International Institute for Sustainable Development
Institut international du développement durable
http://www.iisd.org

How Information and Communications Technologies Can Support Education for Sustainable Development

Current uses and trends

Leslie Paas, IISD Associate
with Heather Creech, Director, Knowledge Communications

January 2008

The International Institute for Sustainable Development contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change, measurement and assessment, and natural resources management. Through the Internet, we report on international negotiations and share knowledge gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries and better dialogue between North and South.

IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC) and Environment Canada; and from the Province of Manitoba. The institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.

International Institute for Sustainable Development
161 Portage Avenue East, 6th Floor
Winnipeg, Manitoba
Canada R3B 0Y4
Tel: +1 (204) 958-7700
Fax: +1 (204) 958-7710

E-mail: info@iisd.ca
Web site: http://www.iisd.org/

How ICTs can support Education for Sustainable Development: Current Uses and Trends

Leslie Paas, IISD Associate
with Heather Creech, Director, Knowledge Communications

Prepared with the support of the Province of Manitoba.

Presented to Manitoba Education, Citizenship and Youth.

Table of Contents

1. Introduction

1.1 ICTs in Education

The United Nations Educational, Scientific and Cultural Organization (UNESCO) uses the term *ICTs,* or information and communication technologies, to describe:

> "…the tools and the processes to access, retrieve, store, organise, manipulate, produce, present and exchange information by electronic and other automated means. These include hardware, software and telecommunications in the forms of personal computers, scanners, digital cameras, phones, faxes, modems, CD and DVD players and recorders, digitised video, radio and TV programmes, database programmes and multimedia programmes" (UNESCO Bangkok, 2003, p.75, in Anderson, p.5).

This paper presents a brief history, and identifies current uses and trends for deploying ICTs, primarily in the formal Kindergarten to Grade 12 (K–12) education system, with a focus on the online environment. It considers three main questions:

1. Why do ICTs need to be considered as a critical tool in education for sustainable development (ESD)?
2. What ICTs are currently being used by educators and learners?
3. What can we expect to see in the near future?

Any kind of technology can be understood as a tool or technique for extending human capacity. In this sense, ICTs extend our human capacity to perceive, understand and communicate. The mobile phone enables us to speak from wherever we are to others thousands of kilometres away; television permits us to see what is happening on the other side of the planet almost as it happens; and the Web supports immediate access to, and exchange of, information, opinions and shared interests.

In the field of formal education, ICTs are increasingly deployed as tools to extend the learner's capacity to perceive, understand and communicate, as seen in the increase in online learning programs and the use of the computer as a learning support tool in the classroom. Although universities were certainly leaders in engineering the Internet and interoperable computer systems to connect researchers for e-mail and data exchange, the use of ICTs for education and training has lagged behind other sectors in society. According to White (2005):

> "The use of ICT in education and training has only begun as access to ICT services and higher bandwidths become more available to learners. The danger is that we ascribe to new technologies the characteristics of previous media and accompanying educational practices without development and reflection on new and better ways to support and evaluate learning outcomes."

In order to best use these technologies in education, new pedagogies and learning assessment methods may, and probably will, be required. In this rapidly advancing field, it is worth reviewing the history, current uses and trends in ICTs that will further influence how education practices may be changed in future. Educators are continuing to develop new applications and online resources to support learning objectives in all disciplines. The field of environment and sustainable development education is no exception.

1.2 Education for Sustainable Development – ESD

Education is seen as key in the process of achieving sustainable development. However, in order for formal education to contribute to sustainability, traditional systems and methodologies need to be re-oriented (Tilbury *et al.*, 2002; Huckle and Sterling, 1996; UNESCO, 2003). Visser (1997, p. 2), for example, explains that:

> "Centuries of development in education have not been able to avoid that nearly one billion people in the world are illiterate, more than 130 million children don't attend school, and many of those who do, acquire knowledge that doesn't sustain them or is irrelevant for their needs. There is a clear indication that yesterday's solutions are inadequate for today's problems, and there couldn't be a clearer signal that doing more of the same is not a valid solution."

Research shows that even in developed countries, where educational levels are high, the education system has not succeeded in influencing choices and behaviours that would support sustainable development. According to Tilbury *et al.* (2002, p. 17):

> "We know that in the USA, more than 80% of the population has higher education. We also know that the rates of energy use and the generation of waste in the USA are among the highest in the world. Higher levels of education have not led to more sustainability. Simply educating citizens to higher levels has not been sufficient to attain sustainable societies."

In 2005, UNESCO launched the "Decade for Education for Sustainable Development," which aims to accelerate the implementation of a new vision in education. The Decade is a call for a collaborative process to re-orient educational policies, programs and practices so that education can better play its part in building the capacities of all members of society to work together to build a sustainable future (UNESCO, 2003).

According to UNESCO (2003, p.5):

> "This vision of education emphasizes a holistic, interdisciplinary approach to developing the knowledge and skills needed for a sustainable future as well as changes in values, behaviour, and lifestyles."

Recent research conducted by Paas (2004) finds that many changes called for in ESD could be supported through greater integration of ICTs in the learning environment. The next section briefly traces the history of technological advances and technology policy as drivers for using ICTs in education, and describes the limitations the traditional education system may have in terms of supporting ESD.

2. Brief history of ICTs in Education

2.1 Technological development and technology policy as drivers

The history of the use of ICTs in education is relatively short. Before 1979, computers existed primarily in tertiary level educational institutions. Then, in the eighties, microcomputers began to be distributed to schools, and teachers began to grapple with the question of how to use computing *for* education rather than simply educating *about* computing.

Starting from the mid-nineties, the use of ICTs in schools rapidly expanded in developed nations through curriculum support, networking, the professional development of teachers and software improvements (Aston, 2002). A growing number of researchers and educators began to develop applications that used hypertext, multimedia and networking to build cognitivist and constructivist learning environments aimed at improving learning (e.g., Scardemelia & Bereiter, 1991; Harasim *et al.,* 1995; Resnick, 1996; Schank, 1999). However, these applications were initially found to be ineffective in attaining better results as compared to learning outcomes achieved through traditional pedagogies and assessed against traditional metrics. This finding may be largely influenced by teachers' and learners' lack of familiarity with ICTs (White, 2005; Ungerleider & Burns, 2003), as well as the inappropriateness of the traditional metrics in and of themselves (Siemens, 2005).

In recent years, bandwidth has greatly increased and user familiarity with the Web and ICTs in general has evolved, contributing to an evolution of the Web. Some are referring to this evolution as numbered "versions" or "generations" (Web 1.0, 2.0 and 3.0). Web 1.0 refers to the first implementation of the Web which mainly allowed users to search for information and read it. The main goal of organizations creating such Web sites was to establish an online presence and make information available to anyone at any time. The Web as a whole hasn't moved beyond this stage yet. Web 2.0[1] refers to the trend in social networking, user-generated content and software as a service rather than a product. Many of the social networking tools have been around for a number of years (forums, chats, etc.) but there are new trends in communication and collaboration tools which are emerging (e.g., folksonomies, wikis, blogs, tools like Facebook, etc.). Appendix 1 includes a glossary of the most widely-used social networking tools and sites.

Web 3.0, an emerging concept, is used to refer to the artificial intelligence applications that will increasingly become integrated into the Web, as well as to the increasing interoperability that users will have between the diverse information databases and information sources on the Web. It is also called the "semantic Web," defined as "an extension of the World Wide Web in which Web content can be expressed in a format that can be read and used by software agents, thus permitting it to be

[1] Note that the different generations of the Web refer to applications and usability rather than a strictly technical advance (e.g., increasing bandwidth with fibre optics).Web 2.0 is not to be confused with "Internet2,", which is a not-for-profit advanced networking consortium comprising more than 200 U.S. universities in cooperation with 70 leading corporations, 45 government agencies, laboratories and other institutions of higher learning, as well as over 50 international partner organizations (http://www.internet2.edu/about/). Internet2's main aim is to leverage its high-performance network infrastructure and extensive worldwide partnerships to support and enhance their educational and research missions. However, with an estimated 10 million Internet2-connected users, it could become one of the major drivers for implementing and testing new high-speed Internet applications.

found, shared and integrated more easily."[2] Information and applications on Web 3.0 are expected to adopt a "microformat" as the use of personal devices such as mp3 players, cellular phones, TVs, gaming devices, etc. to access and publish content on the Web becomes more commonplace.

White (2005) summarizes the history of ICTs in education by explaining that the period from circa 1981 to the present has seen the educational use of computers evolve from standalone data processors in computer labs, through to accessing the Web and building a Web presence, to nowadays being able to provide integrated Web services for teaching and learning activities, resource collections, student records, administration, professional development and community relations.

Policy based on the prevailing ideas about ICTs has also been a major driver shaping the adoption of ICTs in education. For example, the late 1980s and early 1990s were dominated by rhetoric surrounding the idea of the transition from the Industrial Society to the Information Society, where managing, generating and sharing information would be key to national economies maintaining the cutting edge in an increasingly globalized market (Strong, 1995). This idea promoted the concept that the education system would need to create a "learning culture," which would prepare citizens for lifelong learning in an information society.

More recently, the focus has shifted from the information society to the knowledge society and policies promoting "connectedness": "the ability to take advantage of information resources" (Ungerleider & Burns, 2003). For the Government of Canada:

> "Connectedness is at the foundation of the knowledge economy and society. The speed and efficiency with which Canadians gain access to, and take advantage of, the Information Highway is of the utmost importance if we are to continue to foster a competitive Canadian presence in the global economy. Making sure that Canadians can access opportunities offered by the knowledge economy is also an essential factor in sustaining productivity growth and quality of life for all Canadians" (Industry Canada, in Ungerleider & Burns, 2003, p.2).

Consistent with this concept of "connectedness," the policy focus for supporting ICTs in education rests primarily on the individual learner and his or her ability to access information. It has not yet shifted to encourage a different modality of learning that emphasizes and shapes peer interactions and social outcomes that are already occurring as a result of building a "connected" society.

2.2 ICTs and ESD

ICTs play an important role in advancing ESD in two ways:

1. by increasing access to educational materials about sustainability (e.g., via distance learning, educational networks and databases); and

2. by helping to promote new ways of interacting in order to facilitate the learning called for in ESD, that emphasizes not just knowledge, but choices, values and actions.

[2] http://en.wikipedia.org/wiki/Semantic_web

At their most basic level, ICTs enable the presentation of course content using multimedia (images, text and sound) and facilitate archiving of that content. But they also provide new means of interactivity and simulation, thereby offering opportunities to improve learning and making new ways of understanding possible. The use of new technologies, thus, can offer exciting new possibilities to promote the changes in education methodologies called for in ESD.

However, simply applying ICTs to the traditional practices in the formal educational system will not work to achieve sustainability. The traditional formal education system was principally based upon an objectivist approach—seeing knowledge as something that should be instructed, existing in a world independent from the experience of the learner. This approach is argued to contribute to the creation and continuation of the unsustainable problems in the world, since it doesn't enable people to connect their actions with the impact they have on the planet (Hein, 2002; Huckle & Sterling, 1996). Whereas, any learning situation which intends to give people the ability to deal effectively with the reality of the world should be problem-based and task-oriented, and should provide opportunities for interaction, collaboration and connectivity (Visser 1997; 1999).

Besides this, presenting content that is unrelated to the daily reality and experience of the learners doesn't give them an understanding of how to effectuate change. As Brazilian educator Paulo Freire explains: "A man cannot participate actively in history, society, in the transformation of his reality, if he is not helped to become aware of reality **and his own capacity to transform it**" (emphasis added) (Freire, 1977, in Otterloo, 2003).

In recent years, the traditional formal education system has increasingly moved from an objectivist approach based on behaviourist learning theories, to include more cognitivism and constructivism. However, George Siemens of the University of Manitoba argues that these learning theories were all originally designed for an education system that predated the availability of ICTs. "These theories do not address learning that occurs outside of people (i.e., learning that is stored and manipulated by technology). They also fail to describe how learning happens within organizations". …, "These theories are learner-centred, while today's society needs a collective-centred learning theory." Siemens (2005) presents a "learning theory for the digital age" called "connectivism," which incorporates the ideas of chaos and the unpredictability that govern today's society; of the learning that occurs outside the formal education system (e.g., communities of practice, personal networks); of the need for lifelong learning; of how technology use makes us change the way we think; and of the link between individual and organizational learning. Importantly, Siemens highlights that:

- Many of the processes previously handled by learning theories (especially in cognitive information processing) can now be off-loaded to, or supported by, technology.
- Know-how and know-what are being supplemented with know-where (the understanding of where to find knowledge needed).

The following section explores current uses and trends in ICTs that will support the type of learning which embodies the ideas of Connectivism, as well as the more established pedagogical practices currently available for ESD.

3. Current Uses

Current uses of ICTs in ESD fall into three broad categories:

1. Information resources, tools and portals for educators;
2. Supplements to classroom-based activities; and
3. Tools for distance/online learning.

3.1 Information resources, tools and portals for educators

It almost goes without saying that the Web provides extensive links to information on ICTs in education; platforms for educators to exchange knowledge, read and publish articles and lesson plans; and connections to support materials for ESD. Appendix 2 contains a sampling of links to Canadian and Manitoba-based teaching support activities related to sustainable development.

However, when looking specifically for research on the use of ICTs for Education for Sustainable Development, including educational policies, pedagogical approaches and classroom uses of ICTs for ESD, there is not much available to date. This may be because ESD has grown from the tradition of environmental/outdoor education, which aimed at getting learners outside to experience and learn about the natural world. Early proponents of the use of ICTs in education were from the civics fields—promoting media awareness activities (researching TV shows, Internet resources, etc.) and cultural understanding activities that use collaborative Internet technologies. However as educators from diverse disciplines are increasingly embracing ESD, more examples of ICT use for ESD are emerging.

The field of geography is one of the first where experts are increasingly using ICT tools as central to the curriculum, including Mapping and Graphics software, Geographic Information Systems (GIS) and Global Positioning Systems (GPS). David Mitchell (Institute of Education, University of London, U.K.) promotes the development of an "e-confident" Geography Department for the secondary school level.[3] He covers the use of a range of tools such as electronic weather stations, data projections, interactive whiteboards, digital cameras, mobile phones, spreadsheet/graphing software, and video and photo editing software. Mitchell notes that "GIS are rarely used in a practical way (as opposed to theoretical) in school geography, but they are widespread in industry and form a key part of geographical analysis. Efforts are being made in the geography education community to develop GIS in the geography curriculum." Although Mitchell also explores how the teaching of geography is an essential part of ESD, he falls short of making direct connections between ESD and ICT use.

Notable examples that make the direct connection between ICTs and ESD are the World Summit on the Information Society's ICT for Development (ICT4D)[4] platform, where practitioners came together to discuss theme of "Enhancing Human Capacity," including capacity building (formal and

[3] http://www.geography.org.uk/projects/gtip/thinkpieces/ictinsecondarygeography/

[4] http://www.ict-4d.org/

non-formal educational skills) and developing e-learning, *inter alia*. Another example is UNESCO's Portal on Communication and Information Resources.[5] The portal contains many articles and cases of how ICTs are currently being used to promote SD throughout the world, including educational examples. Tangentially, the portal itself shows signs of moving beyond a Web 1.0 information repository format, by facilitating the sharing of its information with Web 2.0 information sharing tools.

Figure 1. UNESCO's "Share this story" toolbar

The figure at left shows the footer portion the portal, which provides 10 linked icons to services for tagging,[6] social news sharing and bookmarking.[7]

One innovative application which loosely links ICTs to ESD is Appropedia (http://www.appropedia.org), "a site for collaborative solutions in sustainability, poverty reduction and international development". Appropedia uses a Web 2.0 application (a wiki) to build a shared understanding of SD. Although still somewhat embryonic, users of its education category have included information and resources on the use of ICTs for ESD.

George Siemens has also put together a site using Web 2.0 tools (blog, wiki, forums) to discuss his proposal for "connectivisim" as a new pedagogy for the digital age. However there is no link here made specifically to ESD.

3.2 ICTs as a supplement to classroom-based activities

ICTs applications are being designed to promote collaboration, connectivity, "real-world," experience-based learning, and systems thinking, which are emerging as key pedagogical methods conducive to educating for sustainability. Examples provided are from K–12 as well as in universities.

Collaboration and connectivity

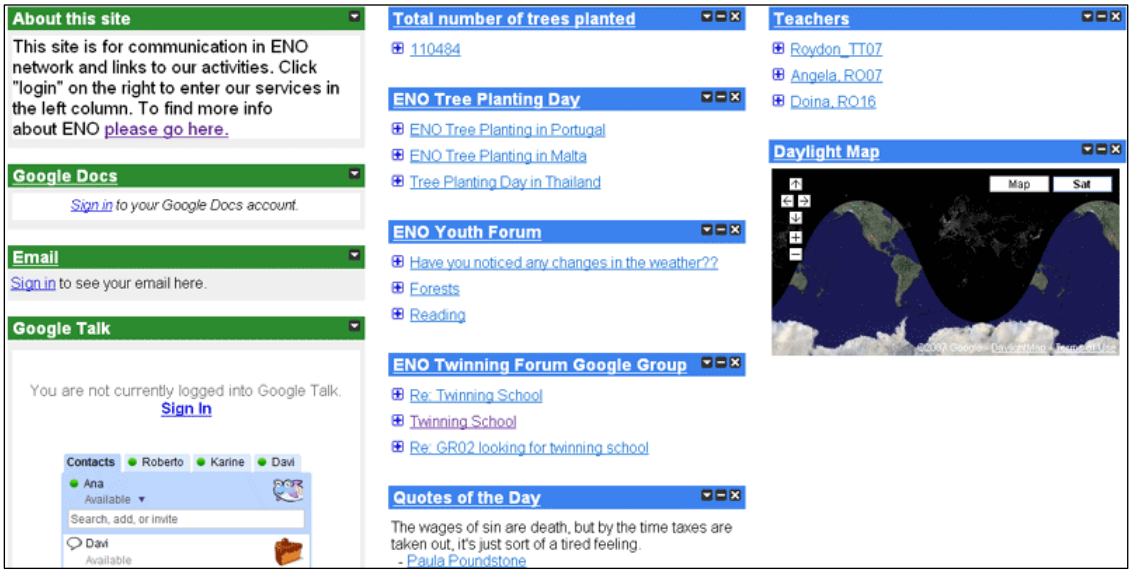
There are many collaborative learning projects on the Internet. ePals is the self-proclaimed world's largest K–12 online community, with more than 325,000 educators and 126,000 classrooms in over 200 countries and territories which "safely connect, exchange ideas, and learn together."[8] ePals provides blogging software and an e-mail program, live classroom collaborations and discussions, best-practice examples of classroom use, and tools for searching projects and connecting with classrooms and finding communities. It is being widely being used as a language and cultural learning tool. A similar set of tools, with the specific mission of "improving life on the planet" is iEARN (the International Education and Resource Network),[9]

[5] http://portal.unesco.org/ci/en/ev.php-URL_ID=20135&URL_DO=DO_TOPIC&URL_SECTION=201.html
[6] Tagging refers to associating a keyword or term to a piece of information Tagging (see http://en.wikipedia.org/wiki/Tag_%28metadata%29)
[7] In order: co.mments; del.icio.us; digg.com; www.furl.net; ma.gnolia.com; www.newsvine.com; reddit.com; www.shadows.com; www.simply.com; myweb2.search.yahoo.com. (See Appendix 1 for descriptions of these tools).
[8] http://www.epalscorp.com/
[9] http://www.iearn.org/

a non-profit organization made up of over 20,000 schools and youth organizations in more than 115 countries. iEARN empowers teachers and young people to work together online using the Internet and other new communications technologies. Over 1,000,000 students each day are engaged in collaborative project work worldwide.

In the area sustainable development and environmental awareness, there is ENO-Environment Online, a global virtual school and network based in Finland, which has approximately 400 participating schools from 104 countries. Four environmental themes are studied within a school year on a weekly basis. Interestingly, its communications platform is based on Google's free suite of communication tools, including Google's groups, maps, docs, e-mail and its "Talk" chat application. ENO's learning activities include a youth forum for discussing SD issues; it uses a global tree planting campaign among schools as a unifying motivator; and applies a school " twinning" model where schools from different countries partner up to learn about specific themes or work on projects together.

Figure 2. ENO-Environment Online communications platform



Real-time, real-world learning

An innovative application involving ICTs can be seen in the emerging tendency of technology-mediated adventure education. Without ever leaving the classroom, millions of students accompany the real-world scientific discoveries of a researcher conducting experiments in the field (http://www.jason.org); follow along in the exploration of the jungles of the Congo (http://www.nationalgeographic.com/congotrek); and feel the excitement of crossing the Arctic with toboggans and huskies in search of environmental data and interaction with Inuit communities (http://www.polarhusky.com). Unforeseen discoveries occur while such expeditions take place, giving students the sensation of following real-time research, often in dangerous and exciting situations or in endeavours that would be inaccessible to the average student. To facilitate teachers' work, these programs provide curriculum-integrated learning activities related to these adventures (Paas, 2004).

Another example of real-time, real-world learning is Space for Species,[10] an educational Web resource by Environment Canada, the Canadian Space Agency and Natural Resources Canada, which aims to promote learning and exploration of the role of satellite telemetry, remote sensing, astronaut observations and weather satellites in wildlife conservation by having kids track migratory animals in real-time via the Internet. Students create migration maps, record climatological and habitat data, and keep field notes as part of a tracking journal. Some work created by classrooms is made available online in a "scrapbook."

Seely Brown and Adler (2008) cite three other relevant examples: the Faulkes Telescope Project, where students in the U.K. have been given free access to two high-powered robotic telescopes (one in Hawaii and the other in Australia) that are used remotely to carry out their own scientific investigations (http://faulkes-telescope.com/); Hands-On Universe (HOU) (http://www.handsonuniverse.org) where students are provided with image-processing software to visualize and analyze data obtained through requests from professional astronomy observatories; and, the Bugscope project, which gives K–12 students access to a scanning electron microscope located at the University of Illinois. Students can send to Illinois any insects they have captured, then log on with their computers to control the microscope in real time and view their specimens (http://bugscope.beckman.uiuc.edu/).

The collective research produced by students engaged in real-world, experience-based learning activities can be very useful. An example of this is the U.S. Government's international Globe Program,[11] which has classrooms around the world collecting diverse local meteorological data and publishing it into an online, distributed database. The collection of information over time and the aggregate data produced worldwide show local and global trends, resulting in the production of real, usable knowledge that can help researchers track changes in pollution levels and climate.

The idea of engaging students in "useful" work while they learn is a trend which has been spreading rapidly through out all levels of education and training in recent years, called "community service learning" (CSL). CSL is defined as "an educational approach that integrates service in the community with intentional learning activities. Within effective CSL efforts, members of educational institutions and community organizations work together toward outcomes that are mutually beneficial.[12] An example of service learning that uses ICTs and is related to SD can be found the Galapagos Islands, where 23 students are currently providing 20 hours each of community service to analyze the electric grid to determine the potential to reduce electricity demand through energy efficiency (SolarQuest®, 2004).

Systems thinking

Interactive multimedia can be used to promote systems thinking through modelling, simulations and games.

STELLA software,[13] considered to be one of the top modelling software programs, has been designed to develop systems thinking in students. Its particular strength lies in helping students to create models of local or global situations, think about variables and communicate to others how a

[10] Space for Species – http://www.spaceforspecies.ca/
[11] Globe – http://www.globe.gov
[12] Canadian Alliance for CSL – http://www.communityservicelearning.ca/en/welcome_definitions.cfm
[13] http://www.iseesystems.com/

particular system works—what goes into the system, how the system might be impacted, what the different outcomes might be. STELLA's developers suggest that it can be used to:

- simulate a system over time—students explore by asking "what if," and watching what happens;
- jump the gap between theory and the real world;
- enable students to creatively change systems;
- teach students to look for relationships—see the "Big Picture"; and
- clearly communicate system inputs and outputs and demonstrate outcomes.

This type of computer-software-assisted learning moves students beyond the traditional knowledge acquisition process into the processes for thinking and communicating, both through their individual use of the software and through group interaction on the models and their implications.

A popular version of simulation software is SimCity which promotes analytic and systemic thinking skills and an understanding of what is involved in building and managing a complex enterprise. Intended for an age range of 10–12 years and up, this software places the user as chief architect and mayor of a city which must be built and managed. The city attracts SIMs (simulated citizens) who have a life of their own and whose activities (building houses, stores, factories) generate a tax base which in turn allows the user to further develop the city. After the city is built, the user "runs" the simulation, and sees which growth-related issues emerge (such as water shortage, inadequate number of hospital beds, rising crime rates, etc.). The most recent version of SimCity incorporates more real-world complexity by including variables such as pollution and natural disasters and allows users to share their creations online with other users.[14]

Multi-player simulations offer an opportunity for students to understand how the actions of others impact outcomes on a larger scale. An example of this is "Rich Man Game,"[15] a free massively played multi-player online educational game used for learning simulating business strategy which has players compete against each other on a weekly basis to make business deals and build up their net worth.

Figure 3. "My Adobe" interface

Simulations are also being used to show how our actions impact the planet. "My Adobe"[16] is an exemplary application in this sense. It is an interactive tool that lets users shape a house that suits them (appliances, furniture, size of house, etc.) and see how their choices affect the climate (e.g., water/energy used, waste created). Users can also join an Adobo neighbourhood, share their Adobos with other people, and see the Adobos of other users.

[14] http://www.learningvillage.com/html/rSimCity4.html (official site:http://simcitysocieties.ea.com/)
[15] Rich Man Game – http://www.richmangame.com
[16] My Adobo – http://myabodo.com/

Scenarios are another learning strategy used to promote systems thinking. Scenarios are used by business, government and NGOs to understand the context for strategy-making. Through imagining alternative situations for the future, scenarios can help learners to appreciate the challenges of sustainable development. The Global Scenario Challenge[17] is a mini-online course designed for adults that introduces learners to the building of scenarios and provides a specific application of scenarios to aid their understanding of "sustainability."

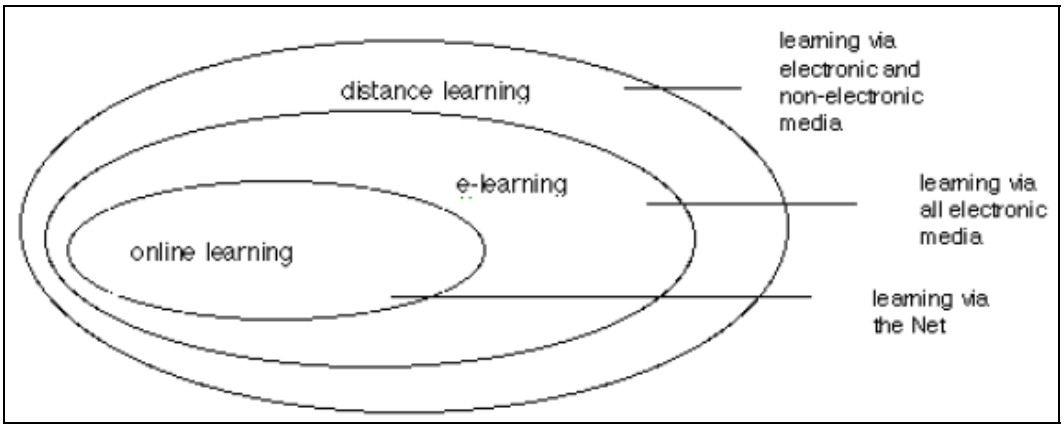
3.3 Distance/open learning, e-learning and online learning

Perhaps the area of education where ICTs are currently most applied is "distance learning" (DL). From its origins of being delivered principally via print, to gradually including telephone/fax support, audio/video broadcasting, audio/video teleconferencing, and computer-aided instruction (via CD-ROMs & Software), DL finds itself in the current generation of being delivered in online learning environments (Moore & Kearsey, 1997).

Currently, terms such as distributed learning, virtual learning, online learning, e-learning, open learning and distance education are all being used interchangeably, although these terms represent applications that can differ widely in target audience, pedagogical/administrative structure and combinations of learning tools provided. CIPD (2007) and Wikipedia's page on electronic learning[18] provide excellent overviews of the types and groups of tools used and differences in online learning terminology.

Anderson (2005) depicts the differences in DL terms according to media uses. Figure 3 below shows that online learning refers to learning that occurs purely via the Internet. E-learning is broader than online learning, since it includes off-line electronic media (such as CD-ROMs). Distance learning is broader than both online and e-learning, because also uses non-electronic media (e.g., printed material).

Figure 4. The relationship between online learning, e-learning and distance learning (From Anderson, 2005, p. 5).



[17] http://wbcsd.org/templates/TemplateWBCSD1/layout.asp?type=p&MenuId=Mjcy&doOpen=1&ClickMenu=LeftMenu#
[18] http://en.wikipedia.org/wiki/Online_learning

This figure illustrates how DL serves as the umbrella concept, encompassing all other approaches. In the following discussion, DL is referred to in this sense. UNESCO (2002, p.11) describes DL as "any educational approach which aims to reach learners in the place where they are: providing learning resources, or permitting them to become qualified without the need for physical presence in the classroom." Educational institutions offer DL in order to reduce scheduling conflicts; to provide access to people who live in remote places or have other difficulties in attending classroom-based courses; or to fill holes in curriculum gaps. Companies and training institutes find DL beneficial in order to minimize travel costs and time spent away from the office while updating employees' skills and knowledge. Most organizations today use a combination of online learning and face-to-face learning activities, called *blended learning* (White, 2005).

Although exact numbers are difficult to track, recent statistics hold that in the U.S., over 90 per cent of public colleges and universities offer online courses (Tucker, 2007). A global estimate in 2005 put the number of online learners at over 130 million.[19] Although DL has been principally applied to adult learning situations, there is increasing up-take in the K–12 sector. According to Tucker (2007) virtual schools in the U.S. served 700,000 students in the 2005–06 school year, a number that tripled since the 2003–04 school year. So far, the majority of K–12 students learning online participate in "supplemental" DL programs, with only a small portion participating in fully online programs.

DL is also widely employed in professional training programs. A recent business survey in the U.K. showed that over 50 per cent of businesses surveyed report using some form of online training (CIPD, 2007). Many professional online learning platforms offer highly sophisticated communication tools designed to reproduce face-to-face training sessions, thereby avoiding learning curves (and travel costs) for participants.

Figure 5. Adobe Connect interface

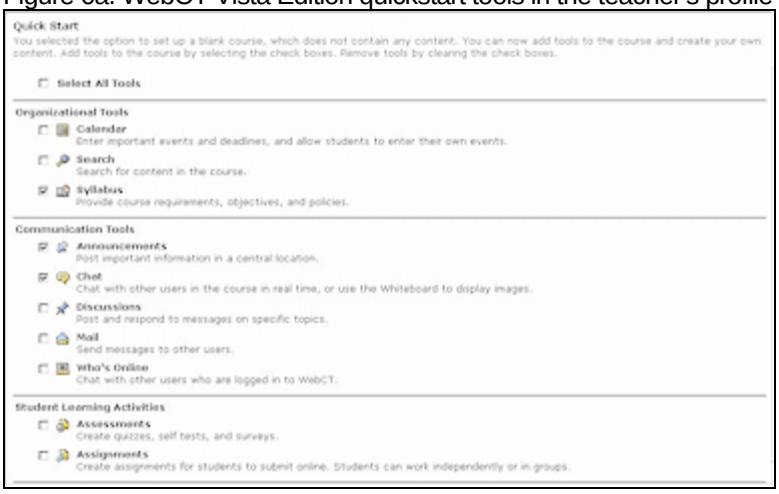
Adobe Connect[20] (previously Macromedia Breeze) is one such example. Instructors can interact with students and invited experts via video-conference and chat, show PowerPoint presentations, instantly apply polls and make documents available. Students can show if they agree or disagree instantly with an idea by showing a thumbs up or thumbs down symbol on their user names.

Because of the high cost of professional platforms, many schools and universities have opted to implement lower-cost platforms such as the University of British Columbia's WebCT (now owned by Blackboard), a classic example of e-learning platforms used in universities and schools.[21] Typically, these types of e-

[19] http://www.ameinfo.com/57210.html
[20] http://www.adobe.com/products/acrobatconnectpro
[21] For a list of similar e-learning platforms to WebCT, see http://en.wikipedia.org/wiki/WebCT

learning platforms are comprised of three different user profiles: students, teachers and administrators, each with specific permissions.

Figure 6a. WebCT Vista Edition quickstart tools in the teacher's profile[22]



The screenshot at the left (Figure 6a)shows the types of controls teachers have in WebCT's Vista Edition, on its Quick Start page. This is essentially a set of links to templates for teachers to include their choice of organization and communication tools (e.g., calendar, chat, search tool, announcements) and student learning activities. The next screenshot (Figure 6b) shows the student's view of the Vista Edition. Course materials can include text, photos, audio/video files, and animations.

Figure 6b. WebCT Vista Edition student view

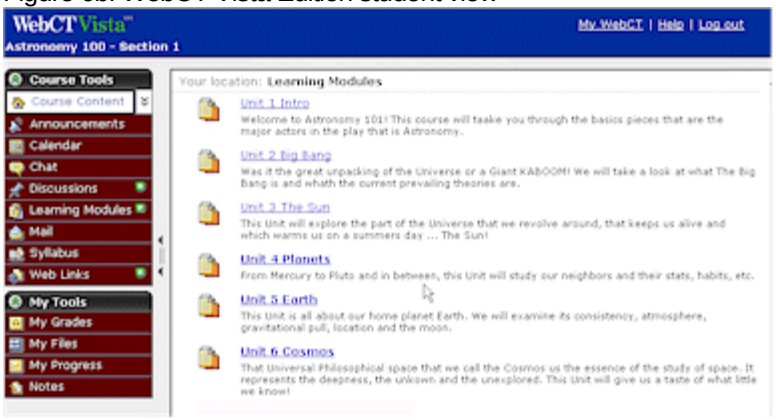


Figure 6b also shows a typical suite of student e-learning tools such as access to grades, personal files, notes and progress reports, communications tools, etc. More recent tools included in e-learning platforms are wikis, surveys and peer assessment tools.

Despite DL's growth and widespread acceptance, it has often been criticized for sacrificing educational quality in the name of prioritizing access and reach, or lowering delivery costs. However, studies increasingly show that with attention to instructional design elements such as interactivity and feedback, and appropriate pedagogy, DL can have superior results in comparison to conventional learning (UNESCO 2002; Werthein & Da Cunha, 2000; Tucker, 2007).

The quality and improvement of DL is being accelerated by hundreds of organizations promoting quality standards, such as the U.K.'s ODLQC,[23] as well as by the accreditation of DL providers, such

[22] http://www.slcc.edu/distance/vista/features.asp
[23] http://www.odlqc.org.uk/

as the U.S.-based Council for Distance Education Accreditation[24] and "Distance Learning Accreditation Europe" (DLAE).[25] Additionally, there are international organizations such as the IMS,[26] which promote collaborative research among institutions to improve DL by developing appropriate pedagogical approaches, promoting interoperability between systems and codifying best practices (IMS 2003).

The creation of arduous DL technical standards and specifications such as SCORM[27] have the objective of facilitating the re-use and sharing of learning activities (called "learning objects") across systems. However, these efforts have generally failed, as they rely on "educators to take on complex and ill-defined tasks in an exchange for an uncertain payoff" (Lamb, 2007). Meanwhile, Web 2.0 tools that rely on users' enthusiasm, such as social data sharing, bookmarking and "remixing" are resulting in much more cross-referencing and re-usability of learning materials than any centralized standards and specifications have done.

DL is seen as very important for achieving Education for Sustainable Development because it can help to facilitate the access to and the reach of ESD programs and content (Visser, 1997; Werthein & Da Cunha, 2000; UBUNTU, 2002.). There are already several universities and organizations delivering educational content related to sustainability via DL. For example, the United Nations Global Virtual University (GVU),[28] through its network of universities and institutions, offers a fully online Master's degree in Global Environment and Development Studies, designed to provide students with the knowledge to address the complexity and interdependence of environment, development activities and decision-making processes.

Access and reach can be further facilitated by open admission policies. For example, The U.K.'s Open University[29] and Canada's Athabasca University[30] provide several undergraduate-level courses related to sustainability, open to anyone who has completed high school. Appendix 3 lists several other online course offerings related to SD. In the area of non-credited training, UNESCO's Open Training Platform (OTP)[31] offerings free non-certifying courses and training resources from over 600 different development institutions worldwide in 21 key domains for local capacity sustainable development.

Technological developments of DL platforms play an important role in facilitating access and reach. This includes everything from designing platforms that accommodate accessing learning materials via hand-held devices, to developing open-source DL content management systems and applications (free software packages which are configurable to create online learning communities).

[24] http://aiea-edu.org/accreditation.php
[25] http://dlae.enpc.fr/
[26] http://www.imsglobal.org
[27] http://en.wikipedia.org/wiki/SCORM
[28] http://www.gvu.unu.edu/prog.cfm
[29] http://css2.open.ac.uk/search/search.aspx
[30] http://www.athabascau.ca/course/ug_subject/list_ef.php#envs
[31] http://www.opentrainingplatform.org

Figure 7. Moodle's interface

There are several open-source course management systems available, of which "Moodle" is currently one of the most widely-used around the—offered in 75 languages. Recent surveys suggest that Moodle is now the number one platform in secondary schools and number three in primaries (Guardian, 2008). According to Moodle's statistics,[32] it has: 37,618 registered sites; 1,666,111 courses; 1,815,543 teachers; and 18,998,599 enrolments.

There are 84 educational sites using Moodle that have more than 20,000 users. Moodle provides similar tools to most other e-learning platforms,[33] and includes resources on constructivist and collaborative pedagogical teaching strategies, as well as developer and teacher forums.

4. Trends and Challenges

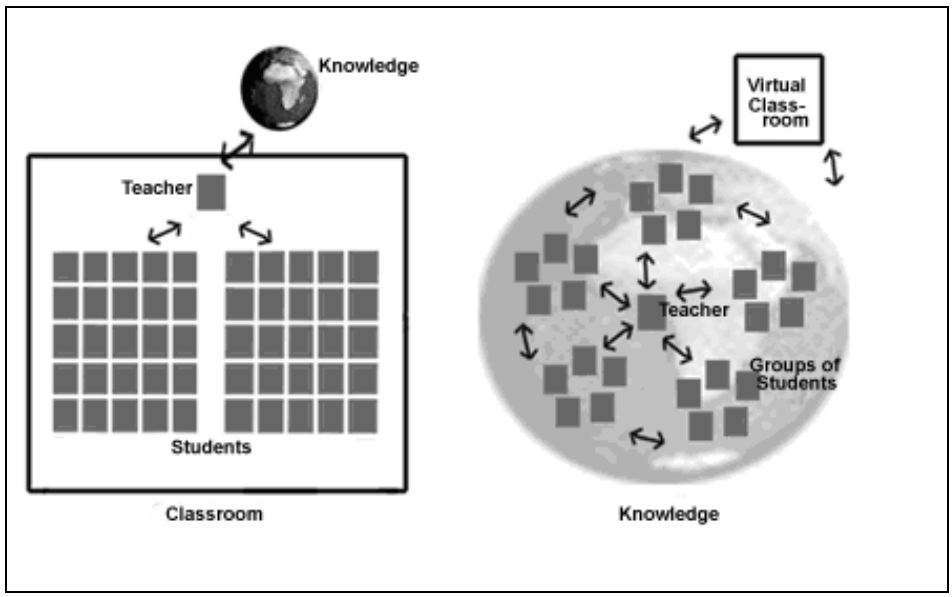
4.1 More online learning environments and more adequate pedagogy

The emerging online learning environments described in Section 3 represent a significant shift in the traditional (objectivist) teaching and learning paradigm. This shift represents a trend that will become consolidated in the coming years.

The illustration below depicts the difference between the traditional classroom model (shown on the left) and the emerging model (shown on the right), with arrows depicting the flow of information that can foster knowledge sharing and creation.

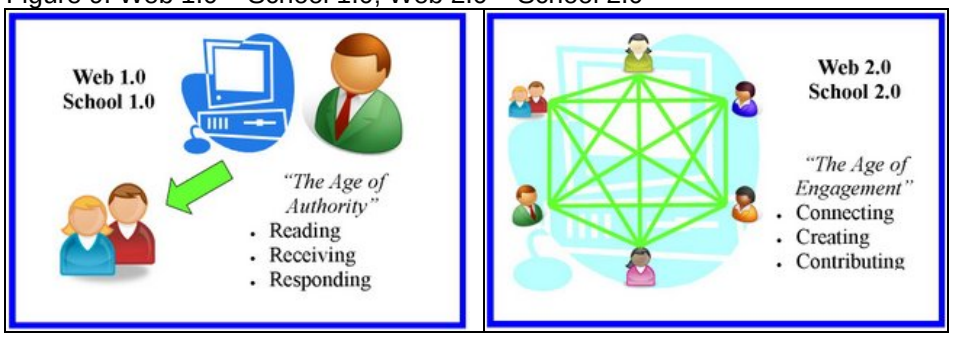
[32] http://moodle.org/stats/ accessed Jan 26, 2008
[33] For a comprehensive overview of Moodle's history and tools, see http://en.wikipedia.org/wiki/Moodle

Figure 8. Traditional model of formal education verses the emerging model education (adapted from Paas, 1999)



In the traditional formal education system, learning is planned to occur in a physical classroom environment which shelters students from outside distractions. The teacher has the role of being the chief transmitter of knowledge to the students, who are seen as receivers. Thus, knowledge is "remote" and brought into the classroom. In the emerging model of education, the teacher has the role as facilitator. The students both actively share their knowledge with each other, which has been constructed based on each individual's unique, real-world experience, and build new understanding, based on shared exploration of facts and the development of process skills (such as math and languages). Thus, in the emerging model, it is the classroom that is *remote*, not knowledge (Paas, 1999). The remote classroom can be understood as the types of emerging online learning environments discussed in Section 3. In these environments, students' individual and group work can be stored and connected to databases that contain entire learning platforms. Steve Hargadon, founder of the Classroom 2.0 social network, depicts this trend with the images below:

Figure 9. Web 1.0 – School 1.0; Web 2.0 – School 2.0



An example of this trend can be seen in Second Life (SL), an Internet-based 3D virtual world where users can socialize, connect and create using voice and text chat. Launched in 2003, this

environment has users called "Residents," who interact with each other through motional avatars. Residents can explore, meet other Residents, socialize, participate in individual and group activities, create and trade items (virtual property) and services from one another.[34]

Universities, colleges, schools and other educational institutions are now starting to use SL. For example, the U.K.'s Open University's "Schome" project (slogan: "not school not home – schome")[35] has built both an adult and a teen SL as a learning space. English schools are also taking advantage of this virtual reality social networking space. As one school states: "Let your Avatar take you to new worlds and advance your English. Learn English speaking with real teachers in a virtual school."[36] There are now even service providers that aim to help educational organizations build learning environments in SL and "purchase lots."[37]

Figure 10. Terra Incognita learning environment in SL

Seely Brown & Adler (2008) also cite the Terra Incognita SL project of the University of Southern Queensland (Australia). This project supports lecture-style teaching but also allows small groups of students who want to work together to "break off" from the central classroom before rejoining the entire class. Instructors can "visit" or send messages to any of the breakout groups and can summon them to rejoin the larger group.

This model for school 2.0 is not just occurring in virtual reality. Launched in 2004, U.K. Building Schools for the Future (BSF)[38] of the U.K. Department of Children, Schools and Families aims to rebuild every school in the U.K. within the next 10–15 years, with a vision for the needs of future learners. This includes providing collaborative spaces that can be accessed on workstations that require no desktop administration. Students simply insert their smart cards into any device and instantaneously gain access to their work. The BSF vision is to stimulate innovation in the ways schools function and to explore new ways in which they can involve the local community, adults, families and local business partners.

In terms of using new social networking tools and environments as a supplement to current classroom teaching, one of the initial challenges will be to develop learning activities that use these tools to leverage student motivation and learning. This is made more challenging as children of the "digital age" have different needs than previous learners (Seely Brown, 2002; Schrum & Solomon, 2007; Green & Hannon, 2007).

[34] http://en.wikipedia.org/wiki/Second_Life
[35] http://schome.open.ac.uk/wikiworks/index.php/Second_Life
[36] http://english.avatarlanguages.com/home.php
[37] http://firesabre.com/
[38] http://www.bsf.gov.uk

Schrum & Solomon (2007) describe ways in which blogs, podcasts, wikis and photo-sharing can be used in K–12 classrooms, with the objective of providing difficult and challenging activities to entice and engage students. Bull *et al.* (2003) describe the innovative use of blogs for student journals, which can be shared with and commented on by other students, linked to outside sites and include photos and texts which can deepen or illustrate the ideas presented. This is "revolutionary" because:

> "Classroom journals rarely function as compelling, inviting writing spaces where students can meaningfully engage with text. Instead, writing and thinking in this space becomes forced, unwelcoming, and inconsequential. Blogs provide a different tool and the potential to reinvent how we work with journals in classrooms, challenging teachers and students to think about writing in authentic ways. Blogs demand multimedia postings, precise economical writing, regular and timely responses, and a new and exciting kind of student involvement" (Bull et. al., 2003, p. 35).

Pedagogical methods may need to be adjusted in order to allow for students to increasingly learn from each other. Green & Hannon (2007, pg. 26) indicate, "with the advent of blogging and tools such as Wikipedia, young people are just as likely to seek feedback from their peers and strangers as they are from teachers and parents. This has led to the blurring of the boundaries between expert and amateur, friend and mentor."

4.2 Increased online users and increased access

Current trends indicate that, in the future, the number of online users will increase, as will the access to ICTs in education. Programs with a mission to "bridge the digital divide" will quickly increase the number of teachers and learners online from developing countries. For example, one laptop per child (OLPC) provides laptops with wireless modems for $100 to children in developing countries. Peru has ordered 272,000 machines for its primary education system and Uruguay has signed a contract for 100,000, and an estimated 150,000 more laptops will be shipped to countries including Rwanda, Mongolia, Haiti and Afghanistan in early 2008 (Bajak, 2007).

With a flood of new users from developing world, we will soon see an increase in the demand for and creation of online activities such as collaboration and cultural/information exchanges among schools. According to the OLPC Web site, the laptop provides tools for writing, composing, simulating, expressing, constructing, designing, modeling, imagining, creating, critiquing, debugging and collaborating. Suggested learning activities enable children to become positive, contributing members of their communities by actively engaging them in a process of learning through doing. Children also learn by teaching, actively assisting other learners. Teachers will also be able to share best practices, as each school represents a learning hub; "a node in a globally shared resource for learning."[39]

Researchers predict that over the next few years, personal, portable, wirelessly-networked technologies (including personal digital assistants such as palmtops, Smart Phones mp3 players) will become ubiquitous and pervasive in the lives of learners, both in and out of school. Children will carry their information with them and will be able to access school resources remotely. This increased use of such devices outside of the school will create a new pressure for schools to adopt

[39] http://www.laptop.org/en/children/

these kinds of ICTs as learning devices (Roschelle *et al.*, 2007; Howe, 2007; Green & Hannon, 2007). "Students can now download French vocabulary onto their iPod – making entertainment and learning devices interchangeable" (Green & Hannon 2007, p. 60).

There are already examples of university services and content delivered to mobile phones, and this trend will increase as students put pressure on campuses to offer meaningful content via mobile devices (The Horizon Report, pg. 5). The iTunes Store has recently created an area devoted entirely to education, where thousands of audio and video files from schools across the country can be searched. Colleges and universities are beginning to build their own iTunes U sites. Apple claims that "more than half of the nation's top 500 schools use it to distribute their digital content to students—or to the world"[40] Some U.S. colleges have been working with the military to distribute entire course content on a PDA to deployed personnel (Reilly, 2005).

4.3 More online content and tools

With more online users in environments that increasingly let everyone contribute and create information, a major challenge will be managing the information students produce. Bull (2006) describes way that RSS feeds can help teachers organize information that comes from student blogs and wikis (RSS feeds notify teachers via the RSS readers that work has been contributed by a student to the course blog or wiki).

More online content and tools will also create a heightened need for people to understand what resources are reliable and authoritative and where to find them. The social bookmarking tools described in section 3.1, and new data mining software agents will increasingly be used to help educators keep abreast of new developments in ESD. Users will deploy these types of tools to find information according to evaluations of its quality and relevance. The practice of tagging[41] in social bookmarking and social news sites is already resulting in the ranking of online information, sites and applications. Meta-knowledge and databases (such as this Web2econsultant[42] page that lists and categorize sites on social bookmarking services), will be easily maintained up-to-date as they move toward user-based Wikipedia-style editing and updating formats.

Shaffer (2008) has composed a research piece on what Computer "literacy" in university education really means, compiling articles and resources from findings of several educators at all levels of education who hold that "literacy/fluency with respect to information and information technology (whatever we call it) belongs in the university curriculum, and should be treated with a depth of concept appropriate for a university education."

Another challenge that is already arising from Web 2.0 technologies in education is the easy re-use of information, or "remix" to create new information, and to what degree this should be considered copying or plagiarism, or if it indeed this constitutes a new form of creativity and social learning. Brian Lamb, Manager of Emerging Technologies and Digital Content for The University of British Columbia's Office of Learning Technology, has written a compelling piece on how educators are embracing Web 2.0 tools that facilitate content "remixing" or "mashups" in their classrooms, with

[40] http://www.apple.com/education/itunesu/
[41] http://en.wikipedia.org/wiki/Tag_%28metadata%29
[42] http://web2.econsultant.com/social-bookmarking-services.html

positive results. However, the success of these efforts requires educational institutions to adopt open and discoverable resources, open and transparent licensing and open and remixable formats. Lamb explains,

> "Educators and higher education decision-makers have an obligation to carefully and critically assess new technologies before making radical changes. Taking a more freewheeling approach to content reuse and making campus technologies more accessible to data mashups require significant changes in existing practices and attitudes" (Lamb, 2007).

However, the greatest challenge will be organizing appropriate content, devising activities and learning environments which promote the kind of thinking and understanding required to live sustainably. This means devising courses that don't just teach about sustainability but teach for sustainability. With the artificial intelligence and data mining applications that will emerge as the Web 3.0 evolves, as well as the increasing interoperability of databases and information sources, the learning captured by collective efforts of students will increasingly become incorporated into and influence human knowledge in general. This is the essence of the connectivism pedagogy envisioned by George Siemens. ESD will require appropriately harnessing collective understandings by devising and applying the appropriate tools to record and share sustainability values and practices.

5. Final observations

An essential step in the journey to sustainable development is educating citizens to recognize the problems facing the world today (natural resource depletion, increasing pollution, poverty and so forth), as well as the opportunities for innovation and progress (such as new energy technologies and full-cost accounting systems) and empowering them to act responsibly towards a sustainable future. ICTs are important tools for reaching greater numbers of learners as well as facilitating new ways of learning and understanding that will be required to implement the complex solutions required for sustainability. The continued expansion of networks technologies, bandwidth, and computer capacity, coupled with increasing user familiarity with the tools, social networking applications, and the acceptance of innovative pedagogical methods in the educational system offer new and exciting new possibilities for ESD.

Based on this review of the history of ICTs in ESD, current uses and trends, the authors suggest that additional work is needed in the following areas:

1. Further exploration of the connection between ICTs and ESD. This paper has found that there is little research available that demonstrates and confirms the synergies between these areas of practice. Although there is a wealth of research on educational technology, a further step needs to be taken to link ICTs for ESD. This line of enquiry may ultimately lead to recommendations for educational policy development that more explicitly encourage the incorporation of ICTs into an ESD oriented curriculum.

2. Exponential increases in the quantity of information and knowledge management and sharing tools will generate two needs:

a. the need to help students (and educators) assess the quality of information and opinions to which they are increasingly exposed, especially taking into account the tendency for a greater emphasis on peer learning, interaction and the tendency for social networking tools to quickly create a "critical mass"; and

b. the need for educators to learn how to use these same tools to track advances and keep up-to-date in their knowledge area.

3. Finally, there is a need to devise new measures for learning outcomes in an ICT-supported and connected learning environment, as well as to determine whether educational pedagogies, tools and learning environments are really helping to educate citizens to live sustainably.

6. References

ANDERSON, J., 2005, "IT, E-learning and teacher development," *International Education Journal*, ERC2004 Special Issue, 2005, Vol. 5(5):1–14.

ASTON, Mike, 2002, "The development and use of indicators to measure the impact of ICT use in education in the United Kingdom and other European countries," *Developing Performance Indicators for ICT in Education*. UNESCO Institute for Information Technology (IITE). Chapter 43, Pp. 62–73.

BAJAK, Frank, 2007, "Laptop project enlivens Peruvian hamlet. The my hero project." *Associated Press*. December 24, 2007. <http://www.myhero.com/hero.asp?hero=Laptop_Peru_AP>

BULL, Glen, 2006, "Collaboration in a WEB 2.0 environment," *Learning & Leading with Technology*. ISTE (International Society for Technology in Education), April 2006.

BULL, Glen; BULL, Gina; KAJDER, Sara, 2003, "Writing with Weblogs: Reinventing student journals," *Learning & Leading with Technology*. ISTE (International Society for Technology in Education) Vol. 31(1).

CIPD, E-learning: progress and prospects. Chartered Institute of Personnel and Development (CIPD), 151 The Broadway, London SW19 1JQ, UK2007. <http://www.cipd.co.uk/subjects/lrnanddev/elearning/elearnprog.htm?IsSrchRes=1>earnprog.htm?IsSrchRes=1>

EDU CAUSE & NEWMEDIA, 2007, The Horizon Report 2007 Edition. The New Media Consortium and the EDU CAUSE Learning Initiative. <http://www.nmc.org/pdf/2007_Horizon_Report.pdf>

GREEN, Hannah; HANNON, Celia, "Their space: Education for a digital generation," *Demos*. Tooley Street London SE1 2TU2007.136. <http://www.demos.co.uk/files/Their%20space%20-%20web.pdf>

GUARDIAN, 2008, "Moodle nudges forward," *The Guardian*. Guardian Unlimited. January 8, 2008. <http://education.guardian.co.uk/link/story/0,,2236721,00.html>

HARASIM, L. HILTZ., SR; TELES, L.; TUROFF, M., 1995, *Learning Networks: A Field Guide to Teaching and Learning Online*. Cambridge, MA:MIT Press.

HOWE, Walt, 2007, A brief history of the Internet. Walt Howe's Internet Learning Center, January 2007. <http://www.walthowe.com/navnet/history.html>

HUCKLE, John, 1997, *From Development Education to Citizenship Education: Starting the definition debate*. Development Education Commission, March, 1997. <http://john.huckle.org.uk/documents/decpaper.doc>

HUCKLE, J.; Sterling. S., 1996, *Education for Sustainability*. London: Earthscan.

IISD, 2004, *Basics & Issues*. International Institute of Sustainable Development. <http://www.iisd.org/sd/>

IMS, 2003, *IMS Learning Design Best Practice and Implementation Guide*. IMS Global Learning Consortium, Inc. January, 2003. <http://www.imsglobal.org/learningdesign/ldv1p0/imsld_bestv1p0.html>

LAMB, Brian., 2007, "Dr. Mashup;" or, "Why educators should learn to stop worrying and love the remix," *EDUCAUSE Review*. Vol. 42(4) (July/August 2007): 12–25. <http://connect.educause.edu/Library/EDUCAUSE+Review/DrMashuporWhyEducatorsSho/44592>

MOORE, M. G.; Kearsley, G., 1996, *Distance Education: A system view*. Wadsworth Publishing Company.

OTTERLOO, A., 2003, *Educação Popular: Um Desafio Permanente. Centro de estudos e práticas de educação popular – CEPEPO*. <http://www.cepepo.org.br/artigos/revista2.htm>

PAAS, L. C., 1999, *A integração da metodologia colaborativa e a tecnologia Internet para a aprendizagem organizacional e individual no PPGEP. Dissertação de Mestrado. Programa de Pós-graduação em Engenharia de Produção. Universidade Federal de Santa Catarina*. Florianópolis, SC.

PAAS, L. C., 2004, *Educação para Desenvolvimento Sustentável por Meio da Aventura. Tese de Doutorado. Programa de Pós-graduação em Engenharia de Produção. Universidade Federal de Santa Catarina*. Florianópolis, SC.

PELGRUM, W. J.; Law, N., 2003, *ICT in Education around the World: Trends, problems and prospects*. UNESCO: International Institute for Educational Planning. Paris.

REILLY, Sue, 2005, Space at a Premium? Courses now offered on PDA. Defense Activity for Non-Traditional Education Support (DANTES), Number 346. September 2005. <http://www.dantes.doded.mil/dantes_web/library/docs/bulletin/sep05.pdf>

RESNICK, Mitchel, 1996, Distributed Constructionism. Proceedings of the International Conference on the Learning Sciences, Association for the Advancement of Computing in Education. Northwestern University, July, 1996. http://llk.media.mit.edu/papers/archive/Distrib-Construc.html>

RESNICK, Mitchel, 2006, "Computer as paint brush: Technology, play, and the creative society," in Singer, D.; Golikoff, R.; Hirsh-Pasek, K. (eds.), *Play = Learning: How play motivates and enhances children's cognitive and social-emotional growth*. Oxford University Press.

RICHARDSON, B., nd, *Systems Thinking and the STELLA Software: Thinking, Communicating, Learning and Acting More Effectively in the New Millennium*. ISEE Systems, Inc. http://www.iseesystems.com/resources/Articles/STELLA%20IST%20-%20Chapter%201.pdf

ROBERTSON, Susan L., 2005, "Re-imagining and rescripting the future of education: Global knowledge economy discourses and the challenge to education systems," *Comparative Education*. Taylor & Francis Group Ltd. Vol. 41(2) (May 2005):151–170.

ROSCHELLE, J.; Patton, C.; Tatar, D., 2007, "Designing networked handheld devices to enhance school learning," in M. Zelkowitz (ed.) *Advances in Computers*. Vol. 70.:1–60.

SCARDAMALIA, M.; BEREITER, C., 1991, "Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media," *Journal of the Learning Sciences*. Vol. 1(1):37-68.

SCHAFFER, Henry E., 2008, What is Information and Computer "Literacy" in University Education? (North Carolina State University – NCSU) ncsu.edu <http://www.ncsu.edu/it/open_source/it-educ-u.html>

SCHANK, R. C.; CLEARY, C., 1995, Engines for Education. Lawrence Erlbaum Associates, Inc. Hillsdale, New Jersey 07642. <http://www.ils.nwu.edu/~e_for_e/>

SCHRUM, Lynne; Solomon, Gwen, 2007, "Web 2.0 and you: Starting the conversation," *International Society for Technology in Education* (ISTE). <http://www.iste.org/Content/NavigationMenu /Educator_Resources/YourLearningJourney/Web20/21F80026.pdf>

SEELY BROWN, John, "GROWING UP DIGITAL: How the Web changes work, education, and the ways people learn," *United States Distance Learning Association USDLA Journal*. Vol. 16(2). <http://www.usdla.org/html/journal/FEB02_Issue/article01.html>

SEELY BROWN, John; ADLER, Richard P., 2008, "Minds on fire: Open education, the long tail, and learning 2.0," *EDUCAUSE Review*. Vol. 43(1) January/February. <http://www.educause.edu/ir/library/pdf/ERM0811.pdf>

SIEMENS, George, 2005, "Connectivism: A learning theory for the digital age," *International Journal of Instructional Technology & Distance Learning*. Vol. 2(1). January 2005. < http://www.itdl.org/Journal/Jan_05/article01.htm>

SOLARQUEST®, 2004, Action, Communications, Technology & Science: Service Learning in the Galapagos Archipelago. ACTS™ Executive Summary.

STRONG, Maurice, 1995, Connecting with the world: Priorities for Canadian internationalism in the 21st century. A Report by the International Development Research and Policy Task Force. International Development Research Centre (IDRC); International Institute for Sustainable Development (IISD); North-South Institute (NSI).

TILBURY, D.; STEVENSON, R. B.; FIEN, J.; SCHREUDER, D., 2002, *Education for Sustainable Development: Dimensions of Work*. IUCN Commission on Education and Communication – The World Conservation Union. <http://www.iucn.org/themes/cec/education/dimensions.htm>

TUCKER, Bill. Laboratories of Reform: Virtual High Schools and Innovation in Public. Education. Education Sector Reports: Virtual Schools. http://www.educationsector.org June, 2007.

UBUNTU. Ubuntu Declaration On Education and Science and Technology for Sustainable Development, Sept, 2002. <http://www.unesco.org/iau/sd/unbutu.html>

UNESCO. Decade of Education for Sustainable Development (January 2005 – December 2014) Framework for a Draft International Implementation Scheme. UNESCO, July, 2003.

UNESCO IITE. Expert Meeting. ICTs In Education: State-Of-The-Art, Needs And Perspectives - Indicators And Information Systems. 28-30 March 2001, IITE (Moscow). Final Report Unesco Institute For Information Technology. Moscow, 2001. <http://unesdoc.unesco.org/images/0012/001257/125765eo.pdf>

UNGERLEIDER, A Systematic Review of the Effectiveness and Efficiency of Networked ICT in Education: A State of the Field Report to the Council of Ministers of Education, Canada and Industry CanadaCharles; BURNS, Tracey, 24 October, 2003. (http://www.cmec.ca/stats/SystematicReview2003.en.pdf>

VISSER, J. (1997). Elements for a Vision of Where the World of Learning is Going. Learning without frontiers: beyond open and distance learning. World Conference on Distance Education, Pennsylvania State University. [Online]. Available: http://www.unesco.org/education/educprog/lwf/doc/icde/icde.html

WERTHEIN, J. e Da CUNHA, C. Fundamentos da Nova Educação. (Cadernos UNESCO Brasil, Série Educação; 5) Brasília: UNESCO 2000.

WHITE, Gerry.Beyond the Horseless Carriage: Harnessing the potential of ICT in education and training. Education.au limited. 2005. <http://www.educationau.edu.au/jahia/webdav/site/myjahiasite/shared/papers/horseless_carriages_GW.pdf>

Appendix 1: Handbook for the digital age: A glossary of terms and sites

Based on Green & Hannon, 2007, pp. 12–14, with updated definitions from Wikipedia and/or the descriptions provided by each application's site.

Bebo is a popular social networking site often for younger users with over 22 million registered members. It is estimated that about five people register every second (although a much smaller number of members are regularly active on the Web site).

Blog – a Web site that often takes the form of an online personal diary. The word "blog" is derived from Web log and blogging subjects are as varied as human interests.

Co.mments – a tool for keeping track of when new blog comments have been posted.

Del.icio.us is a social bookmarking Web site. It enables individuals to save their favourite articles, blogs, music and reviews; share them with friends, family, co-workers and the del.icio.us community; and browse other people's favourites.

Digg is a social news tool which allows people to collectively determine the value of content. Everything on Digg—from news to videos to images to podcasts—is submitted by users (open to everyone). Once something is submitted, other people see it and Digg (rate) what they like best.

Facebook is a social networking site that uses corporate e-mail addresses, particularly university e-mails, to verify users as members of already existing social networks and then becomes an online extension of that network.

Flickr is a photo-sharing Web site. Not only an online photo album, its focus on the art of photography encourages and supports the growth of social networks through common creative interests.

Folksonomies (also known as collaborative tagging, social classification, social indexing, social tagging and other names) is the practice and method of collaboratively creating and managing tags to annotate and categorize content. Examples of sites that permit tagging include Flickr and Del.icio.us.

Furl saves a personal copy of any page on the Web with a single click.

GoogleVideo is similar to YouTube. It allows users to upload their own content, provides access to stock content and a marketplace for music videos, TV episodes and trailers.

iMovie is a piece of software designed to make editing and producing professional-looking videos intuitive and quick in order to reduce obstacles to home video creation.

IRC or Internet Relay Chat is a communication tool similar to MSN in that it allows the instant exchange of text messages. However, unlike MSN, it allows strangers from all over the world to meet online and to communicate.

iTunes is music library management software that allows users to import music from CDs, organize it into playlists, play music, purchase it from an online store and load it on to their iPod.

MSN is one of a range of services that allow text messages to be sent from one computer to another instantly so that a conversation can be carried out over the Internet.

Ma.gnolia is a social bookmarking Web site very similar to del.icio.us and Simply.

Mashups combine data elements from multiple sources, hiding this behind a simple unified graphical interface. An example is the use of cartographic data from Google Maps to add location information to real-estate data from Craigslist (http://www.craigslist.org), thereby creating a new and distinct Web service that was not originally provided by either source.

MySpace is a fast-growing social networking site with over 100 million registered members globally. It offers an interactive, user-submitted network of friends, personal profiles, blogs, photos, music and videos.

Newsvine is a Web service that provides a system for social news, similar to Digg.

Online international multiplayer games take place in a computer-generated imaginary world. Players guide their custom-designed character through a virtual life. They are open-ended games that provide players with almost limitless possibilities. Popular examples include World of Warcraft and Second Life.

Piczo is another social networking and blog site distinguished by its "walled garden" approach protecting user privacy by not providing search facilities for users.

Podcasts are audio or video recordings that are downloaded automatically by software on subscribers' computers every time a new edition is posted on a Web site. Easy to produce and distribute, the consumer can, and often does, turn creator.

Reddit is a Web service that provides a system for social news, similar to Digg.

RSS feed – sometimes referred to as Web feed or syndicated feed, is a data format used for providing users with frequently updated content. Content providers publish a feed link on their site which end users can register with program called a feed reader, news reader or aggregator.

Shadow.com unblocks any Web site from school or work.

Simply is a social bookmarking Web site very similar to del.icio.us.

Social networking refers to the aspect of Web 2.0 that allows users to create links between their online presence such as a Web page or a collection of photos. These links may be through joining online groups or by assigning direct links to other users through lists of "friends" or contacts.

Stumbleupon – a popular social bookmarking Web site very similar to del.icio.us.

Web 2.0 refers to a "second generation" of Internet-based services that emphasize online collaboration and sharing among users, often allowing users to build connections with other users.

Wikis are Web sites where content can be edited by any visitor to the site. An example of a wiki is **Wikipedia** – an online encyclopedia providing free content to all visitors and to which any visitor can add their own information or make corrections simply by clicking the *edit this page* link.

Xbox and Nintendo are a cross between a VCR and a computer. These are machines whose primary and, until recently, only, purpose was to run games. Either plugging into a television or existing as portable handheld units, these were often the first computers to enter the family home.

Yahoo! My Web 2.0 is a social bookmarking tool similar to del.icio.us.

YouTube allows people to post their own videos for others to watch, to give their opinions on the content that is there, and to make links between videos. YouTube has grown into an entertainment destination with people watching more than 70 million videos on the site daily.

Appendix 2: Sample links to ESD teaching support activities

This appendix contains a sampling of links to teaching support activities related to sustainable development, grouped into two separate tables: (1) activities developed by Manitoba-based organizations; and (2) activities developed by Canadian organizations outside of Manitoba.

Table 1. Activities developed by Manitoba-based organizations

Title/URL/Description	Level	GELO?*	Lang
1. The Marquis Project: http://www.marquisproject.com: A Brandon-based organization that has created "Fair Game," a series of short role-playing games for Grades 10–12 that explore the costs and benefits of world trading systems. The organization also visits schools to give its Composting 101 presentations, where students have a chance to touch and smell humus from different sources, and often a vermicomposter is built that is left in the classroom for the students to take care of.	Diverse	Not clear	Eng & Fre
2. Fort Whyte Centre School Program: http://www.fortwhyte.org/ FortWhyte offers curriculum-based education programs that recognize the importance of a healthy environment and community.	Diverse	Not clear	Eng & Fre
3. Living Prairie Museum: Environmental Education: http://www.winnipeg.ca/publicworks/naturalist/livingprairie The City of Winnipeg offers several environmental education programs for classroom field trips at several locations, or provides for an environmental educator to come to the classroom.	Daycare to Grade 6	Not clear	Eng & Fre
4. ESRI Canada: http://k12.esricanada.com/importantinfo/mbteachers.html All publicly funded elementary and secondary schools in Manitoba now have access to the following products and services through licensing agreements between ESRI Canada and Manitoba Education and Youth. ArcView (version 3.x or 8.x) - GIS software; ArcCanada Version 3.0 - Canadian and World datasets for ArcView; On-line training for educators - learn about GIS and how to use ArcView.	K–12	Not clear	Eng
5. Environmental Conservation Laboratory Environmental Education: http://umanitoba.ca/environment/ecl/index.php?p=environmentaleducation Three educational programs from the University of Manitoba that allow students in rural community to have hands-on experience in dealing with the environment.	Not clear	Not clear	Eng

GELO = **G**uidance on **E**valuation of **L**earning **O**utcomes

Table 2. Activities developed by Canadian organizations outside of Manitoba

Title/URL/Description	Level	GELO?*	Lang
1. Green Street: http://www.green-street.ca/ A Canada-wide initiative designed to link teachers with sustainability programs provided by environmental organizations, that are free and/or available at low cost and that are of the highest quality.	K–12	Yes	Eng & Fre
2. Pembina Institute's Green Learning: http://www.greenlearning.ca Provides active learning curriculum units for B.C., Alberta and Ontario. Principal programs are eCards, an online exploration of renewable energy; eneraction, which seeks to empower kids to take action on energy issues in their lives, schools and communities; and interactive lessons on renewable energy basics.	Grades 5–7	Yes	Eng
3. EcoKids: http://www.ecokids.ca Earth Day Canada's environmental education program for youth who care about the planet. "Animated, leading-edge technology engages children's minds in the EcoKids tree house, where they discover Play & Learn, the EcoKids Club, Storybooks, an art Gallery, an environmental forum and much more."	Younger kids (not explicited)	Yes	Eng
4. Toyota Evergreen Learning Grounds: http://www.evergreen.ca/en/lg/lg.html Lesson plans and techniques for teaching outdoors, resources with curriculum connections and online library and teachers' discussion forum. Teachers may also submit their lesson plans to a collaborative searchable data base. Also houses the Native Plant Database and the Bean Keepers pilot project which teaches schools how to plant beans to avoid erosion.	K–12	No	Eng
5. Space for Species: http://www.spaceforspecies.ca/ Site by Environment Canada, the Canadian Space Agency and Natural Resources Canada, which promotes learning and exploration of the role of satellite telemetry, remote sensing, astronaut observations and weather satellites in wildlife conservation by having kids track migratory animals in real-time via the Internet.	K–12	Yes	Eng & Fre
6. Sierra Club of Canada B.C. Chapter: http://www.sierraclub.ca/bc/programs/education Several educational programs, and online resources for teachers (e.g., Ecoprovince Map, where students click on a map to see the animals and plants that live there).	K–12	Yes	Eng

GELO = **G**uidance on **E**valuation of **L**earning **O**utcomes

Table 2. (Continued from previous page)

Title/URL/Description	Level	GELO?*	Lang
7. Wonderville: http://www.wonderville.ca Site by The Science Alberta Foundation simulating a town created where kids can try science experiments and find science facts, with activities and content based on Alberta science curriculum.	Grades 3–7	Yes	Eng
8. Power of One: http://www.powerofonehumaneeducation.org Classroom activities and downloadable presentations for teens on environmental issues, consumerism, media, society and animal protection. Geared toward promoting values such as integrity, respect, responsibility, fairness, kindness and citizenship.	"Teens"	Not clear	Eng
9. Quagmire: http://www.clean.ns.ca/default.asp?mn=1.20.73 An interactive game by Clean Nova Scotia that seeks to stimulate students' participation and critical thinking. Kids can debate, take on the roles of stakeholders such as government, industry, business, farmers and environmental organizations to discuss real-world issues such as the fate of a saltwater marsh located in the Maritimes.	Grades 5-12	Yes	Eng
10. Wetland Ecosystems Series: http://www.ducks.ca/resource/teachers/lesson_plans/index.html Ducks Unlimited Canada has developed three wetland and environmental education units of free lesson plans – developed by teachers to meet curriculum requirements in the life sciences. These include a teacher's guide, field activities and a companion student journal. *See also, projects by Ducks Unlimited International:* ***Project Webfoot:*** *http://www.ducks.org/projectWebfoot/ (extensive curriculum materials including lesson plans, books and CD-ROM on wetlands conservation and wildlife, that can be integrated into their existing school curricula); and* ***Greenwings:*** *http://www.greenwing.org/index.html (features online games and activities for young children, related to wetlands and nature, although without teacher's support and without being integrated into the curriculum).*	K–12	Yes	Eng & Fre
11. The Nature Challenge: http://www.davidsuzuki.org/_pvw370829/NatureChallenge/at_School/ The David Suzuki Foundation has developed the "Nature Challenge Teacher's Guide" with 20 lesson plans in accordance with the B.C. curriculum to engage students, promote understanding and encourage informed choices about environmental conservation.	Grades 4–7	Yes	Eng

GELO = **G**uidance on **E**valuation of **L**earning **O**utcomes

Appendix 3: Online Courses for Learning about Sustainable Development

This appendix lists 20 online courses for learning about Sustainable Development, noting the duration of each course, its target audience, cost, the degree to which it offers a learning support structure (total, partial or none) as well as if course completion provides a certificate or not. The information is organized as follows:

- Courses by International Organizations – Examples 1–7
- Courses by Universities – Examples 8–16
- Courses by local governmental or local non-governmental organizations – Examples 17–20

Note that this research does not list all online courses available. For a list of other degree programs and courses related to environmental education, see http://www.enviroeducation.com/online/, or research Newsweek's distance learning database: http://www.newsweekdistancelearning.com/; or see http://www.studyonline.com.au/area/environmental-studies/.

Organization/URL & Headquarters	Course Titles & Descriptions	Duration (each course)	Target Audience	Cost (each course)	Learning Support	Certificate
1. Earth Council Geneva (http://earthcouncil.com/lms/) **E-learning** Switzerland	Over 30 courses listed under the general topics of: Climate Change; Global Change; Biodiversity; Desertification; and "Sustainability Series" (e.g., **The Economics of Sustainability**)	20–30 hours over 4–5 weeks	"Representatives of government, civil society, business, the media, and other practitioners"	USD $100–500 (Depends on course, student's country and institution affiliation.)	Total	☑
2. World Business Council for Sustainable Development Capacity Building (http://wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=NjU&doOpen=1&ClickMenu=LeftMenu) **S**witzerland & U.S. *Limited pedagogical structure and lack of interactivity make examples B & C more like hypertext online articles than courses.*	**A) Chronos®** - an e-learning tutorial on corporate priorities for SD, developed in partnership with the Cambridge University Programme for Industry. (http://www.sdchronos.org/en/index.htm)	Not indicated	"Employees from a wide range of companies and sectors"	1 licence= £50; 10,000 licences = £50,000.	Total	☑
	B) Sustainable Business Challenge an introduction to key issues and trends, policy topics, emerging themes and business concepts for the 21st century.	Self-paced	Business employees	Free	Partial	**X**
	C) **Global Scenario Challenge** introduces scenarios to aid in the understanding of sustainability.	Self-paced	Business employees	Free	Partial	**X**
3. Unitar E-learning (http://www.unitar.org/elearning/index.htm) Switzerland	Three courses under the umbrella term **Training to Sustain Human Development:**					
	A) Multilateral Diplomacy and International Affairs Management Programme	6 weeks, 40–50 hours	Must be a Government official of a UN Member state, or staff of an NGO	USD $400	Total	☑
	B) Debt and Financial Management Programme	6 1-week modules of 6–8 hours		Free	Total	☑
	C) Environmental Law Programme	4 10-week modules		Free	Total	☑
4. UNESCO-IHE – Institute for Water Education (http://www.unesco-ihe.org/education) The Netherlands	Offers 11 courses training needs in the field of water education, including Wetlands Management; Water & Environmental Law and Policy; Cleaner Production and the Water Cycle, among others.	10 weeks – 4 months	Mid-career professionals with a BSc-level degree	€ 550	Total	☑

Organization/URL & Headquarters	Course Titles & Descriptions	Duration (each course)	Target Audience	Cost (each course)	Learning Support	Certificate
5. Youth Action for Change (http://www.youthactionforchange.org/?location=Courses) Web-based organization *Not clear if this course is ongoing or just offered once.*	**Sustainable Development** Courses emphasize peer-to-peer education, being taught by young people for young people. Includes courses on environment and sustainable development issues	1-3 months	YAC members (youths)	Free	Total	☑
6. SDLEARN – Sustainable Development eLearning Network (http://www.sdlearn.net/) Oregon, U.S. *Not clear if these courses are ongoing*	Offers a platform and pedagogical support for organizations that want to provide online courses related to SD. So far only lists a few courses, for example: **Digital Literacy for Development Professionals**; and **Fundamentals of Integrated Soil Fertility Management**	5 modules over 6 weeks (5 hours per week)	Professionals with basic English and computer skills	Not clear	Total	☑
7. Solar Energy International (http://www.solarenergy.org/workshops/description.php#Online) Colorado, U.S.	**Sustainable Home Design Online** How-to build energy efficient, sustainable solar homes.	6 weeks, 8–15 hrs per week	Owners, architects, builders, designers and contractors	USD $650	Not clear	☑
8. United Nations University – Online Learning (http://www.onlinelearning.unu.edu/) Japan	**Open Educational Resource** This resource provides structured learning materials online (didactic content, a Wiki and commenting tools) in 3 subject areas: 1. **Environmental Impact Assessment** (http://eia.unu.edu/); 2. **Strategic Environmental Assessment** (http://sea.unu.edu/); 3. **Forest Policy and Economics** (http://foper.unu.edu/)	Self-paced	Formal graduate and postgraduate students, plus practitioners/ professionals	Free	Partial	Available upon negotiation with participating universities
9. Global Virtual University (http://gvu.unu.edu/courses.cfm?pageid=1031&courseid=1003) Norway and Japan	**Global Environmental Issues** A course based on the structure and results of the publication "Global Environment Outlook: The status of the global environment."	225 hours over 9 weeks	"Adults, from many countries and cultures, age 21 and up"	USD $750	Total	☑

Organization/URL & Headquarters	Course Titles & Descriptions	Duration (each course)	Target Audience	Cost (each course)	Learning Support	Certificate
10. Open University UK (http://css2.open.ac.uk/search/search.aspx) United Kingdom	A search using the key words "sustainable development" returns several courses offered in diverse areas related to sustainability, which can be taken independently or toward a degree program. (e.g., **Working with our Environment: Technology for a Sustainable Future –** http://www3.open.ac.uk/courses/bin/p12.dll?C02T172)	Varies, usually 6–9 months	Mostly open to all with a high school degree and appropriate level of English. Some courses only for sponsored students of international organizations.	£315 – £1185	Total	☑
11. Athabasca University (http://www.athabascau.ca/course/ug_subject/list_ef.php#envs) Alberta, Canada *Scroll to Environmental Studies*	Lists a few courses related to sustainability in the Environmental Studies course grouping. (e.g., **Case Studies in Environmental Protection: Popular Education, Community Sustainability, and Global Connections**)	10–20 hours per week, must be completed within 6 months	Open to all with a high school degree and appropriate level of English	CAD $578	Total	☑
12. Open Universities Australia (http://www.open.edu.au/) Consortium of universities in Australia	A search of all distance education courses offered throughout the consortium returned 6 courses. (e.g., **Environmental Sustainability**)	13 weeks	Open to all with a high school degree and appropriate level of English	AUD $695 plus 195 if overseas student	Total	☑
13. Cape Breton University (http://www.cbu.ca/distance/students/courses/envi.html) Nova Scotia, Canada	**Online Environmental Engineering program** includes 7 undergraduate-level courses which examine the consequences of energy use, industrialization, and urbanization in order to provide working models for sustainable development.	3.5 months	Registered students and students enrolled in distance programs in any Canadian Virtual University partner (http://www.cvu-uvc.ca/)	CAD $658.50	Total	Can be used toward a degree
14. University of Minnesota Independent and Distance Courses (http://idlwebdb.cce.umn.edu/searchresults.asp?textsubj=environment) Minnesota, U.S.	Offers two relevant courses: **Ecology and Society;** and **Issues in Sustainable Agriculture**. Note the latter is offered via print distance education with Web support.	9 months	No pre-requisites but recommended for juniors and senior level students	USD $762 (for residents) USD $1,658 (non-residents)	Total	☑

Organization/URL & Headquarters	Course Titles & Descriptions	Duration (each course)	Target Audience	Cost (each course)	Learning Support	Certificate
15. **University of Toronto – Centre for Environment** (http://www.ies.utoronto.ca/Default.aspx?tabid=68) Ontario, Canada	**Environmental Distance Education Individual Courses** Offers 8 graduate-level courses which can be taken individually or toward a certificate program. These include: Environmental Case Management; Principles of Renewable Energies; Introduction to GIS for Environmental Management.	3 months	Need a post-secondary degree. Some prerequisite courses required	CAD $900	Total	☑
16. Colorado State University's International Institute for Sustainable Development (http://www.colostate.edu/Orgs/IISD/Online.html) Colorado, U.S.	**Online Certificate Program in Community-Based Development** Twelve short courses including: community mobilization; capacity building; monitoring & evaluation; etc. See for example, **Methods for Sustaining Development**	5-week courses – 20 hours per week	People who work or plan to work or volunteer in community development	USD $345	Total	☑
17. Senac Pernambuco Ensino a Distância Pernambuco, Brazil	This Brazilian public vocational training institution offers Environmental Citizenship Education; Sustainable Ecotourism; Environmental Law; ISO 1400, among other relevant courses.)	40–60 hours, time span varies	Anyone interested.	Equivalent to CAD $40–100	Total	☑
18. **Globe-Net** (http://www.globe-net.ca/special_features/primer_overview.cfm) British Columbia, Canada	**The Globe Net Climate Change & Carbon Trading Primer** – basically a learning-oriented hypertext online article on climate change.	Self-paced	General public	Free	None	**X**
19. The Natural Step (http://www.naturalstep.ca/elearning/) Ontario, Canada	**Sustainability: Step by Natural Step** An introductory training course "for organizations and communities seeking a holistic framework for moving forward on sustainability."	3 hours, self-paced	"Business, government, and community organizations"	Single user ID for CAD $120 plus 5% GST Volume discounts available	Partial	☑
20. Solar On-line: Learning Center (http://www.solenergy.org/html/home/home.html) Web-based organization	Offers 3 ongoing courses related to Photovoltaic design and implementation. Not directly related to SD but promotes the use of renewable energy toward a cleaner environment.	6 weeks, (10 lessons) 30–60 hours	"End Users, Owner-builders, Industry and Trades People, Decision Makers and Project Managers, Facility Managers, Entrepreneurs"	USD $150–300	Total	☑