); Expert (5)	Video (5); Audio (5); Text (1)	Computer (5); Mobile (2)	Beginner (5); Expert (5)	Video (4); Audio (5); Text (5)	Computer (5); Mobile (2)
Materials	Beginner (3); Expert (5)	Video (3); Audio (2); Speech (1); Text (1)	Computer (5); Mobile (2)	Beginner (3); Expert (5)	Video (4); Audio (5); Speech (3); Text (5)	Computer (5); Mobile (3)
Fundamentals	Beginner (2); Expert (5)	Video (3); Audio (2); Speech (1); Text (1)	Computer (5)	Beginner (2); Expert (5)	Video (4); Audio (5); Speech (3); Text (5)	Computer (5)
Experiments	Beginner (1); Expert (5)	Video (3); Audio (2); Speech (1); Text (1)	Computer (5); PDA (3); Mobile (1)	Beginner (1); Expert (5)	Video (5); Audio (5); Speech (4); Text (4)	Computer (5); PDA (3); Mobile (2)

characteristics of the ontology resources could be represented. Therefore, we define the importance indexes of educative resources for both examples of e-learners (shown in Table 2).

Now, we execute the FOSP functions: weight, sequence, alternative, threshold, and granularity. This execution is based on using the component-based definition of the AEH system by using the values that came from both Table 1 and Table 2.

- **The FOSP weight function:** We can suppose that the user is a **beginner** with the **visual learning style**, which uses a **computer** to access the educational resources. The FOSP adaptive strategy executes weight function for different values of resources. For example, in the case that the educational resource is *techniques*, the value of weight function is:

weight: Role × Style → Integer, or

weight: (5 × 5 → 25)

In the case that the educational resource is *experiments*, the value of weight function is:

weight: (1 × 3 → 3)

If the educational resource is *materials,* the value of weight function is:

weight: (3 × 3 → 9)

And, if the educational resource is *fundamentals*, the value of weight function is:

weight: (2 × 3 → 6)

Based on these results, we conclude that the course about painting techniques that represent the best educational material fits in with the learner who is a beginner who uses a visual learning style and the computer as a device to access the educational materials. The next courses could be the following: the course about painting materials, or the course about fundamental elements of painting technology, while the course about painting experiments would not fit in with the beginner's profile.

- **The FOSP sequence function:** Using the definition (11) with the different values of the educational resources, the FOSP sequence function calculates the next order of these resources: (1) *techniques*, (2) *materials.* Now, the FOSP alternative function is executed.
- **The FOSP alternative function:** For example, in the case that the educational resource is *techniques*, the value of alternative function is:

alternative: Media × Style → Integer, or

alternative: (5 × 5 → 25)

In the case that the educational resource is *materials*, the value of alternative function is:

alternative: (5 × 3 → 15)

We conclude that the course about painting techniques represents the better solution for the beginning learner. At the same time, the course about painting materials represents an alternative solution for the beginner.

- **The FOSP threshold function:** Using the definition (15) with the different values of the educational resources, the FOSP threshold function calculates the next order of these resources: (1) *techniques*, (2) *materials.*
- **The FOSP granularity function:** The FOSP granularity function specifies the max number of objects presented for the context. For example, the course about painting techniques includes 8 sub courses, while the course about painting materials includes just 2 smaller sub courses.

All results of the FOSP functions are shown in Table 3.

Now, we execute the FOSP operations: Filter, Order, Select, and Present, based on the results of the FOSP functions shown in Table 3. The results of the FOSP operations are adapted to the specific user's profiles.

In a case when the e-learner is a preschool child, result of Present operation includes components of the educative resource – *techniques*: (1) Tempera, (2) Wash Painting, (3) Aquarelle, (4) Oil Painting, (5) Varnish Painting, (6) Encaustic, (7) Gilding, and (8) Drawing.

When the e-learner is an expert in the domain of painting technologies, the eQ agent system offers components of the educative resource—*experiments* that include the following components: (1) physical methods and (2) chemical methods.

Table 3. The results of the FOSP functions

Instance name	A) e-learner is a preschool child					B) e-learner is an expert				
	weight	sequence	alternative	threshold	granularity	weight	sequence	alternative	threshold	granularity
Techniques	25	1	25	5	8	20 / 25	2	20 / 25	4 / 5	8
Materials	9	2	15	3	2	20 / 25	3	20 / 25	4 / 5	2
Fundamentals	6	-	-	-	4	20 / 25	4	20 / 25	4 / 5	4
Experiments	3	-		-	2	25 / 25	1	25 / 25	5 / 5	2

Summary

The important characteristics for considering user stereotypes could be extended with the aim to give more precise and adapted results of the educational processes. It means that new instances from the ontology for personalized adaptation should be considered, including those instances made as a result of the IEEE PAPI Standard extension. Moreover, we could achieve usage of the eQ agent system in the Semantic Grid environment by introducing instances that represent instruments needed for doing online experiments. This kind of environment could be used to execute specialized experiments about painting technologies and materials. Then, the experts can use expensive, but distributed scientific devices, in an ubiquitous and pervasive manner. They can share the results with other practical scientists, remote colleagues, and students, as well as members of various online societies (physics, chemistry, government, police…).

CONCLUSION

The process of training and learning in Web-based and ubiquitous environments brings a new sense of adaptation. E-learning needs to use new technologies in order to provide advanced knowledge sharing and collaboration between different user's profiles and different user's needs. Thus, the Semantic Grid can be used for the creation of new scientific results, new business, and even new research disciplines.

With the development of more sophisticated environments, the need for them to take into account the user's traits and user's devices on which the training is executed, and to place them within the context of the training activities, has become an important issue in the domain of building novel training and learning environments. Hence, our approach for achieving adaptivity is based on using the eQ concepts, MAS, AEH systems, and the BDI rational agent's paradigm in the Semantic Web and Grid environment. The benefits of taking the proposed approach are numerous, and can be characterized as follows:

- **Collaboration** with other students, teachers, tutors, experts
- **Knowledge-based:** It includes domain knowledge representation in the form of ontologies, as well as knowledge about the learner and his/her social and emotional context.

- **Ubiquitous:** The capability to support multiple pedagogical models and to automatically adopt them.

In this chapter, an example of fine art professional training illustrates the potential benefits of using personalized adaptation in professional training environments. As the potential benefits, we can mention the following:

- Adaptation by focusing on the main subjects from the domain of artistic training (painters, conservators, restorers, technologists, fraud investigators)
- Using all available resources (learning materials, training devices) wherever the user is physically located
- Exploring ancient and current technologies with the aim of finding better solutions
- Analyzing generated results and deciding about using preventive painting strategies
- Collaboration with the aim of achieving the original expertise and art fraud investigation

In addition, we can stress the possibility to envisage Semantic Grid, which behaves like a constantly evolving organism, with ongoing, autonomous processing rather than on-demand processing (De Roure, Jennings, & Shadbolt, 2005). Thus, the Semantic Grid becomes an *organic Grid* which itself can generate new processes and new knowledge, manifest in the physical world through ambient intelligence vision.

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APPENDIX I: CASE STUDY

Fine Art Professional Training

The application for fine art professional training recognizes the user with the "artistic personality" (personality type), "introverted perception" (personality factor), "visual" learning style, in which the user type is an "expert" that explores "art fraud" and uses a "PDA" (user device). Thus, the first level of *contextual* personalized adaptation is finished. Now, the content is adapted for that user, which is the task of the eQ FOSP Manager Agent. This agent supervises four other eQ agents, who, one after the other, performs the main operations of the FOSP adaptive strategy (Filter, Order, Select, and Present). The eQ Filter Agent starts to perform Filter operation by selecting just those components that have their weight function greater than threshold function. Both of these functions are related to the semantically annotated FOSP sets that represent content from both the ontology for personalized adaptation and the domain ontology. The eQ Filter Agent sends the filtered components as results to the next agent—eQ Order Agent, which performs Order operation by sorting the selected (filtered) components according to the sequence value. It sends a sequence of the selected components to both the eQ Select Agent and the eQ FOSP Manager Agent. The eQ Select Agent performs Select operation by selecting the component with the highest alternative value, and finally, the eQ Present Agent performs Present operation according to having the granularity value from the sets of the selected or the alternative components. All values of considered FOSP functions, such as threshold, weight, alternative, sequence, and granularity, are related to the ontology concepts, such as Role, Style, Media, and Context (FOSP sets).

Fine art professional trainings based on the use of physical methods could be realized with different optical tools (microscopes, dermatoscopes, micro-abrasion equipment, equipment for UV and F exploring, cameras). In the case of the above explained user, the eQ Present Agent brings some physical methods as a result. Actually, it means that the eQ Present Agent offers trainings by using X-ray, UV exploring, and F-exploring as training methods that could be used to achieve art fraud investigation.

Questions

1. How can the results of the eQ agent system be executed in the case of using different typology of personality in modelling user stereotypes than *Jung/Briggs-Myers* typology?
2. What kind of typology of personality would you use in modelling user stereotypes?

APPENDIX II: USEFUL URLS

Pervasive Computing Reading Group – Papers, Related Conferences, & Journals
http://www.cs.utah.edu/~sgoyal/pervasive/

IEEE Pervasive Computing - A catalyst for advancing research and practice in ubiquitous computing
http://www.computer.org/portal/site/pervasive//

Emotional Intelligence – White Papers, Case Studies
http://jobfunctions.bnet.com/search.aspx?scname=Emotional+Intelligence&dtid=1

Web site on Emotions, Emotional Intelligence, Learning & more
http://eqi.org/toc2.htm

IEEE PAPI Standards – PAPI Learner, Drafts, and Specifications
http://edutool.com/papi/

Jadex – BDI Agent System
http://vsis-www.informatik.uni-hamburg.de/projects/jadex/

W3C Workshop on Metadata for Content Adaptation
http://www.w3.org/2004/06/DI-MCA-WS/

ProLearn Project (Professional Learning) Research Activities
http://www.prolearn-project.org/index.html

APPENDIX III: FURTHER READING

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