

# **The Impact of the Semantic Web on Education**

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The use and gathering of Information affects all aspects of today's culture and affect business practices, educational research, marketing, and even entertainment. The promises of the Semantic Web have allowed many individuals and groups to begin in depth research into how it will affect their particular interest. The World Wide Web has allowed an unprecedented amount of information to become available to almost anyone with a browser and an Internet connection. The focus now becomes, how do we harness this knowledge and make sense of it for our own benefit, public and private. The educational arena is one of these many areas that could benefit tremendously from the as-yet unrealized Semantic Web.

The Semantic Web is a concept introduced by Tim Berners-Lee in 1999. The subtitle to his article "The Semantic Web," gives a general description of what he and others hope to accomplish by implementing "a new form of Web content that is meaningful to computers will unleash a revolution of new possibilities" (Berners-Lee 34). In his now-famous example, Berners-Lee envisions having autonomous agents handle our personal and public information to solve everyday problems of all types such as scheduling, verifying medical providers based on insurance plans, reschedule appointments with business contacts, and even how to interact with family members to ensure proper care of family members. In this article, the authors declare "the Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out

sophisticated tasks for users” (34). The difference between the World Wide Web and the Semantic Web relies on the integration and compatibility of information rather than just the interchange of files using the Web as the delivery system. Another major component of this concept is relating the multitude of information available to real-world situations in a meaningful context.

In order for this new technology to work correctly and efficiently, however, current methods of obtaining and structuring information must be standardized and available for access by a multitude of computer agents and people. The World Wide Web Consortium (W3C) is a “collaborative effort led by W3C with participation from a large number of researchers and industrial partners” (<http://www.w3.org/2001/sw>) and was created by Tim Berners-Lee in October 1994. Currently, over 400 member organizations are part of the W3C and it also works with interested parties, the public and full-time staff to develop Web standards. Many groups of interested people work together in special interest groups to further the goal of creating and using the Semantic Web including the Rules Interchange Format Working Group, the OWL Working Group, the Semantic Web Deployment Working Group, and the Health Care and Life Sciences Interest Group. In addition, according to an online analytics site Compete.com, the W3C Web site “attracted at least 11 million visitors annually by 2008” (“World Wide Web Consortium” retrieved from <http://www.wikipedia.org>). The WC3 consortium has been exploring ways in which the Semantic Web “allows data to be shared and reused across application, enterprise, and community boundaries.” These tools include revising

current methods to meet Semantic Web standards as well as creating new tools. They have created many standards and programming languages along with a practical application of these tools. The Semantic Web tools are primarily based on Resource Description Framework (RDF). In February 2008, the W3C announced the publication of SPARQL, which they define as the key standard for opening up data on the Semantic Web (W3C press release, 2008).

Education is vitally important as the world develops more ways to communicate effectively and almost instantaneously. People are now able to gather information on a wide variety of topics necessary to achieve in both the academic realm and the business realm, formally and informally. In order to grow intellectually and competitively with today's expanded interests and developments, people need access to information. In "The Educational Semantic Web: Visioning and Practicing the Future of Education," the authors declare "the information age, with its emphasis on knowledge growth and multiple forms of communication, is dependent upon citizens being able to learn effectively...Moreover, the social costs of neglecting education exacerbate schisms between those with opportunities for learning and those without" (Anderson, 2004). The concept and theories behind the Semantic Web could provide this opportunity to expand the scope and ability to provide learning opportunities "unbounded by geographic, temporal, or economic distance" (Anderson, 2004).

e-Learning (also called distance learning or just-in-time learning) is a current educational method that utilizes some of the same information and structure as Berners-Lee's vision of the Semantic Web and also has many of the same. A Semantic Web education environment would require resolution of many of the same problems and benefits in order to function efficiently and reliably across many different platforms and different kinds of users. Learning management systems utilize education servers and other Semantic Web-like agents in order to deliver the proper information to its users. Key concepts of the Semantic Web are also found in e-Learning environments and in a Semantic Web learning environment. For example, content authoring (authority, reliability) have many of the same concepts discussed in terms of "expression of meaning" in the Semantic Web area of research. The "web of trust" often discussed in terms of the Semantic Web parallels building learning communities and adding a social dimension to a learning environment. However, e-Learning is not the Semantic Web but could potentially shape how users feel about the impact of the Semantic Web on an educational environment.

In "Education and the Semantic Web," the author, Vladan Devedzic, describes how the Semantic Web could be used in educational settings during educational activities such as teaching, learning, collaboration, and assessment. Pedagogical agents access information and learning objects that has been structured in ways that are Semantic Web standards and accessible using Semantic Web protocols through educational services or educational servers. Pedagogical agents are "autonomous software entities that support human

learning by interacting with students/learners and authors/teachers and by collaborating with other similar agents, in the context of interactive learning environments” (Devedzic, 47). Learning objects are defined by David A. Wiley as “any digital resource that can be reused to support learning” (Wiley, 2001). Educational servers can personalize the learning environment it supports for each person by having preferences, personal information, and educational information available for each person who accesses the server. The servers also use a presentation planner “to select, prepare, and adapt the domain material to show to the student” (Devedzic, 47).

Another important part of the educational setting is the content that is presented to each student. Authors/teachers must develop educational content according to the accepted pedagogical issues such as human learning theories. Once appropriate content is available, Semantic Web protocols and technologies comes in to play. Semantic markup must provide access to shareable educational ontologies. These ontologies must be compatible across platforms and protocols in order to be useful by students and teachers alike in this educational setting. According to Devedzic, it is also important to create educational ontologies within the current framework of HTML, RDF, and XML in order for them to be useful and used by prospective students and authors/teachers.

Articles regarding the Semantic Web also discuss the problem of metadata. This also affects how this information might be used within a proposed educational setting that utilizes the standards and protocols of the

Semantic Web. In "Semantic Web Metadata for e-Learning," the authors define some common misconceptions about metadata and its creation as well as what this means for education. The authors contend that the arguments against metadata stem from six 'misconceptions.' These objections slow down the development of a true Semantic Web and hinder the application of potential solutions. The misconceptions are: metadata (1) is objective data about data; (2) is only produced once; (3) must have logically defined semantics; (4) can be described by metadata documents; (5) is the digital version of library indexing systems; and (6) is machine-readable data about data (Nilsson, 2001). Defining metadata, who has the authority to define metadata, and how metadata is created is very important especially in a learning environment. Sources, authors, and teachers must be trusted sources and have innate credibility. Different authors and uses must be layered on to specific pieces of metadata in order for the autonomous agents of students/searchers to find the correct information in the correct context. Nilson concludes by saying that "learning...cannot be confined within rigidly defined boundaries...moreover, a learning environment has to support trust building" and provide a multi-layered form of communication in order to be valuable to students and teachers (Nilsson, 2001). Metadata must have a common denominator and be flexible in order to be useful in a learning environment. Another problem that must be solved before the Semantic Web can be fully realized in the educational realm (beyond the technical standards and protocols) is the melding of educational theory and pedagogical requirements with the use of varied sources of information.

Currently the creation of content relies solely on content experts and there are few means to automate this type of information. Collaborative authoring methods might eventually help reduce the workload of content creation. The Internet obviously provides an easily used, accessible, and accepted platform for author collaboration. A daunting problem for the educational community is the breadth of topics and areas of research that must be incorporated into the Semantic Web educational environment in order to be accepted by teachers and students alike. The acceptance of protocols and standards adopted the World Wide Web Consortium and other organizations are needed to create a reliable manner for this type of content management.

There are several programs and tools that market themselves as 'Semantic' learning technology. In "Semantic-aware components and services of ActiveMath, the authors describes the program's "strongly related to semantic representation of educational content" and also discuss performance issues of the program (Melias 420). ActiveMath is a "complex web-based adaptive learning environment with a number of components and interactive learning tools" (Melis 405). They utilize semantic content markup for mathematics and annotate this material with educational metadata. ActiveMath tools can also provide a course generator, a semantic search engine, and allows user evaluation in order to improve the program and the personal educational environment for each learner. As discussed earlier, it is important to keep content reusable and usable across multiple platforms. ActiveMath uses semantic XML for mathematics documents. They also use a version of the

European standard for mathematical symbols and expressions called OpenMath. ActiveMath uses a mediator approach to information integration in order to ensure that content and its “components can abstract from the knowledge source,” a key concept in the Semantic Web educational environment (Melis 409). However, a large problem for the successful development of the Semantic Web also hinders the true performance of programs such as ActiveMath remains the generation of content. Although there are multiple sources and standards for mathematics educational content, these systems must struggle to reduce the workload of content production, facilitate collaborative authoring, and increase the flexibility of semantically encoded content (Melis 420).

In “Semantic Web Metadata for e-Learning: Some Architectural Guidelines,” this Knowledge Management Research Group based in Stockholm, Sweden discusses one of their projects, Edutella, an infrastructure and a search service for a peer-to-peer network. This program will “facilitate the exchange of educational resources” (Nilsson 2001). Their primary aim is to solve some of the problems about metadata. The services they envision will include searching, mapping, and replication. “Searches will be routed to anyone who has registered a matching answering capability. Mapping will enable translation between schemas [to] allow very flexible reuse of information” (Nilsson 2001). Open source formats will be used exclusively and “replication will allow metadata about learning resources to be spread across the web, which will simplify the discovery of the corresponding resources” (Nilsson 2001).

Education is a vital component of success as individuals and as a society. It is especially important to be able to provide reliable, personalized, just-in-time learning in the academic and competitive business worlds. The wealth of information available on the World Wide Web can be harnessed using Semantic Web protocols and standards and incorporating pedagogical theories and processes to provide a complete educational environment to students/learners and authors/teachers. A multi-layer, flexible structure for metadata to allow the addition of context information and content specific metadata is one stumbling block. More importantly, the creation of metadata from reliable, trustworthy sources that gives confidence to instructors is absolutely vital in a Semantic Web educational setting. Berners-Lee's 1999 vision of the Semantic Web seems to offer a perfect platform to use in e-Learning and educational settings. However, the current projects can only go so far without more breakthroughs and hard work from the W3C and other organizations like it.

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