

## Web 3.0 in Education & Research

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**Abstract** - *The continuous evolution of the Internet has opened unimaginable opportunities and challenges in web based education and learning. The traditional version of web i.e. Web 1.0 started as a Read only medium; the next version Web 2.0 established itself as Read/Write medium. Now the currently evolving version of web, viz., Web 3.0 is said to be a technologically advanced medium which allows the users to Read/Write/Execute and also allows the machines to carry out some of the thinking so far expected only from the human beings. In a short time, Web 2.0 and now Web 3.0 have created new tools and technologies for facilitating web based education & learning. To begin with, this paper discusses some definitions of the Web 3.0, its evolution and characteristics. Next, we have discussed about the possible future Web 3.0 technologies, trends, tools and services that will assist in the areas of online learning, personalization and knowledge construction powered by the Semantic Web.*

**Index Terms** - Web 3.0, Semantic Web, Educational Technology, Online Learning, 3D learning environments, e-learning.

### 1. INTRODUCTION

For about last two decades, the World Wide Web(WWW) is being used to improve communication, collaboration, sharing of resources, promoting active learning, and delivering of education in distance learning mode. The WWW helps teachers in planning suitable online delivery structure, sharing goals of learning, and activities for their courses.

In recent years, many of the universities and educational institutions world wide offer online services such as admissions, virtual (online) learning environments in order to facilitate the lifelong learning and to make this compatible with other educational management activities. For example, a teacher may create a purely Web-based delivery system including online handouts in respect of student's activities, projects and lists of resources for reference. The students and other learners may access web based material anytime from any where in the world, being connected through Internet.

Since the 1990s when the World Wide Web was established, it

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has evolved from the earlier versions, viz. Web 1.0 to Web 2.0, and finally is evolving into the newest version, viz., Web 3.0. In respect of different versions of web, the Wikipedia states: "Web 1.0 is Read Only, static data with simple markup for reading. Web 2.0 is Read/Write dynamic data through web services customize websites and manage items. Web 3.0 is Read/Write/Execute." In Web2.0, user not only reads information from the internet, but also provides information through internet to share with others. Currently we have many popular Web 2.0 interactive applications like *Blog, Podcast, Mashup, Tag, RSS/Atom, Wiki, P2P, Moblog, Adsense* and so on. Compared with Web 2.0, there is not a very clear definition available for Web 3.0 till now. Web 3.0, to be discussed in detail below, is a term used to describe the future of the World Wide Web. Views of different pioneers on the evolution of Web 3.0 vary greatly. Some believe that emerging technologies such as the *Semantic Web* will transform the way the Web is used, and lead to new possibilities in artificial intelligence based applications. Other visionaries suggest that increase in Internet connection speeds, modular web applications, or advances in computer graphics will play the key role in the evolution of the new version of World Wide Web [1].

### 2. DEFINITIONS OF WEB 3.0

The term '*Web 3.0*' was first coined by John Markoff of the New York Times in 2006 [6], and first appeared significantly in early 2006 in a Blog article "*Critical of Web 2.0 and associated technologies such as Ajax*" written by *Jeffrey Zeldman*. Major IT experts and researchers support different approaches to the future Web. There is complete agreement among the experts about how Web 3.0 will evolve. Below we discuss the opinions of pioneers in the field in this respect.

Tim Berners-Lee, coined the term *Semantic Web*, and promotes the concept of conversion of Web into a big collection of databases [2].

About Web 3.0, Tim Berner Lee [3] says:

"People keep asking what Web 3.0 is. I think maybe when you've got an overlay of scalable vector graphics - everything rippling and folding and looking misty-on Web 2.0 and access to a semantic Web integrated across a huge space of data, you'll have access to an unbelievable data resource."

Netflix founder, *Reed Hastings* [4] thinks that Web 3.0 would be a full video Web as stated below:

"Web 1.0 was dial-up, 50K average bandwidth; Web 2.0 is an average 1 megabit of bandwidth and Web 3.0 will be 10 megabits of bandwidth all the time, which will be the full video Web, and that will feel like Web 3.0"

Yahoo founder, *Jerry Yang* thinks that the new era of tools & techniques for creating programs, data, content and online applications will blur the distinction between professional, semi-professional and consumers. At the TechNet Summit in November 2006, Yang stated [4]:

“Web 2.0 is well documented and talked about. The power of the Net reached a critical mass, with capabilities that can be done on a network level. We are also seeing richer devices over last four years and richer ways of interacting with the network, not only in hardware like game consoles and mobile devices, but also in the software layer. You don't have to be a computer scientist to create a program. We are seeing that manifest in Web 2.0 and Web 3.0 will be a great extension of that, a true communal medium...the distinction between professional, semi-professional and consumers will get blurred, creating a network effect of business and applications.” Finally, we consider what Google’s CEO, Eric Schmidt [5] stated:

“Web3.0 as a series of combined applications. The core software technology of Web3.0 is artificial intelligence, which can intelligently learn and understand semantics. Therefore, the application of Web3.0 technology enables the Internet to be more personalized, accurate and intelligent.”

These are some of views about Web 3.0 of the different experts of IT industry. Next, we discuss some of characteristics of Web 3.0.

### 3. CHARACTERISTICS OF WEB 3.0

Four characteristics of Web 3.0, as given below, can be summarized from the above definitions and descriptions.

#### 3.1 Intelligence:

Experts believe that one of the most promising features of Web 3.0 will be *Web with intelligence*, i.e., an *intelligent web*. Applications will work intelligently with the use of Human-Computer interaction and intelligence. Different *Artificial Intelligence (AI)* based tools & techniques (*such as, rough sets, fuzzy sets, neural networks, machine learning etc*) will be incorporated with the applications to work intelligently. This means, an application based on Web 3.0 can directly do intelligent analysis, and then optimal output would be possible, even without much intervention of the user. Documents in different languages can be intelligently translated into other languages in Web3.0 era. Web 3.0 should enable us to work through natural language. Therefore, users can use their native language for communication with the others around the world [6].

#### 3.2 Personalization:

Another characteristic of Web 3.0 era is Personalisation. Personal or individual preferences would be considered during different activities such as information processing, search, formation of personalized portal on the web. *Semantic Web* would be the core technology for Personalisation in Web 3.0 [7] [8].

#### 3.3 Interoperability:

In the context of Web 3.0, the terms Interoperability, collaboration and reusability are basically interrelated. Interoperability implies reuse, which is again a form of collaboration. Web 3.0 will provide a communicative medium for knowledge and information exchange. When a person or a software program produces information on the Web and this information is used by another, then the creation of new form of information or knowledge takes place [24]. Web 3.0 applications would be easy to customize & they can independently work on different kinds of devices. An application based on Web 3.0 would be able to run on many types of Computers, Microwave devices, Hand-held devices, Mobiles, TVs, Automobiles and many others. Pervasive Web is the term used to describe this phenomenon where web is operable to a wide range of electronic devices.

#### 3.4 Virtualization:

Web 3.0 would be a web with high speed internet bandwidths and High end 3D Graphics, which can better be utilised for virtualisation. The trend for future web refers to the creation of virtual 3-Dimensional environments. An example of the most popular 3-D web application of Web 3.0 is *Second Life* [7].

### 4. TECHNOLOGY TRENDS FOR WEB 3.0

Based upon the above definitions, it is likely that the new generation of web applications will have some specific core technologies to support them. In this section, we present some of the major trends in terms of technologies that might become the building blocks of the next generation of the Web. Figure 1 depicts the evolution of the web in terms of the core technologies, the content and services available to end users.

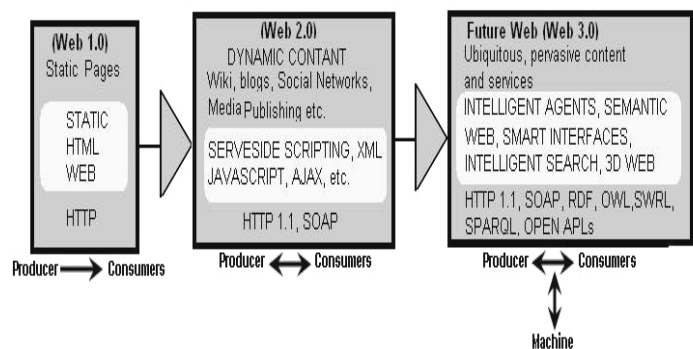


Figure 1: Evolution of the Web

#### 4.1 Semantic Web:

The extension of the World Wide Web that provides an efficient & easier way to share, find and combine data & information from distinct sources is called Semantic Web. In the simplest terms, we can define Semantic Web as a relationship between things, described in a manner which makes people and machines able to understand. We may say,

Traditional World Wide Web = Web of Documents with Limited Interoperability,

Semantic Web = Web of Integrated, Linked meaningful Data.

Semantic Web is all about data integration. The Semantic Web converts “display only” data to meaningful information by using *metadata*. *Ontologies*, which contain the *vocabulary*, *semantic relationships*, and *simple rules of inference and logic* for a specific domain, are accessed by software *agents*. These agents locate and combine data from many sources to deliver relevant information to the user [23].

One of the objectives of Semantic Web is to identify and provide the exact required data that matches the keywords provided by the user. For example, if we search keyword *datamining* through Google, yahoo or any of search engines, millions of web pages appear as search results out of which a few may have some relevant information and all other pages may be useless. Web 3.0 in terms of Semantic Web is the third generation of World Wide Web in which machines will have the ability to read Web contents like Human beings and also the ability to follow our directions. For example, if you order to check the schedules of all the show timings of a film in theaters, for your preferred timings, within a 20 km radius, then it follows and provides the appropriate information in respect of your preferences.

#### 4.2 The 3D Web:

This trend of the future World Wide Web refers to the formation of virtual 3-dimensional worlds on the Web. The use of 3D graphics will be extensively utilized in the development of Web 3.0 tools or applications. High speed Internet, quicker processing speeds, higher screen resolutions, 3D gaming technology and augmented reality will transform the Web browsing into a 3D experience, where you actually move through the virtual corridors of the Web, as a virtual *avatar* of your real self [2]. Recently several Internet-based elementary virtual worlds, such as *Radar Networks* [9], *Second Life* [11], *IMVU* [12], *Active Worlds* [13], and *Red Light Center* [10], have gained huge attention by the public worldwide. Users of these virtual worlds are growing in a big way everyday. For instance, at the end of March 2008, *Second Life* had more than 13 million accounts with around 38,000 users logged on at any particular moment [14]. These types of environments allow users to experience new things which they may never be able to have in their real life. Users create avatars on the Web and allow them to reside in the virtual worlds. The residents or avatars of these virtual worlds can explore, interact with other residents, socialize, participate in different activities, create and serve different types of services. The possible interactions in these virtual worlds occur through text, chat messaging, audio chat, and/or with video.

#### 4.3 The Social Web:

The Social Web explains the interaction of people with one another using the underlying technologies of World Wide Web. Technology advancements in Web 3.0 will take the current social computing to a new level called *Semantic Social Computing or Socio-Semantic Web* which will develop and utilize knowledge in all forms, e.g., content, models, services, & software behaviors [15]. Semantic Web and, in general, Artificial Intelligence technologies will add underlying knowledge representations to information, tags, processes, services, software functionalities and behaviors. The wisdom of crowds will come not from the consensus decision of the group, but from the semantic and logical aggregation of the ideas, thoughts, and decisions of each individual in the group. Instead of linking documents only, the future Social Web will link people, organizations, and concepts automatically.

#### 4.4 The Media Centric Web:

The most of traditional search engines provide search results on the basis of text inputs. Web 3.0 searches will not restrict them only to the text based searches. Web 3.0 searches will be able to find out the related similar media objects based on its features. The search engines would be able to take input(s) as a media or a multi-media object and will be able to search out related media objects based on its features [2]. For example, to search images about cars, we need to provide an input as an image of a car and the search engine should be able to retrieve images of cars with similar features. The same kind of search possibilities should be applied with other media objects such as audio and video. The work in this direction is already going on. Some good examples of this kind of technology can be found on software like *Ojos Riya* [16] photo sharing tool that allows to automatically *tag* images using face recognition, similarly the site *Like.com* [17] enables the user to search for products based on similar images.

#### 4.5 The Pervasive and Ubiquitous Web:

Remarkable developments in technologies such as wireless communications, wireless networking, mobile computing devices, artificial intelligence, software agents, Enabling technologies (e.g., Bluetooth, BANs, PANs, 802.11 wireless LANs), embedded systems, wearable computers have led to the evolution of Pervasive & Ubiquitous computing platforms. According to Peter Robinson [25], Ubiquitous and pervasive computing may be defined as the task of embedding small and mobile devices into existing IT and computing infrastructures, so that it allows users to access and manipulate information where and when it matters, even while on the move. The scope and use of web services will not limit us only to computers and mobiles but web services will be equally available in clothing, appliances, and in automobiles and much more. We need not evoke these services every time; they will work and perform their task themselves cooperatively and automatically. The involvement of user to devices to access and work would be almost nothing. For example, using the future web services we

can find windows and curtains that check the weather and automatically open and close accordingly; home appliances that know our daily routines and preferences and communicate to each other to provide us with a more comfortable living [2]. As stated above, Web services would play an important role in this direction and device embeddable form of light weight web services will be required. The communication between different types of devices and the Web would be possible with the help of *Service Oriented Architectures (SOA)* and related technologies for ensuring cross-platform interoperability. Some leading software companies are working in this direction. Microsoft has released a *development API* [19] also, it has released exceptional innovations featured product called *Life Ware* [19], which is an excellent example of what this technology can bring in the future [20].

### 5. TOOLS AND SERVICES OF WEB 3.0 FOR EDUCATION & RESEARCH

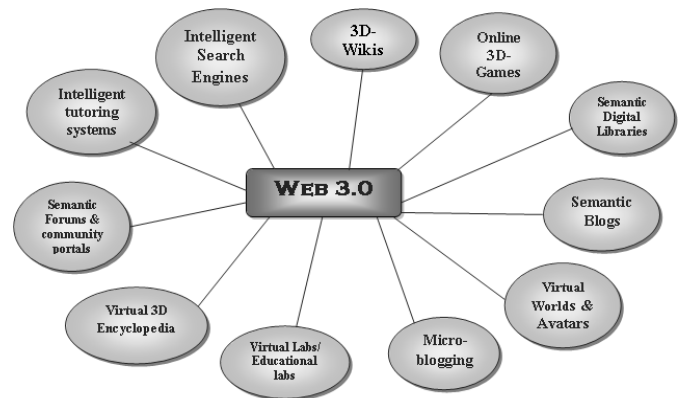
The learning in Web 2.0 emphasizes the active participation of internet users and interaction among social communities, through *social network tools* or *social software* such with Blog, wiki, social book marking and social networking. The tools & services of Web 3.0 technologies would foster a more open approach to learning. Web 3.0 has been proposed as a possible future web consisting of the integration of high-powered graphics (*Scalable Vector Graphics or SVG*) and semantic data. There have also been discussions around 3-D social networking systems and immersive 3-D internet environments that will take the best of virtual worlds (*such as Second Life*) and gaming environments and merge them with the Web.

About Web 3.0 in learning, the *Tony Bingham*, ASTD President and CEO says:

“In the Semantic Web, content will find you—rather than (you) actively seeking it, your activities and interests will determine what finds you, and it will be delivered how you want it and to your preferred channel. The Semantic Web provides tremendous potential for learning.”

We are in the beginning of a new revolution in information management and sharing that will make more and more content available to any combination of human and computer processing, allowing new means of collaboration between and across disciplines.

Web 3.0 offers many tools and services for different kind of web applications on Internet, as shown in figure below.



**Figure 2: Web 3.0 Tools & Services**

Next, we describe briefly some of the Web 3.0 tools and services which are useful for the education and research:

#### 5.1 Learning with 3D-Wikis / Virtual 3D Encyclopedia:

A *Wiki* is a system that allows one or more people to build up a collection of knowledge in a set of interlinked web pages, using a process of creating and editing pages. Wikis are playing significant role in content creation, publishing, editing, revising, and collaborating for knowledge creation. Wikis are being used for maintaining and building a repository of content and material. Students are able to work collaboratively and post large items. Ease of use of the wiki software makes it a simple matter for an editor (faculty) to delete/revert or modify the content. With the evolution of 3D web, researchers & technocrats have been working on new projects to bring a new dimension to the world of Wikis & encyclopedia. Some examples of this kind of technology can be found on software like *Copernicus-3D Wikipedia* (see <http://copernicus.deri.ie>) [18]. Suppose a Learner had performed the search and chose one of the results related to information about a specific geographical region, the camera will move to the particular place on the spinning globe to send relevant audio/video information. For instance, the camera will “fly” towards the island of Ireland as a result of searching for *irish heritage park*; eventually, the article about the Irish Heritage Park in Williamsburg will be presented to the user alongwith the video on irish heritage park [18]. 3D Wikis would be able to provide rich & effective environment involving all media and animation, for learners, so that they can have better impact on learning & knowledge.

#### 5.2 Learning with 3D Virtual worlds & Avatars:

As mentioned earlier, a 3D virtual world is a mix of 3D gaming technology, augmented reality, simulated environment powered with Internet technology where users interact through movable *avatars*. Users create *avatars* on the Web and allow them to reside in the virtual worlds. Learners can create their own *avatars* on the web & reside in these worlds. Virtual worlds can be seen as the beginning of new era of e-learning as they allow

learners to do role-play, 3D modeling, simulations, creativity and their active involvements. There is a huge space for conducting research relating to the pedagogical benefits of teaching and learning in 3D virtual worlds. Recently several web based 3D virtual worlds, such as *Second Life* [11], *IMVU* [12], *Active Worlds* [13], and *Red Light Center* [10], have gained attention by the students and teachers for education & learning worldwide. Educators may conduct classes in a variety of different settings within a 3D virtual world where they can interact in real like environment of a class. Educators & learners may collaboratively conduct sessions from geographically dispersed locations in a shared virtual 3D space. They can allow educators & learners in conducting meetings, seminars, presentations, digital exhibitions where learners can come and interact like the same way we do in our real life. 3D virtual worlds available today and in coming future will be very helpful across a diverse range of disciplines including education, medicine, business, commerce, science, communication, media, art, architecture and design, law, computer science, language learning, history and geography to mention but a few.

### 5.3 Intelligent Search Engines:

In the last few years, learning processes have benefited from the technological evolution of the web. The dispersion of the web has permitted the introduction of new educational processes, which are more flexible for accessing the resources for learning. Now a days Internet has become the most useful and powerful source of information. In order to effectively deal with the huge amount of information on the web, advanced web search engines have been developed for the task of retrieving useful and relevant information in multimedia form for its users [21]. When you use a traditional Web search engine, the engine isn't able to really understand your search. It looks for Web pages that contain the keywords found in your search terms. The search engine can't tell if the Web page is actually relevant for your search. It can only tell that the keyword appears on the Web page. A Web 3.0 era of Agents based-search engine could find not only the keywords in your search, but also interpret the context of your request. It would return relevant results and suggest other content related to your search terms. Experts believe that Web 3.0 will provide users with richer and more relevant experiences. Experts also believe that with Web 3.0, every user will have a unique internet profile based on that user's browsing history. Web 3.0 will use this profile to tailor the browsing experience to each individual. That means that if two different learners, each performed an internet search with the same keywords using the same service, they would receive different results determined by their individual profiles [22]. Students will also benefit from knowledge construction powered by the Semantic Web. A Semantic Web *Agent* based search engine will return a *multimedia report* rather than just a list of hits. A smart agent can return local lectures, relevant blogs, books and television programs about the topic to the learner. Ontologies will link the

learner's needs and characteristics so that personalized agents can search for learning material based on the learners' needs [23]. Learners can apply the same kind of search possibilities with other media objects such as *image*, *audio*, and *video*. Some examples of this kind of technology can be found on software like *Ojos Riya* photo sharing tool that allows to automatically tag images using face recognition [16], or *Like.com* which enables the user to search for products based on similar images [16].

### 5.4 Online 3-D Virtual Labs / Educational labs / Simulations or 3D Web:

3D rich graphical user interfaces will act as a powerful platform for the users to participate and perform collaborative activities, sharing results and exchanging media information among participants in a more natural way [26]. The following are some of the examples of 3-D Virtual Labs/Educational labs/Simulations or 3D Web based applications that will shape future education:

1. **To visit places those are not accessible:** Visiting different places in virtual worlds would benefit learners in many ways. Ancient places where students can reach there in a small span of time virtually. For example, to take a look at ancient places like Tajmahel, Red fort or Rome, Students can interact & experience with the environment of the places, other students and can have their teacher as guide through the web. Similarly, they can see the Egyptian pyramids or visit an Egyptian village in the same way. There is so much scope where we can teach the students and give them a safe and economic way of experiencing such things.
2. **To promote student collaboration:** Students can come together & meet virtually in diverse and attractive manner. They can collaborate & work on common projects. Students & Educators may have discussions, talk, connect, and chat on the common projects. Additionally, they can fly over and move things around in a 3D world. They can even use & work in multiple 3D worlds instantaneously.
3. **To promote assessment through Project Based Learning:** For instance, students can do research and create a (virtual) village in, say, the Roman Empire. Additionally, a whole group of students around the world could create this environment while attending a distance learning course. This way they can work together on a project & able to experience the interesting ways of learning at a distance.
4. **To develop scenarios and simulations:** High end graphics and rich 3D internet applications can be utilized to make simulation based environments or Labs where learners can learn or even do experiments. These Labs are so-called dry labs. These Web based Labs can prove to be quite

beneficial for online learners. They could go to an immersive virtual science lab to do experiments. After the simulation, students could go offline into a real science lab to perform the correct experiment and see how it works [27]. High level scientific experiments could be conducted, and expert technical training could be obtained, in ways that a university or school could not afford. For example, imagine splitting atoms, conducting surgery, flying a plane or exploring inhospitable environments.

## 6. CONCLUSION

Web 3.0 is more than a set of useful and new technologies and services. Web 3.0 technologies offer an array of services to make a true online classroom a reality. Because of its very nature Web 3.0 services will be having positive impact on teaching and learning. Web 3.0 technologies offer benefits of 3D-wikis, 3D Labs; Intelligent Agent based search engines, Virtual environments like Avatar and Semantic Digital Libraries etc. In our vision of the Web 3.0, we foresee a scenario where such ubiquitous technologies will create a convergence of real and virtual environments, where the user will seamlessly interact with humans and machines either through virtual means or in the real world. These benefits can be directly aligned to the existing best practices in online education, and make further authenticated and effective educational environment.

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