Ontologies for Personalization: A new challenge for instructional designers

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Abstract

In e-learning environments, instructional design has evolved from “one instructional design for many learners” to “one design for one learner” or “many designs for one learner”. By using the capabilities of semantic web, World Wide Web led the interchange of information about data (e.i., metadata) as well as documents. Such capabilities also indicated a new kind of challenge for instructional designers to design a common framework that allows content to be shared and reused within and across applications.

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Introduction

Personalization is described as adapting learning experience to different learners by analyzing knowledge, skills and learning preferences of individuals (Devedsic, 2006). Personalized learning remove time, location and other constraints in teaching process and aims to tailor teaching for each learner’s constantly changing needs and skills (Sampson, Karagiannidis, & Kinshuk, 2002).

In e-learning environments, instructional design has evolved from “one instructional design for many learners” to “one design for one learner” or “many designs for one learner”. By using the capabilities of semantic web, World Wide Web led the interchange of information about data (e.i., metadata) as well as documents. Such capabilities also indicated a new kind of challenge for instructional designers to design a common framework that allows content to be shared and reused within and across applications. Yet, instructional designers have some challenges in designing instructional environments, ie..the need for better, understanding the nature and the outcomes of the interaction between learners and content, designing learning object and navigational paths, monitoring and analyzing the learning progress.

In order to make an e-learning environment personalized there needs to be;

– Regular and constant data monitoring and analysis tools (Learning Analytics),
– Determining cognitive and non-cognitive personal characteristics accurately, (Learner characteristics)
– Learners’ interaction with –designed- medium: i.e., learning outcomes (Learning & Instruction)
– Tools to diagnose and/or guide learners with study or navigational paths (Ontology and Designing Navigational Paths).

To conclude, it is essential to develop a design framework for personalization. In general, we need ontolog(ies), a learner model, a learning object design model, and learning analytics. In what follows, I will outline the nature and the functions of each one of these components briefly.

Ontologies

One of the possibilities of personalizing the learning process is ontologies based on semantic web. An ontology is an explicit specification of a conceptualization (Gruber, 1995) or a model (Musen, 1998), which is used for structuring and modeling of a particular domain that is shared by a group of people in an organization (O’Leary, 1998). The underlying technology of these systems is the use of a learner model where the information of learner goals, preferences or needs is kept in learner data (Martins, et.al, 2008).

There are various learner and user models in the literature. Yet, it was claimed that, these models are generally either too generic or too complex to handle and they are lack of addressing to model learning object based instructional systems (Kaya and Altun, 2011). Kaya and Altun (2011) proposed an ontology based learner model for e-learning systems which incorporates an instructional learning object design model (figure 1):
Demographic information, current learner status, expectations (learning goals), individual attributes, performance and the context attributes are the essential data that are kept about the user embedded in that model. This model is suggested to being ontology based to provide reasoning and inference functionalities.

Similarly, Aşkar, Altun, Kalinyazgan and Pekince (2010) developed a model for K-12 curricula based on Personalized Ontological Learning Environments (PoleONTO). In POLEonto, learning processes were analyzed as a set of cognitive skills, which were articulated in the curriculum and applied by instructors. In POLEonto context, skill is defined as the interaction and any processes between persons and concepts. For example, the concept of “summary” is stated in one’s mind; yet, they can write about it, they can use summary in other contexts (i.e., essay or composition writing), which is creative thinking. Summary can be manipulated to develop a plan by using its types and functions, which requires decision making. PoleONTO is suggested to propose a new method to separate learner expectations by determining domain concepts.

Aşkar and Altun (2009) developed the CogSkillNet within POLEonto environment; and, discussed how CogSkillNet can be modeled in the e-learning domain. CogSkillNet is an ontology of skills embedded within the curriculum of K-12 education.

In CogSkillNet context, integrated actions represent higher order thinking skills such as problem solving, scientific thinking, and critical thinking (Fig 2)
Skills in CogSkillNet include actions, processes (aka relations and relation types) and delegations as instances. Base actions are pre-defined, universal sets of functions. The following figure represents the conceptual framework of instances in CogSkillNet (fig 3).

CogSkillNet is proposed to provide learners navigation guidance for their learning path based on their progress through cognitive skills and also enabling evaluators to base their assessment process and diagnose the deficiencies in students’ learning as far as cognitive skills.
Learning Objects

A learning object is defined as “…any entity, digital or non-digital, that may be used for learning, education or training” (IEEE Learning Technology Standards Committee, 2001) and also as digital resources that can be reused to support learning (Wiley, 2001).

All learning objects need to have an instructional purpose to be re-used within different instructional settings and each learning object should appropriately support learning through the possible inclusion of educational objectives, content, resources, and assessment.

The fundamental issues about learning objects in instructional design process are; “how to store each learning object so that they can further become accessible through different digital learning and/or content management systems or different delivery modes”, “what should be the size of the learning object (granularity)” and “how can the context be modeled”.

In a study, Aşkar and Altun (2008) highlighted the design processes of learning objects by using the learning space as a metaphor. The proposed model to of learning space metaphor is surrounded by skills and concepts in a K-12 subject domain. Instead of using taxonomical classification for skills and concepts, ontological relations and reasoning is essential in order to navigate within this space with “appropriately small” granules (See Figure 4).

Figure 4: Learning Space

This learning space model stated to creating a meaningful combination of concept-concept, concept-skill, or skill only granules to represent an educational expectation (or standard). As a result this model proposed a separation of learning expectations as concepts and skills based on their ontological relations in a specific domain. Since each expectation include at least a skill and/or concept(s), such an ontologic relationship might enable designers to develop instructionally meaningful and reusable learning objects.

Learning Characteristics:

Determining cognitive and non-cognitive personal characteristics accurately and transforming them into a learning design is a fundamental issue for instructional designers. To design better adaptive e-learning environments, the role of the user as an individual and their characteristics had become the focus. Since individuals have differences both
in cognitive and non cognitive characteristics, their learning processes also different from each other. So, in a uniform standard learning environment learning outcomes will not be same.

The basic cognitive characteristics of individuals are their working memory capacity, attention level, spatial abilities, perception, language acquisition etc. on the other hand non cognitive characteristics can be specified as motivation, attitudes, fear, like, anxiety, self efficacy etc.

There have been different studies showing importance of individual differences in designing learning environments and learning processes. In a study, Sönmez, Altun, Mazman (2012) investigated the effect of individuals’ prior knowledge and experiences on their visual search performances. A visual search task on identifying the phases of mitosis from a microscope view with two different background contrasts was used. As a result, it was found that high prior knowledge group was able to recognize and identify the phases of mitosis correctly in a shorter period of time in comparison to low level prior knowledge group. However, no difference was found between groups for the low color contrast slides. The results revealed that for novices, who are lack of expertise in interpreting microscope images, prior knowledge has an effect when high contrast images were in question.

In another study, Mutlu and Altun (2010) investigated the effect of multimedia instructional designs prepared according to the attention types (focused - split) on recall performances of learners with various short term memory spans (high – medium - low) was investigated. The findings indicated that multimedia instructional designs were effective on recall performances. Learners showed higher recall performances in the multimedia instructional designs prepared on the focused attention type. However, no significant difference was observed in learners’ recall performances in terms of their short term memory spans. Significant differences were observed between multimedia usage periods of learners applied different multimedia.

Uz and Altun (2011) studied the effect of various navigation environments (static-dynamic) on recall performances of students with different object location memory spans (high-low). In this study, 3-dimensional dynamic environments and static environments were used as navigation environments. Dynamic environment was applied to half of the students with low and high object location memory span and static environment was applied to the other half. After that, spatial knowledge recall performances of all the students were evaluated. The results showed that overall, participants had higher recall scores in 2D. Once controlled their location memory, however, results indicate that higher location memory group had higher recall scores in 2D, but did not change for low group. Male participants were advantageous over females in 3-D.

Torun and Altun (2012) investigate the effects of levels of processing and navigation design type on recall and retention in e-learning environments. The participants’ performances of free recall, title recognition, location memory and their retention are measured via two different navigational layout design structured E-learning environments with the same content (story) by giving participants the instructional tasks which were designed in shallow, medium and deep levels of processing. The results of this study showed that left side navigation menu yielded better results in free recall, heading recognition, and location memory and deep level of processing yields better recall performances. Memory performances are affected depending on the design of the given instruction (levels of processing).

To conclude individual characteristics are important in understanding and designing the learning materials and learning environments. However, effect of individual differences could be sensitive to the design of the learning environment.

Learner Assessment:

Learner assessment describes any processes that appraise an individual's knowledge, understanding, abilities or skills. Neuropsychological assessment is the one of the assessment types which is based on determining the strengths and weaknesses in one’s cognitive functions (such as, memory types, attention levels, language ability etc.). There are different neuropsychological test to measure cognitive functions which are essential in learning process. Some of the tests are paper pencil based while some other could be computerized.
Since e-learning environments are computer based environments, while studying effects of cognitive function of individuals in e-learning process computer based test could be more compatible for measuring those functions.

Neuropsychological assessments are frequently being used as test batteries in computer based environments. Keeping data in computer environment would provide following and regular controlling of individual progress for longitude research (Aşkar, Altun, Cangöz, Türksoy, Çevik, 2009). So adapting neuropsychological test into computer based environment through validity and reliability studies and making standardization studies will contribute to this process.

Aşkar, Altun, Cangöz, Çevik, Kaya and Türksoy (2012) aimed to assess whether a computerized battery of neuropsychological tests could produce similar results as the conventional forms. Comparisons carried out with two neuropsychological tests: Line Orientation Test and Enhanced Cued Recall Test. Results showed that the Enhanced Cued Recall Test-Computer-based did not correlate with the Enhanced Cued Recall Test-Paper-and-pencil results. Line Orientation Test-Computer-based scores, on the other hand, did correlate significantly with the Line Orientation Test-Paper-and-pencil version. In both tests, scores were higher on paper-and-pencil tests compared to computer-based tests. Total score difference between modalities was statistically significant for both Enhanced Cued Recall Tests and for the Line Orientation Test. In both computer-based tests, it took less time for participants to complete the tests.

Conclusion

Personalization can be a valuable tool to facilitate lifelong learning with just-in-time and on-the-job training, as well. Different frameworks and learner (and group) characteristics will drive the method of personalization. Instructional designers must have a clear understanding of the learning needs and characteristics of each student. Learning paths must then be created that match with individual learners.

Lastly, it is important to remember that personalization can be expensive and time-consuming if not properly developed and maintained.

References


