Towards a Semantic e-Learning Theory by Using a Modelling Approach

By

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In the present study a semantic perspective on e-learning theory is advanced. A modelling approach is used. The modelling approach towards the new learning theory consists of four stages: Socialization, Externalization, Combination, and Internalization. In Socialization the Teacher-Student-Interaction activates the Exploratory Learning Behaviour. This phase is emotionally and socially loaded. The Externalization is partly emotional but cognitive dimension is needed. It requires creativity (See Bransford et al 2002). It works optimally if it is collaborative of nature. In the Combination phase Hypothetical-Deductive Thinking Ability is needed for Modelling Approach. In the Internalization phase the Learning process requires that students engage in seeking to understand and explain natural phenomena, which further demands testing of the theoretical concepts.

Introduction

The idea in the present study is to advance a new semantic learning theory for e-learners. The instructional semantic web tools are carefully selected and afterwards tested. This presentation is, however, only a research plan for this undertaking.

Learning with a Semantic Web

The semantic web approach was first introduced by the father of the World Wide Web, Sir Tim Berners-Lee, who also got the Finnish Technology Award, the Millennium Technology Prize 2004, for inventing it. One month later he was knighted by Queen Elizabeth II. Sir Tim Berners-Lee has been working since 1989 on this new idea of the semantic web, which adds definition tags to information in Web pages and links them in such a way that computers can discover data more efficiently and form new associations between pieces of information, in effect creating a globally distributed database.

The Semantic Web, connected with other specifications and tools being developed at W3C (The World Wide Web Consortium), including accessibility standards for disabled people and software for mobile devices, is part of Berners-Lees vision of a single Web of meaning, about everything and for everyone.

The World Wide Web Consortium (W3C) develops further interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. It is functioning as a forum for information, commerce, communication, and collective understanding. The **Semantic Web** provides a common framework that allows **data** to be shared and reused across applications, enterprises, and community boundaries. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML for syntax and URIs for naming. In this way the Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation. *(Tim Berners-Lee, James Hendler, Ora Lassila, 2001.)*

This type of a new form of Web content that is meaningful to computers will unleash a revolution of new possibilities. (Fletcher, 2003.)

Sicilia & Lytras (2005, p. 402) advanced a new concept around the semantic web, which they call *The Semantic Learning Organization* (SLO) in hope to integrate the Educational Semantic Web with an Organizational Perspective, which should enable the enhancement of organizational learning processes and mechanisms. This would also have some impacts on the used software, which is used to share knowledge representations, and the form of ontologies.

Naeve et al. (2005) (see also Nonaka & Takeuchi, 1995; and Yli-Luoma & Pirilä, 2005) advanced a theoretical model of e-Learning processes, which should cover at least some of the ideas, which Sicilia & Lytras (2005, p. 402) present of what they call SLO (see Figure 1).

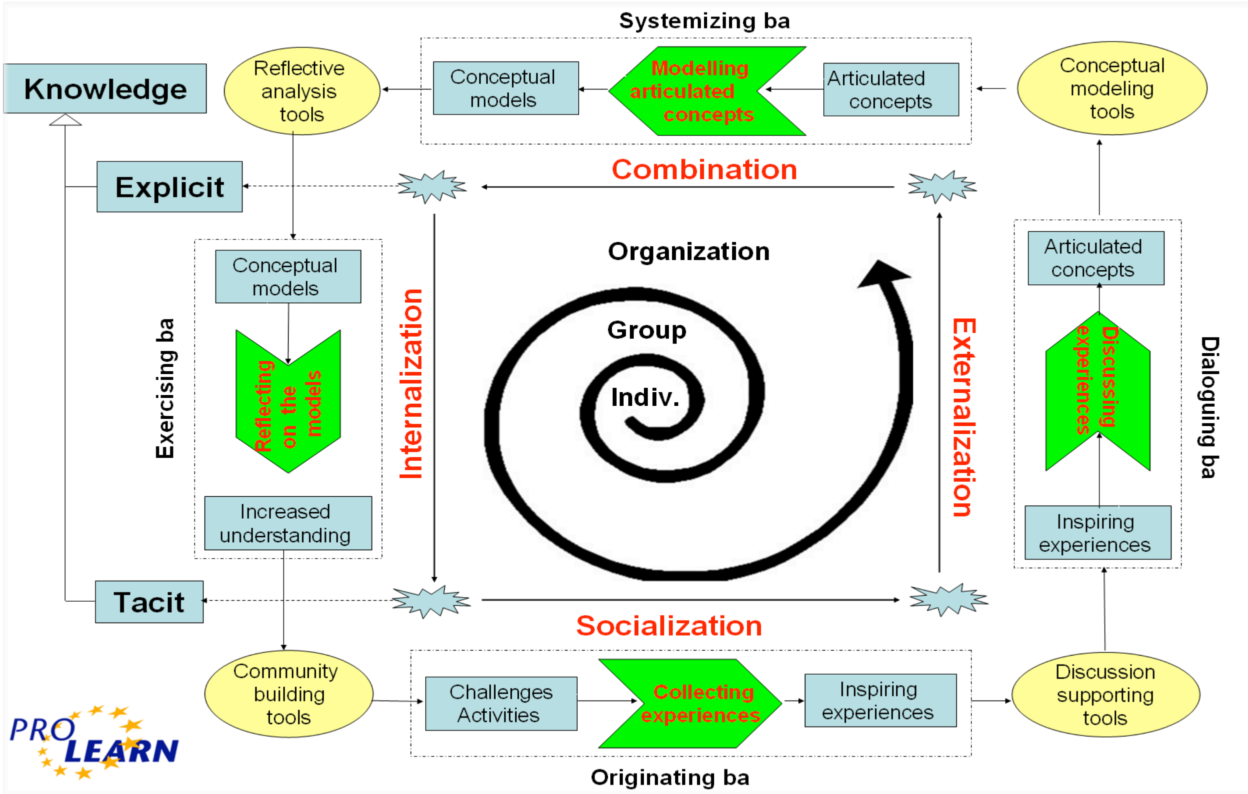
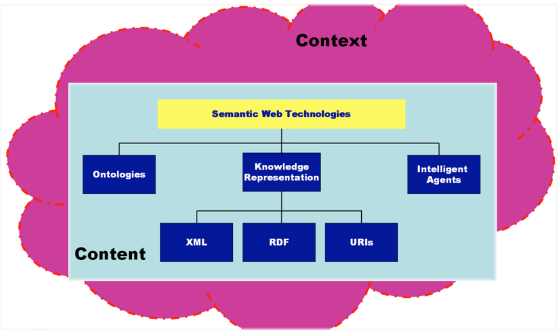


Figure 1: Learning processes with different tools (see Naeve et al. 2005)

In the Figure 1 four different types of learning processes are presented. These processes are supposed to take place in web, especially in Semantic Web. The tools, which are aimed for the four processes should fulfil the ontologies, which define the semantic web. The learning process as a whole is also a cyclic one starting at the individual level and advancing towards the organizational level (SLO).

The learning process is also closely related with Kolbian approach (see Kolb, 1984; Honey Mumford, 1982) and the different sub processes are named according to Nonaka and

Takeuchi (1995), but the processes themselves were defined in Naeve et al. (2005). The tools were also named but not well defined. The main task in the present study would be to have a closer look at the tools selection.



The tools should also fulfil the requirements we have for working in a semantic web. Learning with semantic web technologies always take place in a context with a content. It first began with HTML documents (see Paker, 2006, p. 41) but was then modified with related concepts using XML-syntax and content description (RDF) (see Figure 3).

Figure 2: Learning with Semantic Web technologies

Support Context and Socialization

By support context is considered the social interaction between students and their teachers. Yli-Luoma (1996; 2003) observed that when this interaction is good enough and it covers three special dimensions: emotional attachment, cognitive support, and moral values, it will advance internal working models, which include intrinsic motivation. The intrinsic motivation, however, is mainly activated by strong self-esteem, which is a product of the interaction process. So the best support would seem to be the advancement of strong self-esteem among the learners to activate their learning processes.

Bowlby(1987) argues that the secure emotional attachment activates exploratory behaviour, which is best conceived as mediated by a set of behavioural systems evolved for the special function of extracting information from the environment … activation results from novelty and termination from familiarity (Bowlby 1987, 238).

The activation process was tested empirically by a LISREL-model and reported in Naeve et al. (2005) (see also Yli-Luoma 1996, 2003)

Vygotsky (1962, 1978) demands that the social context has a significant impact on learning process. He argues further that it takes place on two levels, on social and psychological. The social interaction is observed by interpersonal relationships. The psychological process takes place on intra psychological level, which means that the learners construct new information with their thinking abilities. This type of approach has given a contribution to social constructivism, which was developed by Berger and Luckman (1969). The interaction process above refers to synchronous face-to-face learning. What about synchronous or asynchronous distance learning? How do we activate the exploratory behaviour (motivate) at distance and asynchronously? Interaction design is the art of effectively creating interesting and compelling experiences for others (Shedroff 1999).

Community building tools

The distance in time and place would seem to impede the process of bonding (attachment) and of building cohesion in a group. Cohesiveness in a group is positively reinforced if the group goals match the members' own goals, if the group interacts effectively and harmoniously, and if members are attracted to each other (Sears et al., 1991). To build trust and create a feeling of cohesion, intensive personal attention and presence is required, which is difficult to achieve via Internet-based Communication. Bonding (social attachment) is much easier to advance if members have met face to face first. The social interaction among the online learners is crucial not only for knowledge construction and mutual support, but for the reduction of isolation and anxiety during the independent learning process (compare Vygotsky's psychological level).

Comparing face to face learning and online learning, the social context might be the one dimension, where the most differences can be found. The social context is, however, one of the corner stones in learning process. How can online learning be arranged to take place so that the participants maintain mutual caring and understanding through the interaction, which can be offered online. That would mean that the online learners should be able to develop a sense of belonging, social-emotional bonds or attachment, and supportive relationships. 'Collecting experiences' is replaced under Social Context -forum. It would mean that this context is emotionally or affectively loaded. If the learner does not like the subject, he would not be interested to collect any new information or experiences either. The Kolbian approach replaces these two aspects together (see Kolb 1984 or Honey & Mumford 1982). Further, brain research has demonstrated that learning is based on collecting experiences (see Bransford et al., 1999).

According to the theoretical model (see Figure 1) the first tool, which is needed, should cover the advancement of personal relationships, social context, and collecting of experiences. In web technologies there are tools, which should serve interaction between learners or learners and instructors.

Thurmond (2003) defined interaction as:

> *…the learner's engagement with the course content, other learners, the instructor, and the technological medium used in the course. True interactions with other learners, the instructor, and the technology results in a reciprocal exchange of information. The exchange of information is intended to enhance knowledge development in the learning environment. Depending on the nature of the course content, the reciprocal exchange may be absent – such as in the case of paper printed content. Ultimately, the goal of interaction is to increase understanding of the course content or mastery of the defined goals (p. 4).*

Learner-learner interaction can be between one student and another or between several students. In order for effective learning to occur, four types of peer behaviour are necessary in a computer mediated environment: (a) participation, (b) response, (c) provision of affective feedback, and (d) short, focused messaging. Team work, or collaborative learning, involves students working together in groups to complete academic assignments (Alavi, 1994; Palloff & Pratt, 2001).

In an attempt to better understand the differences between the traditional classroom environment and a learning environment augmented or replaced with distance education technology, Restauri (2001) compared *end of course evaluations* between a video conferencing distance education course and an online course.

Data were collected from 142 video conferencing students and 62 online students. Of the online students, 90.3% reported that because of the online format, their interaction with their instructor either improved or remained the same. These same students (61.3%) also reported that they were more willing to respond and partake in the online course than in their traditional classes. These findings provided support that the online format was an acceptable medium for interaction. Restauri (2001) concluded that the face-to-face factor was not important, rather students' interaction needs in the online environment was more dependent on frequency and personalized contact.

Furthermore, high frequency of private e-mail communication between student and instructor has been identified as a strong predictor for higher student grades (Stocks & Freddolino, 1998). In contrast, Beard and Harper (2002) reported that students and instructors were concerned about the lack of learner-instructor interaction in a class that was delivered both in the traditional and Web-based format.

The above would seem to suggest that an online tool with good enough interaction features would work as the community building tools. In the INTeL-project (INTeractive e-Learning) led by Yli-Luoma (2005) a web conference software *ASAP* has been tested. The empirical data collected will be analyzed and reported later on. *ASAP* is a video conference software with chat, presentation (PowerPoint slides), screen sharing, and file sending features. It also has a hand raising feature for better interaction. The instructor can also use different help functions like a hand used as a pointer (see Figure 3 at ProLearn –logo). The instructor can use it herself/himself or also let the students use the different interaction tools: chat, pointer, mark pen, or text with arrow. All interaction tools carry one's name as label. At this stage the learning group should build the learning community and collect experiences. The empirical data collected by now, would seem to confirm that the interaction process is much better than in a face-to-face learning situation. The empirical data also confirms that a teacher presentation of 15-20 minutes would seem to be an optimal selection.

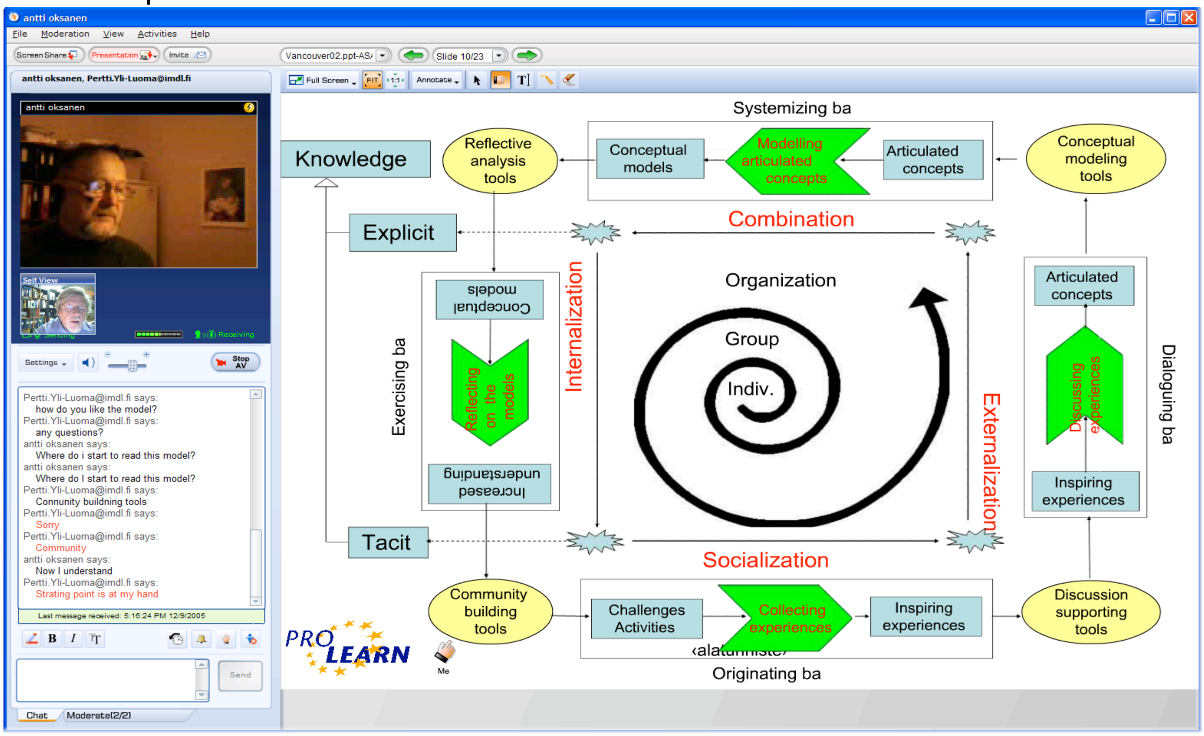


Figure 3: Community building tools – Web conference software *ASAP*

This working tool is used for a web class of 15 students. It has different features enabling the collecting of experiences with good interaction tools making the socialization process easier.

Discussion supporting tools

According to the theoretical approach (see Figure 1 or 3) the next phase in the e-learning process would be *Discussion supporting tools*, with which the learners should be able to reflect on the collected experiences, which should be articulated. For these purposes the project has found this far the best tool: *FlashMeeting* –software.

The social context was needed for activating a colaborative reflextion phase between the online learners (see Honey & Mumford 1982; Kolb 1984). Ravenscroft (2004) argues further that a socio-cultural framework is needed for cognitive change. According to Vygotsky's (1978) argumentation the higher cognitive processes provide a basis and motivation for collaborative, argumentative and reflective discourse. Bransford et al. (2002) suggest further that the collaborative reflextion phase include creativity. Zohar (1997) argues that the creative thinking demands that we can break old rules or are able even for a shift of paradigms. Some brain researchers argue that this kind of thinking is placed in human brains in the same area as motivation, vision, value and meaning – quantum field.

Keeves (2002) demands that the constructvistic approach still works in this phase. Students construct the information and experiences towords a knew knowledge using Piagetian cognitive developmental stage at the Concrete Operational Stages, but they do not need to go beyond these stages. He argues further that at least in the fields of mathematics and science, the basic principals of constructivism are incomplete and inadequate for both learning and teaching these fields.

Sweller (1999) questions strongly the efficacy of so-called 'constructivistic based' learning and argues that evidence for the effectiveness of these learning procedures is almost totally missing with a lack of systematic and controlled experimentation.

The Cognitive Context in the model (See Figure 1 or 4) is mostly described by: cognitive reflection collaborative creative constructivism using Concrete Operational Thinking Stage.

But we need to go furher, beyond the Concrete Operational Thinking Stage.

Figure 4: *FlashMeeting* -software for *Discussion supporting tools*

The *FlashMeeting* –software is used directly after presentation phase, where the collecting experiences (Teacher talk) has taken place. *It* is especially aimed for cognitive reflection. The different features of the *FlashMeeting* –software are given in the Figure 4. It has good reflection and evaluation functioning and the streaming version completes the evaluation feature with its graphical presentation.

Conceptual modelling tools

It was argued above that at least in the fields of mathematics and science higher thinking abilities are needed. Piagetian Formal Operations Stage would seem to fulfil this demand. At the formal operational stage students are able to formulate and test a single hypothesis - they are able to go beyond the data. When the problem is more complex several hypotheses are needed - a model approach would seem to be more suitable. Kaplan (1997, 117) argues that the term 'model' is useful when the symbolic system it refers to is significant as a structure - a system that allows for exact deductions and explicit correspondences. The value of the model lies in the deductive fertility of the model, so that the unexpected consequences can be predicted and then tested by observation and experiment. Evers (2000) has presented a connectionist modelling of artificial neural networks in an educational situation. Penner's (2001) article titled 'Cognition, Computers, and Synthetic Science: Building Knowledge and Meaning through Modelling', laid foundations for a shift towards what he recognises to be a modelling approach. Penner, however, fails to recognise that a model must be tested for adequacy. While he considers practical work in the traditional teaching of science, he does not see clearly its role in a modelling approach. Keeves (1997), however, argues very clearly for a modelling approach.

For the e-learning approach in the semantic web a conceptual modelling tool would seem to be a theoretically demanded tool. The previous two tools, which have been presented here, clearly fulfil the requirements of semantic web tools. What about the third one: conceptual modelling tools? It should be compatible with XTL, RDF, and URIs. When the learners advance their models, then the computers also are able categorize the models.

Naeve (2005) and his research group are developing a concept-oriented modelling technique called ULM (Unified Language Modelling), which is a dialect of the UML (Unified Modelling Language), an international standard for information systems modelling that has emerged from the object-oriented modelling community. The purpose of ULM is to visually represent how one speaks about a knowledge domain. Having visual access to the history of a verbal presentation or discussion renders it a permanence that greatly facilitates the conceptual calibration process that is involved in the negotiation of consensus within a group.

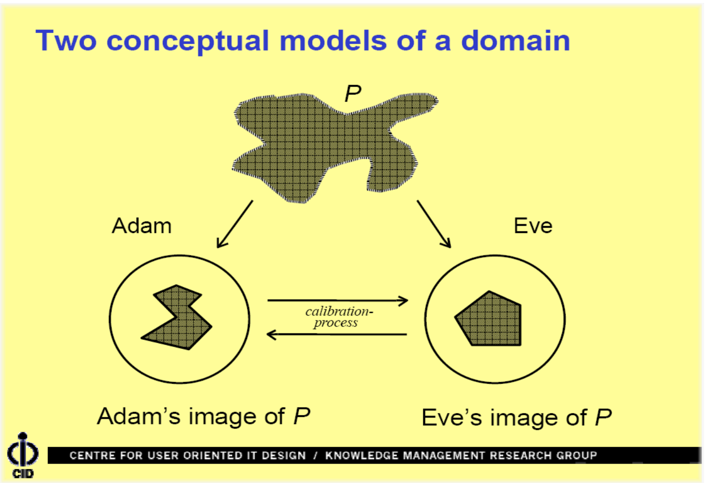


Figure 5: Conceptual modelling tool (Naeve, 2005)

This conceptual modelling tool is interesting from the perspective that it is compatible with semantic web and it can be used in several knowledge areas. In the Swedish educational research the Martonian phenographical approach is the most used paradigm. It has its shortcomings, however, in the analysing processes of the different conceptions, that different learners have of the very same phenomenon. From some empirical studies of learning in higher education phenomenography was evolved, however, as a research specialisation aimed at "describing conceptions of the world around us" (see also Marton, 1981).

The Conceptual modelling tool by Naeve (2005) would seem to be a promising approach even for analyses of describing the different conceptions of the world around us (see also Figure 5). In the present study the theoretical model as given in Figure 1 and 3 the main purpose was to select some semantic compatible tools for the learning process especially for studying it in a semantic web environment. There are, however, several candidates for all the parts in the learning model. The INTeL –project has decided, though, to test those candidates described here. The conceptual model by Naeve (2005) might even give contributions in some qualitative research methods (e.g. phenomenography). We still have one phase left in the learning process: Reflective analysis tools.

Reflective analysis tools

Yli-Luoma's (1992) comparative study among pre university students of physics learning reveals the importance of experimental context. He had seven different countries of which three had an experimental context and four did not have it. The results expose how pre university students understand physics without being evolved in experimental context. In those countries, in which the students were evolved with experimental context, the thinking abilities and understanding of physics were much better developed than in the countries where the experimental context was missing.

Of the above it can be concluded that the theoretical approach in learning process is not enough, but an experimental learning approach, with testing of knowledge, will lead to a better quality of learning. How is the experimental learning process implemented in online learning? Simulations might be possible laboration tools in experimental context. Nakajima (2002) tested it in physics learning using chat -forum as the reflection -tools. His experiment would seem to confirm the idea using simulations as a part of the experimental context.

This is the experimental phase, where the learners should test their advanced models how they work. We could also call it application phase, where learners apply the conceptual models. In mathematics learning it could be a tool to test the mathematical concepts etc. In the INTeL –project an *IVT* –tool (Interactive Virtual Tool) (see Figure 6) has been developed. It is actually 'a desk' where students test their models and where the tutor can come and give her/his contribution if needed. It works real time but the tutor can also come when the learner is not present and is able to give her/his contribution. They can also meet there if needed. The tool is under construction and it is aimed to fulfil the requirements of the semantic web. There could be several candidates here too. An e-portal for the semantic web could be one of them.

In the Figure 6 all the four tools are collected together and replaced where they are supposed to work: *ASAP –web software* for presentation and collecting experiences,*FlashMeeting* as a discussion tool for cognitive reflection, *Unified Language Modelling* for modelling purposes, and *Interactive Virtual Tool* for testing purposes (see Figure 6).

Figure 6: The four different web learning tools

Concluding discussion of the content

The final question would be about the content of learning process. The semantic web would certainly bring many difficulties for several of the face-to-face instructors. Content providers might not be able to give their contributions in producing semantic web compatible content designs.

Semantic Web technology will also have an impact on the way we develop courses – for the Web and also for other platforms of presentation and delivery. It sounds difficult for many of the content providers (see Figure 6). If we, however, can overcome these difficulties, we might be able to reduce the costs of instructions, if we take seriously research like Dodds and Fletcher (2004):

> *Empirical evaluations suggest that use of interactive technologies can reduce the costs of instruction by about one-third. In addition, they can either increase achievement by about onethird while holding time constant or reduce time needed to achieve targeted instructional objectives by about one-third. (Dodds & Fletcher, 2004, 391.)*

Holohan and Pahl (2003, p. 30) have designed a model of semantic web-based courseware design (see Figure 6).

XML offers structure for content and metadata annotations for learning objects. RDF enables the semantic definition of concepts and reasoning about semantics. The ontology provides features to share and reconcile different knowledge representations. That is why we

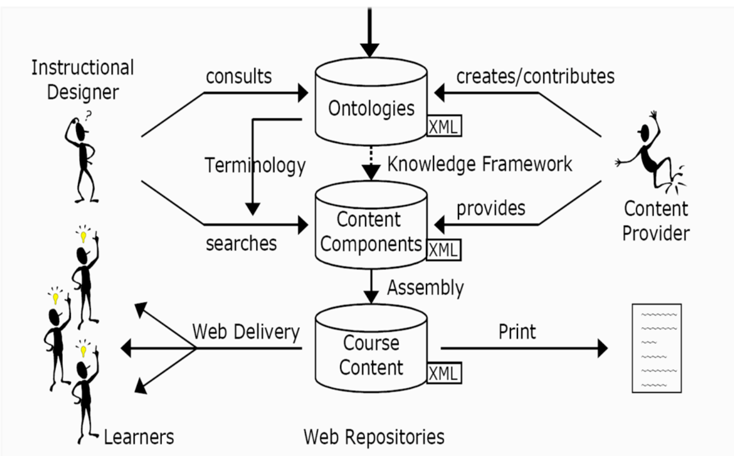


Figure 6: Semantic Web-based Instructional Design (Holohan & Pahl, 2003, p. 30)

need both instructional designers and content providers.

Explicitly modelling diverse learning theories, paradigms and principles is the basic principle of the *Semantic Web*, which will bring structure to meaningful content as well as the ability to process semantics by automated means (see also Berners-Lee et al., 2001).

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