InSIDE: Including Students with Impairments in Distance Education

Deliverable PR1.2 — In-depth recording of educational materials

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Contents

Abbreviations

Acronym	Term
DE	Distance Education
HE	Higher education
HEI	Higher education institution
ICT	Information and communications technology
InSIDE	Including Students with Impairments in Distance Education
IwI	Individual with impairments
JKU	Johannes Kepler University
LMD	Licence, Master, and Doctorate
UABT	University of Aboubekr Belkaid Tlemcen
UAE	Abdelmalek Essaadi University
UB2LA	Blida 2 University
UCA	Cadi Ayyad University
UIT	Ibn Tofail University
UM5R	University of Mohammed V in Rabat
UMMTO	Mouloud Mammeri University of Tizi-Ouzou
UOA	National and Kapodistrian University of Athens
UOM	University of Macedonia
US	University of Sousse
USFAX	University of Sfax
USTO	University of Sciences and Technology of Oran Mohamed Boudiaf
UTM	University of Tunis El Manar
ViHeMo	Visual, hearing, mobility/physical
WP	Work Package
TTS	Text-To-Speech
LCMS	Learning Content Management System

1 Introduction

This document presents the different types of learning material currently available. It includes a distinction between educational materials that are used for in-site teaching from those intended for providing Distance Education (DE). Also, to enhance the focus on accessibility and inclusion, it analyses the accessibility issues of both types of educational material and material specially designed to meet the needs of people with disabilities. Of special importance is the analysis of the digital educational material. For those last type of material there is a special section due to the wide variety of digital formats and methods available for DE.

2 Mainstream Learning Content

The provision of content in traditional education varies greatly. In addition, in latest times with the introduction of digital multimedia in classrooms the amount of resources for doing this has raise too. Below are presented a set of methods to provide education in-site that currently are in use. There is a differentiation between general content and those designed to meet learners with disabilities.

2.1 Educational material

2.1.1 Book

Books used in learning are a very common educational material, in school as well as at university. In recent years, especially at university level education, many books, depending on the field of study, are now available in digital form as well, but not all of them. They usually consist of text organized in chapters. This text is very often enriched by images, graphics and diagrams which further describe the content or help to easier understand concepts explained in the book.

Accessibility features

Printed books offer a pretty poor level of accessibility. They are not accessible to blind people. People with motor disabilities cannot turn over pages and visually impaired people cannot change the text presentation including font size, colour or contrast.

Digital copies of books offer a far better level of accessibility, since they often allow (depending on the format) to change the font size, and to some degree via software, the colour and contrast. Images and diagrams still might not be accessible due to missing alternative texts. Sadly, many PDFs which are basically only a set of images to blind user are

still pretty common. In this case blind users cannot use screenreaders which makes these PDFs documents fully inaccessible to them.

2.1.2 Map

A map is a symbolic representation of a relationship between elements of some space, like objects, regions or themes. Most commonly maps are used to depict geography, but they may also visualize abstract concepts, real or fiction, with or without regard to scale.

Maps can be printed on paper or similar materials, or they may also exist digitally.

Accessibility *features*

Like books, printed maps offer a very poor level of accessibility to blind and visually impaired people. Motor impaired people might be less impacted when using a single map printed on one page.

Most digital copies of maps are still inaccessible to blind people, as spatial relationships between elements of the map are very hard to convey to blind people. Visually impaired people however benefit from digital maps as they can be zoomed and (with additional software) colors and contrast can be changed.

2.1.3 Diagram

Diagrams are symbolic representations of information using visualization techniques. The goal is to describe a concept or relationship of multiple pieces of information. Many different types of diagrams exist tailored to a specific application with varying levels of abstraction and complexity. Printouts as well as digital versions of diagrams may exist.

Accessibility *features*

Diagram are usually inaccessible to blind people and very often to visually impaired people as well.

2.1.4 Blackboard, whiteboard, flipcharts

Blackboards and whiteboards are reusable writing surfaces, while flipcharts are large sheets of papers mounted to a stationery holder with, typically, a tripod. They are used by the lecturer or by participants of a group discussion to write down important items of the lecture or discussion in bullet point style or to visually enhance an argument or explanation to help other learners in the classroom understand what was said.

Accessibility *features*

This tool is inaccessible to blind people and depending on the type and severity of the impairment also to visually impaired people. On the other hand, people with special hearing needs may get advantage of the use of this. It reinforces teaching material and, since it is a different channel of communication that sound, they can be used for better understanding.

2.1.5 Video

Although, videos are not that common, they are still sometimes used in traditional education to provide information which would otherwise be hard or impossible to explain or describe.

Accessibility *features*

Videos are often not accessible to blind, visually impaired, deaf people or people who are hard of hearing. This of course depends on whether (parts of) the information are solely conveyed visually or acoustically. If the whole essential information is visually AND acoustically accessible (audio descriptions and captions), then videos can be accessible.

2.1.6 Slides/Projector

Projectors are a very common tool to support lectures and presentation. They display information, like text, image or videos, visually. A very common use case is to present digital slides via a projector.

Accessibility *features*

Content presented on a projector is not accessible to blind people and also most probably to visually impaired people, depending on factors like the font size, color, contrast and the included graphics.

2.1.7 Handout sheets

During lectures handout sheets may be handed to the students. They may contain additional information, supporting graphics or a summary of the lecture, often provided as bullet points to make it easier for students to memorize the content. They might also contain a textual description of exercises which the students are supposed to solve during the lecture or at home.

Accessibility *features*

Paper handouts are not accessible to blind people and might be inaccessible to people with visual impairments depending on the layout (typeface, contrast, etc.) used. People with

motor impairment could have problems handling them and depending of the forma of sheets, they may use some kind of assistive technology for this purpose.

2.1.8 Hands-On Exercises

Depending on the type of studies and on the lecture content, hands-on exercises may be carried out only by the lecturer or by the students. The aim is to facilitate an efficient knowledge transfer as well as create practical experience for students during lectures.

Accessibility *features*

Depending on the type of hands-on exercise all kinds of accessibility issues can arise and basically all types of people with disabilities may be affected.

2.1.9 Samples of Student Writing

Writing can be an effective teaching method for students. But students often have difficulty on thinking of topics. That's where student writing prompts can be useful. Writing prompts are brief partial sentences designed to help students while writing, such as "The person I admire the most is... " or "My biggest goal in life is..." Just be sure to give students the parameters of the assignment, such as a single paragraph for younger pupils or a full, multi-page essay for older students (Lewis, 2019).

2.1.10 Games

Games can be useful in teaching students everything from money and grammar to social skills. “Sight words bingo”, for example, can help students learn their basic sight words, but there are also relatively inexpensive bingo games that teach money skills, Spanish language, telling time, and even English grammar. More active, outside games such as basketball or football can help students learn social skills, such as sharing, working as a team, and the possibility of losing and winning (Lewis, 2019; SIGHTWORDS, 2019).

2.1.11 Flashcards

Even in our days that students learn through the use of computers and internet-based learning materials, flashcards can be particularly useful for students with learning disabilities, such as dyslexia. Printing high-frequency words, also known as sight words, on the front of flashcards with short definitions on the back can create a good learning tool for students who have auditory or visual learning styles (Lewis, 2019).

2.1.12 Model Clay

Younger students, such as those in kindergarten through third grade, can learn using model clay. For example, a teacher might have young students make letters of the alphabet using clay. Clay can also be used to teach concepts to older students. A well-known concept that can be taught by using model clay is tectonic plates, the theory of how the Earth's surface behaves (Lewis, 2019).

2.1.13 Manipulatives

Manipulatives are physical items such as gummy bears, blocks, marbles, or even small cookies, that assist student learning. Manipulatives are especially helpful in the younger primary grades, where students can use them to help solve subtraction and addition problems (Lewis, 2019).

2.2 Educational material for people with disabilities

This material is intended for satisfying of people with impairments. The main aim of it is the transmission of the same information to student independently of individual abilities.

2.2.1 Braille book

A braille book uses embossed 6 dots arranged as braille characters on a thicker paper that can be combined, depending on the braille language/ alphabet used. These tactile characters mainly correspond to alphanumeric characters with a few exceptions, a special character to highlight that the following characters are digits, Umlaut like ä, ö, ü, etc... Sometimes, text is visually printed on the same page above each braille line to enable a sighted teacher or a facilitator read the text.

Accessibility features

This type of learning material enables blind people to consume text. However, it comes with one severe disadvantage. Compared to printed books, braille books are much bigger and heavier, often multiple books are required to store the same amount of text. This makes it difficult for blind people to carry a comparable amount of information in a non-digital form.

2.2.2 Braille graphics

Braille graphics also make use of embossed paper to carry information in tactile form. This can be achieved using more or less a matrix of braille dots. Braille graphics are used for simple diagrams, maps or very abstract images.

Accessibility features

As the bandwidth of the human tactile sense is much narrower than the human eye, the information needs to be kept very simple. Otherwise, blind people cannot process the information. Depending on the person, if he or she is blind since birth or not and how developed the spatial perception is, braille graphics might be an issue also for simpler piece of information. People who are NOT blind since birth often have a more developed spatial understanding and perception.

2.2.3 Magnified Printouts

Visually impaired people are a rather manifold target group with wildly varying capabilities caused by numerous different diseases or injuries. Some persons of this group benefit from larger text. For these people magnified versions of printouts, with larger font sizes and larger graphics are helpful.

Accessibility features

Not all visually impaired people benefit from larger text and if they do, books or other types of printed text become much bigger and heavier, which limits the mobility.

2.2.4 Audio books or recordings

In addition to physical printouts, books can also be made available via audio. This can range from simple audio recordings with no structure to more complex forms like audio books which usually allow the user to jump to specific chapters. As an alternative, properly formatted e-books with text-to-speech could serve a very similar purpose. Even though modern Text-to-Speech (TTS) software applications can provide rather good results, recordings done by a human speaker still provide a more natural experience for the user.

Accessibility features

This technology is helpful to people with various impairments. It is rather common for blind and visually impaired people to consume information as audio books. However, people with cognitive disabilities benefit from this, too.

2.2.5 Accessible Videos

Videos can be made accessible using audio descriptions (auditive description of an otherwise solely visually available piece of information) and captions (textual description and therefore also visual description of an otherwise solely auditive available piece of information).

Accessibility features

This kind of videos are beneficial for many different target groups, including blind people, visually impaired people, persons who are deaf or hard of hearing and also, cognitively impaired people.

2.2.6 Easy-to-Read

Easy-to-Read text is a form of text which is specifically made simpler and easier to understand without losing essential information. Some techniques applied are the use of shorter sentences (one sentence per thought), the use of more common words and if difficult words are necessary the provision of a clear explanation for each of these words.

Accessibility features

Even though Easy-to-Read is often related to people with cognitive impairment, also other target groups can benefit from it, for example deaf people. People who are deaf since birth often have difficulties with more complex text, since the development of a language is highly influenced by the amount it is used and consumed. Sign language, which is the first language of deaf people, is totally different (grammar, composition of words etc.) than any kind of spoken language like English or German. Therefore, deaf people are far less familiar with spoken languages and often struggle with reading and writing more complex words and sentences.

3 Learning Content in Distance Education

As Distance Education (DE) is based on web platforms, we use the term "web content" or simply "content" to refer to all kind of educational materials used in DE. In general, content includes anything displayed on a website or a web-based platform and any file accessed or downloaded from a website, or get transferred through the internet, such as:

- Presentations (e.g.: MS-PowerPoint)
- Text files (e.g.: MS-Word of PDF)
- Video or audio files.

This content is useful only when it has been designed and developed so that it can be efficiently used by the majority of learners in various circumstances or contexts of use.

3.1 The Components of Web Content

It is essential that several different components of web development and interaction work together in order users of DE to be able to interact with the web learning content. These components include (see Figure 1) (Henry, 2018):

- **content:** the information in a web page or web application, including:
  - natural information such as text, images, and sounds
  - node or mark-up that defines structure, presentation, etc.
- **web browsers, media players**, and other "user agents"
- **users**' knowledge, experiences, and in some cases, adaptive strategies using the web
- **developers:** designers, coders, authors, etc., including users who contribute content
- **authoring tools:** software that creates websites

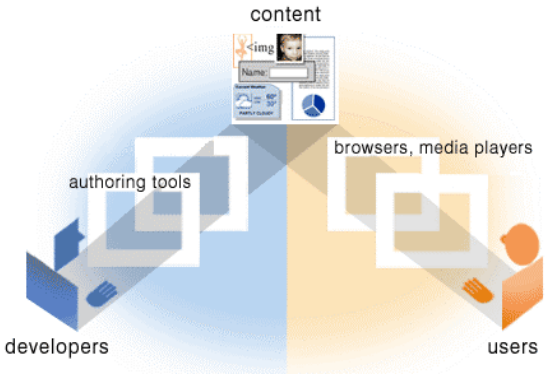

Figure 1: Essential components of web content (Henry, 2018)

It is worth to mention that:

- Web **content developers** usually use **authoring tools** to create **content**.
- **People (users/leaners)** use web **browsers, media players, assistive technologies**, or other **"user agents"** to get and interact with the **content**.

Referring to all the above-mentioned web components, we should highlight the fact that they are interdependent with each other. But, there are significant interdependencies between the components, which means that the components must work together in order end users to be able to interact with the web content in an effective way (Figure 2) (Henry, 2018).

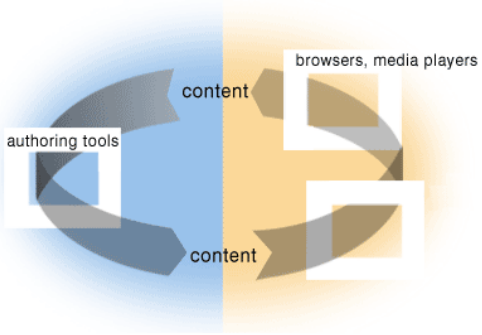

Figure 2: The way the web components are interdependent with each other (Henry, 2018)

3.2 Accessible Learning Content in Distance Education

In order for the web to be accessible to people with disabilities, several additional components of web development and interaction work together. These components include (Fig. 3):

- **accessible content:** the information in a web page or web application, including:
  - natural information such as text, images, and sounds
  - code or mark-up that defines structure, presentation, etc.
  - information files (texts, presentations, audio files etc.) that can be "opened" or "downloaded" by the user
- **assistive technology**, in some cases - screen readers, alternative keyboards, switches, scanning software, etc.
- **users**' knowledge, experiences, and in some cases, adaptive strategies using the web
- **authoring tools:** software that creates accessible websites and accessible content
- **evaluation tools:** web accessibility evaluation tools, HTML validators, CSS validators, etc.

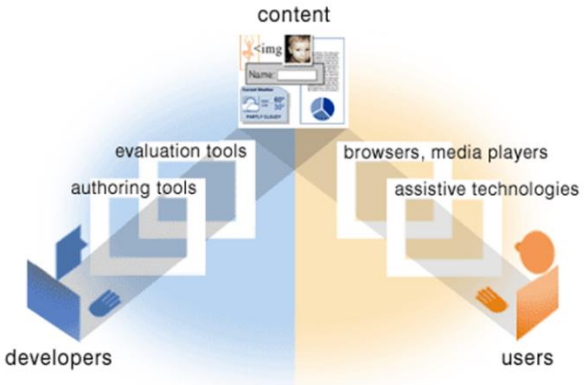

Figure 3: Essential components of accessible web content (Henry, 2018)

Web developers usually use authoring tools and evaluation tools to create an accessible web content and People ("users") use web browsers, media players, assistive technologies (such as screen readers, braille display, switches, screen scanning software etc.) or other "user agents" to get and interact with the content (Henry, 2018).

3.2.1 Interdependencies between Components

There are significant interdependencies between the components; that is, the components must work together in order for the web to be accessible. For example, for alternative text on images (Henry, 2018):

- technical specifications address alternative text (for example, HTML defines the alternative text attribute (alt) of the image element (img))
- WAI guidelines {see 1.2.4} (WCAG, ATAG, UAAG) - define how to implement alternative text for accessibility in the different components
- developers provide the appropriate alternative text wording
- authoring tools enable, facilitate, and promote providing alternative text in a web page
- evaluation tools are used to help check that alternative text exists
- user agents provide human and machine interface to the alternative text
- assistive technologies provide human interface to the alternative text in various modalities
- users know how to get the alternative text from their user agent and/or assistive technology as needed

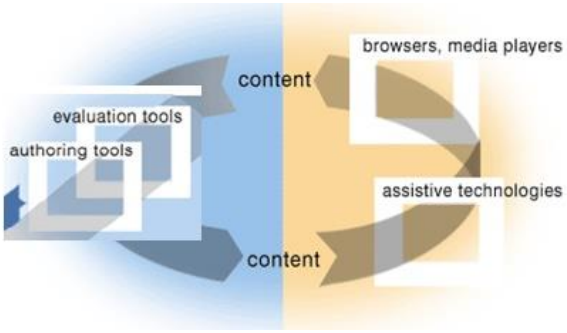

Figure 4: The way the accessible web components are interdependent with each other (Henry, 2018)

3.2.2 The Implementation Cycle

When accessibility features are effectively implemented in one component, the other components are more likely to implement them (Henry, 2018).

- When **web browsers, media players, assistive technologies, and other user agents support** an accessibility feature, users are more likely to demand it and developers are more likely to implement it in their **content**.
- When developers want to implement an accessibility feature in their **content**, they are more likely to demand that their **authoring tool** make it easy to implement.
- When **authoring tools** make a feature easy to implement, developers are more likely to implement it in their **content**.
- When an accessibility feature is implemented in **most content**, developers and users are more likely to demand that **user agents** support it.

3.2.3 When One Component is Weak

If an accessibility feature is not implemented in one component, there is little motivation for the other components to implement it when it does not result in an accessible user experience. For example, developers are unlikely to implement an accessibility feature that authoring tools do not support and that most browsers or assistive technologies do not implement consistently (Henry, 2018).

If one component has poor accessibility support, sometimes other components can compensate through "work-around" that require much more effort and are not good for accessibility overall. For example,

- developers can do more work to compensate for some lack of accessibility support in authoring tools; for example, coding mark-up directly instead of through a tool
- users can do more work to compensate for some lack of accessibility support in browsers, media players, and assistive technology and lack of accessibility of content; for example, using different browsers or assistive technologies to overcome different accessibility issues

However, in most cases the works-around are not implemented and the result is still poor accessibility. Additionally, sometimes poor accessibility support in one component cannot be reasonably overcome by other components and the result is inaccessibility, making it impossible for some people with disabilities to use a particular website, page, or feature (Henry, 2018).

3.2.4 Guidelines and Other Standards

The Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) develops **web accessibility standards** for the different components (Fig. 5):

- Authoring Tool Accessibility Guidelines (ATAG) addresses authoring tools

- Web Content Accessibility Guidelines (WCAG) Overview addresses web content, and is used by developers, authoring tools, and accessibility evaluation tools
- User Agent Accessibility Guidelines (UAAG) addresses web browsers and media players, including some aspects of assistive technologies

These accessibility guidelines are based on the fundamental technical specifications of the web, and are developed in coordination with all W3C technical specifications (HTML, CSS, SVG, SMIL, etc.). W3C also develops technical specifications that directly address accessibility, including:

- ARIA, the Accessible Rich Internet Applications Suite, which defines a way to make web applications more accessible to people with disabilities. It especially helps with dynamic content and advanced user interface controls developed with Ajax, HTML, JavaScript, and related technologies.

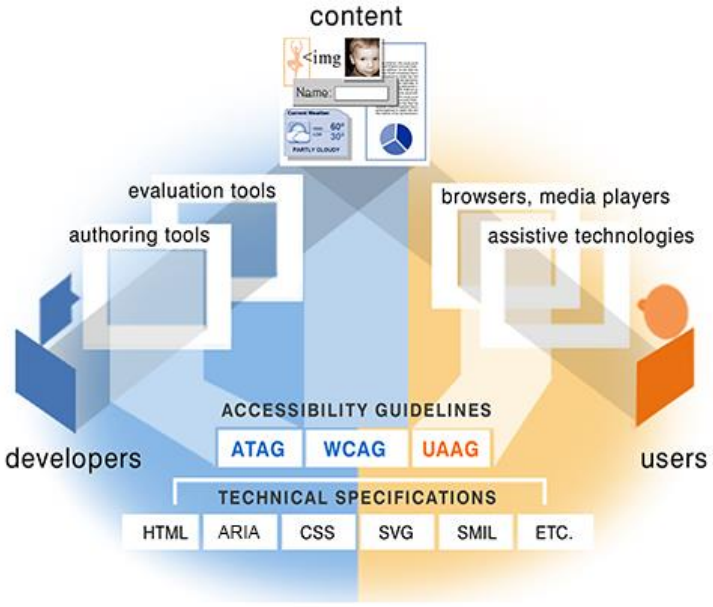

Figure 5: Accessibility guidelines and technical specifications

3.2.5 Content Data Formats

Having referred to the learning content in DE we should get down one level below, focusing on the data formats. It is important to point out that all computer data is at least implicitly and informally formatted, although the format may be informal and undocumented. For trivial or evanescent data there is no little need to worry about how the data is represented or stored. However, for data that must persist, be transported, and/or be shared, it is important to carefully store the data in a known format, so that the intended meaning can be accurately reconstructed (McGrath, 2003).

A data format is a method for representing content data in a digital store (which may be transient or persistent). Essentially a data format has the following aspects (McGrath, 2003):

- A model of data representation,
- A mechanism for describing data, e.g.: for mapping concepts of the data model to digital objects, such as files or memory,
- Optionally, standard methods for manipulating data,
- When the data model is very general, a data format may also have means to specify profiles, e.g.: more specific sub-cases of the data model, which model particular application or community concepts.

3.2.5.1 Data Types & File Formats

It is important to consider what types of data we create and/or work within DE, and what format those data take. The data stewardship practices will be dictated by the types of data that we work with, and what format they are in (Oregon State University, 2019).

3.2.5.2 Data Types

Data types generally fall into five categories (Oregon State University, 2019):

1. **Observational**, with the following characteristics:
   - Captured in situ
   - Can't be recaptured, recreated or replaced.

Examples of observational data: Sensor readings, sensory (human) observations, survey results.

2. **Experimental**, with the following characteristics:
   - Data collected under controlled conditions, in situ or laboratory-based
   - Should be reproducible, but can be expensive.

Examples of experimental data: Gene sequences, chromatograms, spectroscopy, microscopy.

3. **Derived or compiled**, with the following characteristics:
   - Reproducible, but can be very expensive.

Examples of derived or compiled data: Text and data mining, derived variables, compiled database, 3D models.

4. **Simulation**, with the following characteristics:
   - Results from using a model to study the behaviour and performance of an actual or theoretical system
   - Models and metadata, where the input can be more important than output data.

Examples of simulation data: climate models, economic models, biogeochemical models.

5. **Reference or canonical**, with the following characteristics:
    - Static or organic collection (peer-reviewed) datasets, most probably published and/or curated.

Examples of reference or canonical data: Gene sequence databanks, chemical structures, census data, spatial data portals.

3.2.5.3 File Formats

Content data comes in many varied formats: text, numeric, multimedia, models, software languages, discipline specific, e.g.: crystallographic information file (CIF) in chemistry, and instrument specific (Oregon State University, 2019).

The available data types and the corresponding file formats for sharing, re-use and preservation are displayed below (Oregon State University, 2019):

Table 1: Data types and the corresponding file formats for sharing, re-use and preservation (Oregon State University, 2019)

Type of Data	File Formats for Sharing, Re-use and Preservation
Documentation & Scripts	Rich Text Format (*.rtf)
	HTML (*.htm, *.html), XML marked-up text (*.xml), according to an appropriate DTD or schema, e.g.: XHMTL 1.0
	plain text (*.txt)
	widely-used proprietary formats, e.g.: MS-Word (*.doc/*.docx) or MS-Excel (*.xls/*.xlsx), Libre Office (*.odf), MS-PowerPoint (*.ppt/pptx), OpenDocumentText (*.odt)
	PDF/A or PDF (*.pdf)
Qualitative data: textual	eXtensible Mark-up Language (XML) text according to an appropriate Document Type Definition (DTD) or schema (*.xml)
	Rich Text Format (*.rtf)
	plain text data, UTF-8 (Unicode and *.txt)
	plain text data, ASCII (*.txt)
	Hypertext Mark-up Language (HTML) (*.html)
	widely-used proprietary formats, e.g.: MS-Word (*.doc/*.docx)

	LaTeX (*.tex)
Digital image data	TIFF version 6 uncompressed (*.tif)
	JPEG (*.jpeg, *.jpg)
	TIFF (other versions; *.tif, *.tiff)
	JPEG 2000 (*.jp2)
	Adobe Portable Document Format (PDF/A, PDF) (*.pdf)
Digital audio data	Free Lossless Audio Codec (FLAC) (*.flac)
	Waveform Audio Format (WAV) (*.wav)
	MPEG-1 Audio Layer 3 (*.mp3)
	Audio Interchange File Format (AIFF) (*.aif)
Digital video data	MPEG-4 High Profile (*.mp4)
	motion JPEG 2000 (*.jp2)
	JPEG 2000 (*.mj2)
Mathematical /STEM Data	MathML, LaTeX (*.tex), ChemML, CML, MATH files (*.math), Maple Worksheet (*.mw)
Musical Data	MusicXML, Musical Instrument Digital Interface (*.midi), Notation Interchange File Format (*.niff) – based on Microsoft's RIFF, ASCII character in a human-readable way format (GUIDO), Standard Music Description Language (*.smdl) – based on SGML (Standard Generalized Markup Language) (Lee, 2000)
Quantitative tabular data with extensive metadata: a dataset with variable labels, code labels, and defined missing values, in addition to the matrix of data	SPSS portable format (*.por)
	delimited text and command ("setup") file
	(SPSS, Stata, SAS, R data, etc.) containing metadata information
	structured text or mark-up file containing metadata information, e.g.: DDI XML file
	MS-Access (*.mdb/*.accdb)
Quantitative tabular data with minimal metadata: a matrix of data with or without column headings or variable names, but no other	comma-separated values (CSV) file (*.csv)
	tab-delimited file (*.tab)
	including delimited text of given character set with SQL data definition statements where appropriate

metadata or labelling	delimited text of given character set – only characters not present in the data should be used as delimiters (*.txt)
	widely-used formats, e.g.: MS Excel (*.xls/*.xlsx), MS Access (*.mdb/*.accdb), dBase (*.dbf) and OpenDocument Spreadsheet (*.ods)
Geospatial data: vector and raster data	ESRI Shapefile (essential: *.shp, *.shx, *.dbf and optional: *.prj, *.sbx, *.sbn)
	geo-referenced TIFF (*.tif, *.tfw)
	CAD data (*.dwg)
	tabular GIS attribute data
	ESRI Geodatabase format (*.mdb)
	MapInfo Interchange Format (*.mif) for vector data

3.3 Content in Learning Content Management Systems (LCMSs)

In general, the requirements of education include the following (Reem Razzaq & Afaf Badie, 2014):

1. **Courseware Creation, Retrieval and Updating:** Handling research or patent related information. Also, the education needs to interactive retrieval, real time content exchange, multimedia provisioning, etc.
2. **Transform the Content:** For presentation over different devices including handheld and other portable or mobile communication devices.
3. **On-line Publishing:** It indicates the activities such as evolution of a learning architecture in terms of change management and reinventing the conventional training organization apart from other issues. The transition from old to new framework of learning can be noted in Figure 6:

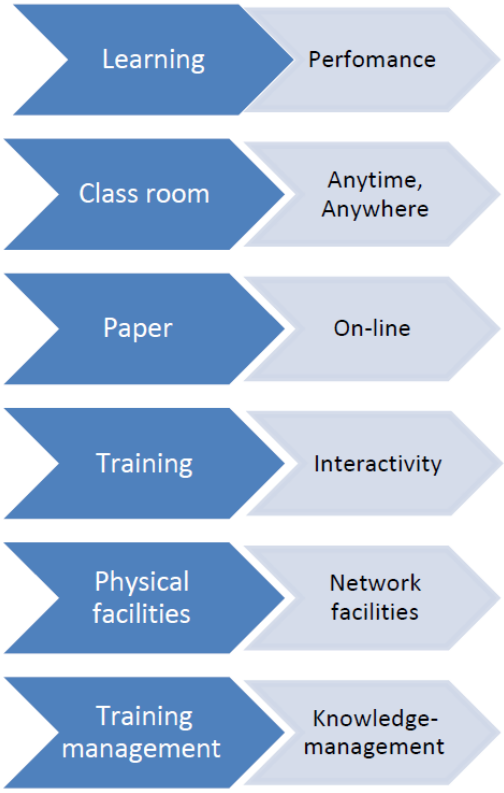

Figure 6: The Transition from Old to New Framework of Learning (Reem Razzaq & Afaf Badie, 2014)

Learning Content Management System (LCMS), which represents a multi-user web-based environment where learning developers can create, store, reuse, manage and deliver digital learning content from a central object repository (Chapman, 2001), meet all the above-mentioned educational requirements.

The primary role of LCMS is to manage digital assets used for developing learning products. These systems provide a database called a **learning content object repository** that will save work done by authors of courses as learning objects, which can be accessed by the same or other authors to develop new learning, workflow information for convenient updating of content, course authoring capability, collaboration tools to enable course authors and learners to work together, some basic LCMS capability, ways to create and administer tests and quizzes (Jurubescu, 2008).

In those systems, the content we have the ability to add, may have been organized in various file formats. All file extensions which is possible to be uploaded on an LCMS, organized into categories based on each file format, are presented in the following table (see Table 2):

Table 2: File extensions that can be uploaded on an LCMS (Moodle, 2019; Blackboard Help, 2018)

File Format	File Extension
Document File	*.bdoc, *.cdoc, *.ddoc, *.doc, *.docm, *.docx, *.dotm, *.dotx, *.epub, *.fdf,

	*.odt, *.oth, *.ott, *.pdf, *.ps, *.rtf, *.rtx, *.stw, *.sxg, *.sxw, *.tex, *.texi, texinfo, *.xdp, *.xfd, *.xfdf
Text File	applescript, *.asc, *.asm, *.c, *.cpp, *.cs, *.h, *.hpp, *.htc, *.ics, *.java, *.jcb, *.jcl, *.jcw, *.jmt, *.jmx, *.jnlp, *.jqz, *.latex, *.m, *.odm, *.php, *.rhb, *.sh, *.sqt, *.tsv, *.txt, *.xml, *.xsl
Image File	*.ai, *.bmp, *.dmg, *.eps, gallery, gallerycollection, galleryitem, *.gif, *.hqx, *.ico, *.jpe, *.jpeg, *.jpg, *.odg, *.odi, *.otg, *.pct, *.pic, *.pict, *.png, *.std, *.sti, *.svg, *.svgz, *.sxd, *.sxm, *.tif, *.tiff, *.wmf
Audio File	*.aac, *.aif, *.aifc, *.aiff, *.au, *.flac, *.m3u, *.m4a, *.mp3, *.oga, *.ogg, *.ra, *.ram, *.rm, *.rv, *.wav
Video File	*. 3gp, *.asf, *.avi, *.dif, *.dv, *.f4v, *.flv, *.m4v, *.mov, movie, *.mp4, *.mp3, *.mpe, *.mpeg, *.mpg, *.qt, *.rmvb, *.webm, *.xbk
Presentation File	*.odp, *.otp, *.potm, *.potx, *.ppam, *.pps, *.ppsm, *.ppsx, *.ppt, *.pptm, *.pptx, *.pub, *.smi, *.smil, *.sxi
Spreadsheet File	*.csv, *.ods, *.ots, *.sxc, *.xlam, *.xls, *.xlsb, *.xlsm, *.xlsx, *.xltm, *.xltx
Web File	*.css, *.htm, *.html, *.js, *.mht, *.mhtml, *.scss, *.vtt, *.xhtml
Compressed File	*.7z, *.gtar, *.gz, *.gzip, *.jar, *.mbz, *.rar, *.sit, *.tar, *.tgz, *.zip
Data Base File	*.accb, *.mdb, *.mw, *.mws, *.nbk, notebook, *.odb, *.odc, *.odf, *.stc
Shockwave File	*.cct, *.dcr, *.dir, *.dxr, *.swa, *.swf, *swfl
Multimedia File	*.aam
Executable File	*.exe
Mind Mapping File	*.isf, *.ist
Menu File	*. mpr

LCMSs gives us the opportunity to structure online courses, which include: texts, images and interactions. These online courses consist of two parts (Reem Razzaq & Afaf Badie, 2014):

- **Upload courses:** Where educators have the ability to create forms and upload files in different formats (*.pdf, *.ppt, *.img, etc.).
- **Download courses:** Where educators and students can view the content of the courses, uploaded in folders, in various formats (*.pdf, *.ppt, etc.), in the form of a table or a list.

3.3.1 Accessibility in Learning Management System

Accessibility describes materials that may be accessed by individuals with disabilities. In recent years, articles concerning disability accommodation and Americans with Disabilities Act (ADA) and Section 508 compliance have become more popular (Web FX: Digital

Marketing That Drives Results, 2019). Students with impairments face barriers to achieve the same academic level as that of their peers. The kinds and severity of problems vary from student to student. They may do well in some areas, but very poorly in others. They may learn what is seen, but not what is heard; they may remember by writing, but not by reciting orally and so on (Horton, 2000). There is no doubt that LMS is a major trend in distance education and educational technology. The use of LMS and its asynchronous nature have provided an independent outlet for these students. Studies have shown that students with disabilities have an increased willingness to self-disclose online. LMS can be perfect solution to improve the academic performance. But LMS consist of various features that could cause accessibility problems for students with disabilities explained below:

- **Assignments:** One way of submitting work is to download the assignment and upload the completed assignment. Friendly and accessible Upload/Download feature needs to be provided.
- **Blogs:** Accessible sorting and filtering options are missing from most blogs.
- **Chat:** Composing entries and reading is difficult simultaneously. Also Scrolling through the messages and selecting or copying desired information is not possible.
- **Forums:** "Filling out Forms" issues are a potential problem along with being able to use sort, filter, and search features.
- **Quizzes:** Navigation between questions is needed. Also timed quizzes are problematic for assistive technology user's just takes more time to complete a quiz.
- **Emails:** Due to inaccessibility of web-based e-mails, most students with disability prefer to use their own e-mail clients. Most LMS e-mail features are not accessible.

There are many more features which are not yet designed with accessibility in mind. So if we generalized all the features of existing LMS, we have following core drawbacks:

- As we know every student with impairment is different, teachers and instructional designers should build the course according to their requirements but existing LMS is designed in general without considering the students requirement.
- Ever student with disability has its own learning style, so LMS should provide some sort of provision for different teaching styles. But there is no such accommodation as such in the existing LMS.
- Depending upon the type of student with impairment, screen content, layout and navigation has to vary. Again, these accommodations are totally ignored in the existing LMS.

3.3.2 Learning Objects

The creation of standardized contents for use in the different modes of learning: face-to-face, blended and / or virtual learning is crucial in XXI century universities. The Learning Objects (LO) approach aims to facilitate the design of small units of content that can be

combined and reused in different courses and in this way take advantage of the development of educational programs and materials (PAHO, 2019).

All the above-mentioned files (see Table 1 & 2) are potential LOs in DE and they can enrich the learning process by becoming part of the educational design that an educator organizes, in order to conduct his/her lesson.

However, several problems have made defining LOs difficult. One bothersome difficulty is that existing definitions are far too general to be of any use in identifying, developing, or criticizing LOs. For example, Ellis (2002), trying to define the term LO, begins with the following phrase: "At its most basic level, a LO is a piece of content that's smaller than a course." Friesen (2001), also illustrates this same problem, when he quotes from an IEEE definition of LOs: The Learning Technology Standards Committee (LTSC) defines an object as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning". The LTSC provides examples of these objects, including "multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning".

In the literature on LOs, the importance of context is not in question. So, because "context" is so important, it should be made part of the definition. A LO is not just any digital file or any object under the sun. At the least, anything that could be considered a LO would need associated instructional information. This occurs even with mundane "objects." Images are often placed in textbooks, but the images themselves are always captioned and explanatory material is provided in the text. Of course, in technological settings where the goal is to use these objects in semi-automated instructional systems, the provision of this type of instructional context is critical.

A look at the pedagogical intention behind the production of objects is also necessary. Clearly, although many digital objects could be construed as LOs, not all digital files are LOs. Other objects may or may not become LOs, as pedagogical intent is required for that to happen. A file can become a LO if someone decides to use it as one. Intent is necessary, and this brings us to the last component of the LO definition, which is "associated metadata". We have already seen that files are not useful as LOs without the provision of context. A rose might be a rose by any other name, but it is not an object unless there is some discourse associated with it.

Armed with this initially simplistic perspective on LOs, we can provide a first definition of LOs. A LO is a digital file (image, movie, etc.) intended to be used for pedagogical purposes, which includes, either internally or via association, suggestions on the appropriate context within which to utilize the object (Sosteric & Hesemeier, 2002).

According to Churchill (2007), the following interpretations of what a LO may be can be noted:

1. Any digital or non-digital entity for technology-supported learning
2. Any digital resource used to support learning
3. Any digital resource used to mediate learning
4. A reusable digital resource built in a lesson
5. Interactive practice exercise
6. Small, stand-alone unit of instruction
7. An instructional component that includes instruction that teaches a specific learning objective and assessment that measures achievement
8. A collection of 7±2 components containing content, practice and assessment parts
9. A content object with a pedagogical component
10. Combined knowledge object and a strategic object representing a mental model to be developed by a learner through incremental elaboration
11. Interactive digital resource illustrating one or more concepts
12. Interactive visual representation.

Based on these interpretations, a LO may be:

a) an instruction or presentation object,
b) a practice object,
c) a conceptual model,
d) anything digital,
e) anything digital and non-digital.

According to the Learning Technology Standards Comitee (LTSC) of IEEE, the term LO is defined as any entity, digital or non-digital, that may be used for learning, education or training, and may also be reused or referenced in a learning context supported by technologies. Thus, a LO is an instructional module that has the following four characteristics (PAHO, 2019):

a) **It is reusable:** it can be easily contextualized according to the specific needs of the teaching-learning process and is adaptable to the needs of a particular course, unit or module.
b) **It is flexible:** it can be easily modified and updated.
c) **It is accessible and interoperable:** it is independent of the technologies used and the operating system (multi-platform).

In addition, a LO can be defined as any digital or non-digital object that has an educational purpose in a specific context, regardless of its inner qualities.

LOs are classified taking into account their educational use and levels of granularity:

According to their educational use, LOs can be classified into (PAHO, 2019):

- **Instructional objects:** articles, workshops, seminars, case studies, etc.
- **Collaboration objects:** forums, chat, Elluminate/Collaborate, online meetings, etc.
- **Practice objects:** simulations, software, online labs, research projects, etc.

- **Assessment/evaluation objects:** partial evaluation, final certification, etc.

Granularity is another feature that applies to LOs within the context of education, which is related to reusability. Granularity refers to the possibilty offered by a LO to determine which of the educational elements that are a part of it can retain their qualities in the case they are separated from the context of the original LO as a whole (PAHO, 2019).

The concept of granularity refers specifically to the dimensions that a LO can have, which directly influence its educational reusability. The smaller the object, the easier it will be to combine with others and therefore more reusable (PAHO, 2019).

According to the IEEE-LOM, there are four levels of granularity (PAHO, 2019):

a) **N1:** It is the smallest level of aggregation, a unit for learning. For example, a chest X-ray image, multimedia elements or fragments. (Applicable to material apparently indivisible, such as a PDF file, etc.).
b) **N2:** A collection of educational objects of level 1, a learning unit (lesson) on acute respiratory infections with radiological images. For example, a collection of atomic materials (an HTML file with images).
c) **N3:** A collection of level 2 learning objects, for example, a modular unit or course of respiratory syndromes. For example, two or more materials of level 2, collection of lessons on acute respiratory infections from different sources, a website made up of multiple HTML documents.
d) **N4:** The higher level of granularity. For example, a set of courses for a diploma or degree. (Diploma, Masters).

Additionally, Churchill (2007) proposed a classification of LOs which contains the following types of them: presentation, practice, simulation, conceptual models, information and contextual representation objects (see Table 3). Expanding his suggestion, Churchill (2007) composed a definition of the LO that might serve as an umbrella for the six types proposed by the classification. All types of LOs appear to have these common characteristics:

a) they are digital, utilizing different media modalities (and often interactivity) to represent data, information, reality, concepts and ideas, and
b) they are designed to afford educational reuse.

Accordingly, he proposed the following general definition: “a LO is a representation designed to afford uses in different educational contexts”. This definition, to be clearly understood, should be considered in the context of the proposed classification (Churchill, 2007).

Table 3: Types of LOs (Churchill, 2007)

LO type	Explanation	Simple example
Presentation object	Direct instruction and presentation resources designed with the intention to transmit specific subject matter	An instructional sequence on classification of triangles
Practice object	Drill and practice with feedback, educational game or representation that allows practice and learning of certain procedures	Quiz question requiring a learner to use representation of a protractor to measure angles and answer a question regarding ratio between base and height of the right-angled triangle
Simulation object	Representation of some real-life system or process	Simulation of a compass allowing a learner to draw a geometric shape (e.g.: equilateral triangle)
Conceptual model	Representation of a key concept or related concepts of subject matter	Representation that allows manipulation of parameters of a triangle, which in turn changes displayed modalities such as visual representation of a triangle, and numerical values of sizes of its angles and sides, and displays a graph showing changes in relationship between sides or angles
Information object	Display of information organized and represented with modalities	Representation that allows learners to change angles and sizes of a triangle and, based on configuration, to obtain information such as the type of triangle illustrated, a picture showing it in real-life and a short description of its properties
Contextual representation	Data displayed as it emerges from represented authentic scenario	Representation that shows real-life examples of triangles (e.g.: roof of a building) and allows a learner to use representation of a tool (e.g.: tape measure) to collect data about dimensions of these triangles

3.3.2.1 Analysis of the types of LOs

Presentation objects: Presentation objects include resources designed with a purpose to transmit a body of subject matter or lead to achievement of a specific learning objective. A presentation object attempts to transmit knowledge to learners by displaying messages representing chunks of subject matter. These messages can be aided by modalities and usually, certain principles are in place to ensure that learners are motivated and not overloaded. Content of such objects is usually divided into screens and sections, with a learner going through one section at a time. Other forms of a presentation object can be slide presentations with or without talking heads, videoed or audio-recorded lecturers, demonstrations, instructional video segments and animated instructions (Churchill, 2007).

Practice objects: Practice objects allows learners, to practice certain procedures (e.g.: dismantling a water pump), complete crosswords, drag objects and carry on certain tasks (e.g.: dragging a protractor to measure an assigned angle), engage with an educational game or answer quiz questions. They might be designed to:

1. Incorporate interactivity and modalities and require learners to engage in some purposeful action and decisions before answering a question or executing an action.
2. Provide constructive feedback (which might utilize modalities) and encourage learners to reflect on their action and further explore material, digital libraries, the internet, post a question on-line, engage in discussion with classmates, etc.
3. Facilitate extension of learners' current levels of understanding (or misunderstanding)
4. Enable learners to build models of their own action and mistakes while executing a procedure.

Educational games might also be considered as practice objects, because they can promote persistent practice until a degree of competency or understanding is achieved. In more contemporary approaches, practice objects can be considered as parts of a learning activity process, rather than as some postlearning task that aims to strengthen learners' recall and understanding of subject matter presented by a teacher or resources. Thus, a practice object might be given an instrumental role in an activity. Whatever learners conceptualize from their involvement with a practice object can be utilized for examples to inform their problem-solving decisions (Churchill, 2007).

Simulation objects: Simulation objects represent some real system or process: e.g.: a simulation of a microscope or of electricity consumption in a household. They allow a learner to explore, usually by trial and error, operational aspects of a system, carry on a task that the system supports, and develop a mind model of that system's functionalities. Although fidelity is often high in simulations, development of skills is hardly ever completed, and learners must usually move to a real system to complete their practice to genuine competency level. However, by the time a learner shifts to the real system, he or she would already have constructed a mind model of the system's functionalities and operational possibilities. This is particularly effective when learning to use the real system requires an understanding beyond being able to operate it (e.g.: understanding how a system works) and when the real system is expensive, unavailable or available in limited number, or

learning to operate it is costly and possibly dangerous. A simulation might also involve dynamic processes such as manufacturing processes, financial flows and energy consumptions. In this case, a learner might manipulate certain parameters as he or she learns to manage that process (Churchill, 2007).

Conceptual models: A conceptual model is a type of a LO that represents one or more related concepts or ideas, usually in an interactive and visual way. It might be appropriate to think of a conceptual model as a representation of a cognitive resource existing in the mind of a subject matter expert, as useful conceptual knowledge that aids decision-making, disciplinary problem-solving and discipline- specific thinking. Psychologists use a variety of terms such as schemas, mental models and concepts to more or less, indicate the same idea that there are constructs in the human mind that mediate higher psychological functioning. Sometimes the term representation is used for constructs in the human mind (Churchill, 2007).

Information objects: An information object utilizes information visualization capabilities of contemporary technology to provide educationally useful information. This type of LO might be just a single representation (an image) or a multimodal display and a visual interface providing information dynamically based on interaction. Information can be represented in tables, matrixes, mind maps, illustrations, formulas, pictures, animations, videos, diagrams, 3D models and by the way of other modalities (van Someren et al., 1998). Tufte (1990; 1997; 2001) discusses a range of visual techniques (e.g.: graphs, illustrations, icons, pictures) to represent information. For Tufte, representations can be built to present complexity through visual clarity. He suggests that traditional visualization is greatly expanded with new technologies which allow interactive, three-dimensional and animated formats. Interactivity (e.g.: buttons, clickable hot-spots, roll-over area, sliders, text-entries and drag-and-drops) allow information space to be organized in a way that enables learners to engage in exploring information, changing modalities, manipulating certain parameters or configuring options and observing changes in information, and otherwise manipulating the information they are accessing through the interface (raw information might reside within an information object, or in a database). Interactivity and modalities allow large quantities of information to be represented and made available for display in a small screen space. The ways in which technology makes this possible are best illustrated by a collection of articles edited by Bederson and Shneiderman (2003). A single interface (that is, a single screen without a change of page) might be designed to act as a point of access to a large amount of information. This would allow learners not just to experience interaction and/or a lot of information in mediated formats, but also to construct a mental space of information from the LO and understand how different pieces of information are related.

Contextual representations: The idea behind a contextual representation is to allow learners to explore some realistic scenario and collect data, usually for the purpose of inquiry and problem-solving. For example, learners might collect data about volcanic activity, weather conditions, air pollutants in the atmosphere, population of life forms at great ocean

depths, statements of opinion from people, and so on. Usually, there is a contextual representation of some imaginary or real place inaccessible to learners because it is distant, time and place dependent, involves danger, is too small or too big to allow data collection, requires sophisticated tools for collection of the data, requires lab conditions, requires expertise and so on. Engaging learners in collection of authentic data allows them to experience the origins of that authentic data, and explore the context and tools used in data collection. This might also enable learners to experience authentic problems or discipline-specific inquiries as they engage in collection and exploration of data (Churchill, 2007).

All the above-mentioned types of LOs learners and teachers can view, use and interact with them through distance learning environments and Web 2.0 tools, which today, are part of the daily learning process.

3.3.2.2 Accessibility and LOs

LOs, when referenced in accordance with international standards and in dependent of platforms, can be located and reused, either alone or in the composition of larger objects, with defined goals and educational strategies, in different educational contexts. Thus, the current concern of researchers is the quality of LOs distributed on the Web, at the virtual learning environments and LOs repositories (Macedo & Ulbricht, 2012).

Insofar as technology evolves and enters the educational system, accessibility issues are grown, with the creation of potential access barriers. In the systemic approach to online education, the more suitable combinations of content, media and technologies are offered, the greater the scope and accessibility of the created content (Macedo & Ulbricht, 2012).

Accessibility issues in Web content are discussed mainly by the Web Accessibility Initiative (W3C-WAI) and the IMS-GLC-ACC (Accessibility Guidelines.) Within the W3C documents, the closest accessible to the creation of LOs is the Web Content Accessibility Guidelines (WCAG) (W3C Web Content Accessibility Guideline 2.0., 2008) with general scope in the development of web contents. IMS recommendations and accessibility standards are tackled in the specifications: IMS GLC-ACC (Accessforall Metadata, IMS-ACCLIP - (Accessibility for Learner Information Package), and IMS - ACCGuide -Guide for Developing Accessible Learning Applications (IMS Global Learning Consortium, 2019)."Web content, according to W3C-WCAG, refers to information in a Web page or a Web application, including any text, images, forms, or sounds" (Chisholm & May, 2009).

In the perspective of universal design, a product is universally accessible if it is apparent, reached to all individuals without adaptation. It is not about developing other specific content and directed to supply a deficiency, but to provide people with disabilities, access to such information. In the LOs, according to NCAM, CAST (WGBH.org, 2018) adaptations of access can change the nature of a content and divert attention from the main aim of learning, so in inclusive education, all individuals should have access to the same didactic and pedagogical content; they must have the same perception about everything that is

presented, without loss of information or detriment of content relevant to the understanding of the subject.

Accessibility should be considered from the beginning of the project of a LO, and not an adaptation after its creation. Any education object should be accessible to all students with or without disabilities or at least provide equivalent alternatives when necessary (Macedo & Ulbricht, 2012).

People with disabilities often use adaptive/assistive technology that requires an alternate/ accessible format so the technology can access the information in a specific manner for the user. This can include people who (Queen's University/Accessibility Hub, 2019):

- are blind or have low vision
- cannot hold publications or turn pages because of a physical disability/ print-disabled
- have difficulties accessing information on the Internet, or
- are deaf of have difficulties hearing video presentations.

Alternative format allows all students with disabilities to participate fully and ensures equality of opportunity in pursuing their education (Garvey, 2011).

3.3.3 The Elements of Documents

The term Document can be used to refer to all kind of electronic or digital content/educational material used in DE as it includes mainly books, newspapers, journals, periodicals, webpages, reports, articles, letters, pamphlets, and e-mails (Kouroupetroglou, 2015b). According to the communication theorist Marshall McLuhan, a document is the "medium" in which a "message" (information) is communicated (McLuhan & Fiore, 2005). The content of electronic documents includes mainly text and images (i.e. figures, drawings, graphs, pictures, charts, diagrams, maps, photos, etc.). Furthermore, it may include mathematical or in general scientific symbols and formulas. The term *text-document* refers to the textual content only of a document.

Besides its content, a printed or electronic document contains a number of *presentation elements* or *attributes* that apply on its text content (see Figure 7) (Kouroupetroglou 2015a): a) design glyphs or typographic elements (i.e. visual representation of letters and characters in a specific font and style) and b) arrangement of the content on the page and the document as a whole. For example, the title of a chapter can be recognized by placing it at the top of the page and in larger font size than the body of the text. Also, text color, but also the bold font style, can be used to indicate emphasis in a specific part of a text-document. Rich-text content is a text document that preserves all its presentation elements (Kouroupetroglou, 2015a). In contrast, a plain-text document ignores the presentation elements.

The files of text documents, composing an organized source of information that makes sense to the reader and can be adapted to his/her interests. The way a document is composed and presented either on paper or on screen, refers to the term “document architecture” (Peels et al., 1985). Kouroupetroglou (2015) proposed a general document architecture, which constitutes an extension of the basic ITU/ISO model (ITU, 1993; ISO, 1989).

The elements of this architecture can be classified in three layers (see Figure 8) (Kouroupetroglou, 2015a):

- **Logical layer:** It associates content with structural elements such as headings, titles/ subtitles, chapters, paragraphs, tables, lists, footnotes, and appendices.
- **Layout layer:** It associates content with architectural elements relating to the arrangement on pages and areas within pages, such as margins, columns, alignment and orientation (portrait or landscape).
- **Typography layer:** It includes font (type, size, color, background color, etc.) and font style such as bold, italics, underline.

Figure 7: Presentation elements of a document (Kouroupetroglou, 2015a)

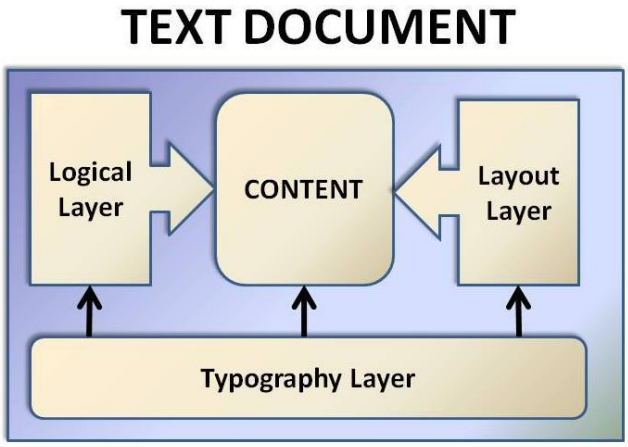

Figure 8: Text document architecture (Kouroupetroglou, 2015a)

The above three layers are complementary and not independent. Typography can be applied to both the logical and the layout layers of a document. Moreover, typography can be applied to the main body of the text directly. For example, a word in bold can be used either for the introduction of a new term or to indicate a person's name. Also, a heading can be arranged in the center of a line (layout layer) (Kouroupetroglou, 2015a).

The organization of a document can be classified into two main aspects: the logical and the physical. The logical layer of the document architecture defined above corresponds to its logical organization with the same elements (e.g.: headings, titles/ subtitles, chapters, paragraphs, tables, lists, footnotes, and appendices). At the page level, the physical organization of a document is described by its layout layer in connection with the physical realization of a number of logical layout elements (e.g.: headings, titles/ subtitles, paragraphs, tables, lists, footnotes). The organization of a printed of electronic multipage document as a whole corresponds with the physical implementation of a part of its logical layer elements (e.g.: chapters, appendices, indexed, references). The organization of a document is domain specific (e.g.: textbook, scientific paper, technical report, newspaper, magazine) (Kouroupetroglou, 2015a).

A basic requirement in document accessibility is the accessible format selected for a user to support accessibility not only to the content of the documents, nut also the typography, logical and layout layers.

3.3.4 Accessible formats

Accessible Formats or (alt formats or alternate text) are course materials including textbooks, documents, exams, handouts, etc., converted into various accessible alternatives such as MS-Word documents, PDF's, braille, large print, audio and digital text.

Fully accessible format means that (NYSED.gov/Special Education, 2019):

- All text is digital and can be read with text-to-speech, modified with regard to font size, and navigated by unit, chapter, section and page number (or other appropriate segments).
- Images include alternative text and long descriptions when appropriate (alternative text is a replacement for an image that serves the same purpose as the image itself. It is read by a screen reader in place of the image).
- Math equations are provided as images with alternative text or in the content file using MathML, Latex.
- Content reading order, levels and headings are determined by publisher tagging.
- Text can be converted to Braille.
- School districts should note that just because a document is digital or online, it is not inherently accessible. File types to consider, from most to least flexible are:
  - Digital Accessible Information System (DAISY)
  - Hyper Text Markup Language (HTML)
  - Portable Document Format (PDF), (unlocked, embedded fonts, single page)
  - Rich Text Format (RTF)/Word document.

3.3.4.1 Braille

Braille is a tactile system of reading and writing that is made up of a series of raised dots evenly arranged in quadrangular letter spaces or cells. The configuration of dots can be read with the fingertips by people who are vision impaired.

Accessibility features

- Braille is unique written system that may be the most accessible option of reading and writing for students who are blind or have a significant visual impairment.
- Tactile perception and discrimination skills are necessary for efficient braille reading.

Note: (An average classroom textbook in braille usually weighs 8-10 pounds and is bound in sections for usability).

Works with

- Students who have been trained in the use of braille.

3.3.4.2 Braille Ready File (BRF)

Braille Ready File (*.brf), often referred to as eBraille or web-braille, is a specialized digital text format used to create embossed braille or be read using a braille display or with a refreshable braille device.

Accessibility features

- Braille is unique written language that may be the most accessible option of reading and writing for students who are blind or have a significant visual impairment.

- Digital files on a refreshable display prevent the need to carry and store large volumes of embossed braille text.

Works with

- Refreshable braille display
- Braille embosser

3.3.4.3 Tactile Diagrams

Diagrams, pictorial information and graphs are reproduced this way for people who are visually impaired. Diagrams are drawn onto special paper which is then heated. Any area that has been drawn on is raised so that a relief diagram is produced. Braille notes can be added, and diagrams are often accompanied by a braille explanation. Diagrams may need to be simplified or altered before being produced in tactile form.

3.3.4.4 Digital Talking Book (DTB) / DAISY

A Digital Accessible Information System (Daisy) Talking Book (DTB) is a digital or human voice recording of the full electronic text with the capability to navigate, offer extensive speed adjustments and bookmark sections of the book (Jolley, 2002). A Daisy talking book is made up of a series of files linked together. A computerized text DAISY book can be read using refreshable Braille display or screen-reading software, printed as Braille book on paper, converted to a talking book using synthesized voice or a human narration, and also printed on paper as large print book. In addition, it can be read as large print text on computer screen.

Accessibility features

- Text-to-speech capabilities allow the text to be read aloud
- Highlights text as it is read for improved comprehension
- Built in bookmarks and electronic navigation
- Images are tagged with alternate text descriptions that can be read aloud
- Page numbers of the Daisy correspond to the page numbers of the printed text
- Older Bookshare Daisy files did not contain graphics. Newer Bookshare Daisy files and Daisy files converted from NIMAS will have graphics with alternative text that can be read aloud
- Content is “Reflowable”, meaning the text is optimized to fit the page regardless of font size
- Most Daisy readers will have a series of additional beneficial features such as:
  - Dictionaries
  - Bibliographers
  - Contrast and color: Boost the contrast with various built-in color variations
  - Built-in graphic organizers

- Pronunciation assistance
- Highlighting of Digital Text for notes
- Web access.

Note: To open Daisy book use the (*.opf) file, in a specialized Daisy reader.

Works with

- Text-to-speech programs such as Read: OutLoud
- Kurzweil 1000 and 3000
- Read and Write: Gold
- AIM-VA and Bookshare.

3.3.4.5 Hybrid books

Hybrid Book is a document format which was created at Masaryk University and has been used to publish digital documents at the University since 2002. It was originally a digital text synchronized with an audio recording and navigable through its hierarchical structure, primarily intended for students/users with visual impairments. Over the last ten years, the Hybrid Book has developed into a mature document format enabling an undistorted access to information to students and other users with various disabilities (visual or hearing impairment, learning disabilities etc.) as well as users without disabilities find this document format advantageous for its multi-modality (Hladík, Gůra & Ondra, 2018).

The original text/audio data setup has been extended to the triad text/video/audio and the main aim of the designed data structure is to synchronize thus distinguished types of records and it allows including more than one of each media (text, video, audio).

The extension of the data setup with video component has been made primarily in order to add a translation of the document into sign language (besides the mentioned audio recording) to enable access of the content to deaf using sign language. But it is obvious that it offers further applications – the hybrid document is a convenient format to save and publish recordings of live events (such as lectures, presentations etc.) as a synchronized compilation of audio and video record of the event together with text transcript of the speeches of the event (Hladík, Gůra & Ondra, 2018).

As the primary application of the Hybrid Book is publishing scientific documents, the system has to provide several advanced features considering complexity of access to such a content. Currently, the development of those features mainly concerns (Hladík, Gůra & Ondra, 2018):

- extended navigation in tabular data which supports screen-reader users and considering sign language translation of those data
- inclusion of symbolic structures (e.g. math formulae) and flow diagrams
- tool to handle user's commentaries

Characteristics of the Format

The descriptive structure is designed so that it allows synchronization of records of various types based on “synchronization points” only, i.e. if it is possible to describe a given record with a succession of points (e.g., timestamps in an AV recording), it is then also possible to add this record to a Hybrid Book document. It is also possible to add static data (such as images and graphs) in the form of links (Hladík, Gůra & Ondra, 2018).

3.3.4.6 Electronic publications (ePub)

ePub (short for electronic publication) is a free and open e-book standard by the International Digital Publishing Forum (IDPF). ePub files are simplified versions of the Daisy format and are usable on most all electronic devices. AIM-VA converts ePubs from Daisy, NIMAS, and word files.

Accessibility features

- Compatible with text-to-speech programs.
- Content is “Reflowable”, meaning the text is optimized to fit the page regardless of font size.
- Readable on the computer as well as many mobile devices.
- ePubs created by AIM-VA are available on the student’s bookshelf, can be streamed online and read aloud using Streamit!
- Built in bookmarks and electronic navigation through “Table of Contents” often included
- Publishers can tag images with alternate text descriptions that can be read aloud.
- Page numbers correspond to the page numbers of the printed text if programmed by the publisher.

Works with

AIM-VA's Stream-It and popular eReaders. These include, but are not limited to; iPad, Kindle, iPhone, Android, Kobo, Nook, Sony Reader, Windows Phone, PC and Mac OSX notebook/desktop systems.

3.3.4.7 HTML

HTML, which stands for Hypertext Markup Language, is the predominant markup language for web pages. Books that are downloaded in HTML include many different files which can be opened from a central index file. They are extremely compatible from computer to computer and you only need to have a web browser such as Firefox or Internet Explorer to be able to open these files.

Accessibility features

- Compatible with text-to-speech programs

- Content is "Reflowable," meaning the text is optimized to fit the page regardless of font size.
- Can be opened in any web browser, with or without internet access.
- Built in bookmarks and electronic navigation
- Publishers can tag images with alternate text descriptions that can be read aloud.
- Page numbers correspond to the page numbers of the printed text if programmed by the publisher

Works with

Read OutLoud; Kurzweil; Web browsers such as Internet Explorer, Firefox, Chrome; or a text editing program such as Notepad.

3.3.4.8 Large print

Large print is defined as print for text passages that is larger than the commonly used print and font sizes from eight to twelve points in size. Large print is typically defined as 16pt or 18pt font size or larger. Large print refers to paper and is either printed on the same size page or more frequently, is presented on larger size pages.

Accessibility features

- Many large print books come in multiple volumes. No volume is greater than 270 pages
- Trade books come in 16 point or greater font and are available in a traditional book-bound fashion
- For most textbooks, large print will be 18 point font.

Works with

- Students who need larger text (students with low vision).

3.3.4.9 Giant Print

This describes Large Print where the letter size is larger than 18 point font. Generally, students do not require access to their learning materials in font sizes greater than 24 point so this format is not commonly used.

3.3.4.10 E-Text

Electronic Text is a general term for any document that is read in digital form, but especially a document that is mainly text. The most common four file types of electronic formats used in the education setting are: Microsoft Word, Portable Document Format (PDF), PowerPoint, and Excel Spreadsheets.

3.3.4.11 Plain Text

Electronic text files without formatting (as created with Windows Notepad or TextEdit). Plain text format is important because it is flexible and has total compatibility. File sizes are small (in terms of bytes), so can be transferred easily between PCs, laptops, Macs, Smartphones, Braille note-takers or USB thumb drives and opened with a massive choice of programs. Text output can be formatted and converted as required by the end user and contains no inaccessible material so is entirely accessible to screen reader users.

3.3.4.12 MS-Word

A MS- Word Document is the file type used with the commonly known program Microsoft Word. This format is optimized by using the Microsoft sans serif typeface in black; unless a font color is needed for instruction and active hyperlinks. Due to special character limitations, math, science, and music texts are not available.

Accessibility features

- Includes content related graphics which are programmed with alternate text descriptions that can be read aloud
- Font style matches the original text (e.g.: bold, italics, underline)
- Page numbers correspond to the page numbers of the printed text
- Footnotes are positioned within text to provide greater understanding of content
- Headings are created for navigation and can be viewed in the document maps
- Microsoft Word files can be easily saved as RTF files.

Note: This format requires a compatible text-to-speech program to have the text read aloud.

Works with

- Best if used with Microsoft Word.

3.3.4.13 NIMAS Format

NIMAS is the National Instructional Materials Accessibility Standard. NIMAS means the standard established by the Secretary of Education to be used in the preparation of electronic files suitable and used solely for efficient conversion into specialized formats. This format is only available for text copyrighted in or after 2006. These files are stored in the NIMAC, a virtual library which can only be accessed through AIM-VA (Accessible Instructional Materials).

Accessibility features

- If graphics are present, alternative text that can be read aloud may also be available
- Electronic navigation through “Table of Contents”
- Requires special software to read.

Note: This format is traditionally used by Authorized Users such as AIM-VA and Bookshare to create other formats. This format is compatible with some software programs but is not commonly used by local education agencies.

Works with

NIMAS files are source files and are not student-ready. For more information: NIMAS Files Best Practices (National Center on Accessible Educational Materials).

3.3.4.14 PDF Accessible

A PDF Accessible file is a digital scan of a book or document that turns printed text into an electronic format that is readable by a computer or portable device. These scanned files will look exactly like their printed counterpart and will maintain formatting regardless of screen size or magnification.

Accessibility features

- Provides an identical digital representation of a printed book
- Compatible with text-to-speech programs
- PDFs can be opened by using a variety of programs on the computer as well as many mobile devices
- Users can increase the page size without distorting the text; allowing PDF Accessible files to be used as digital large print
- Most PDF readers will have a series of additional beneficial features such as:
  - Highlights text as it is read for improved comprehension
  - Contains note taking features like in text highlighting and commenting
  - Bookmarking and electronic navigation.

Works with

Adobe Reader and text-to-speech programs such as: Read: OutLoud, Kurzweil 1000 and 3000, Read and Write: Gold.

Extras

Students can type their answers right on the page of a PDF, Accessible and PDF, and Fully Accessible Workbooks using the free Adobe Acrobat Reader, following the below-mentioned guidelines:

- Click on Comment tool on the right side of the screen
- Click on the plain 'T' on the top Comment bar
- Click on the page where you want to type your answer. Type it!
- Print the page when you are finished!

Note: NIMAS files are source files and are not student-ready.

3.3.4.15 PDF Fully Accessible

A Fully Accessible PDF is a PDF that was converted directly from a structured WORD document. These documents look exactly like word documents and are annotatable, readable by a computer, and are optimized by adding additional accessibility features to the file, like "tags". A tag contains information such as header locations, hyperlinks, and alternative text descriptions for graphics. This allows PDF Fully Accessible documents to be bookmarked, navigated much easier, and provides detailed information about images in the text.

Accessibility features

- Compatible with text-to-speech programs
- Includes content related graphics which are programmed with alternate text descriptions that can be read aloud
- Font style matches the original text (e.g.: bold, italics, underline)
- Page numbers correspond to the page numbers of the printed text
- Footnotes are positioned within text to provide greater understanding of content
- PDFs can be opened by using a variety of programs on the computer as well as many mobile devices
- Content is "Reflowable", meaning the text is optimized to fit the page regardless of font size
- Most PDF readers will have a series of additional beneficial features such as:
  - Highlights text as it is read for improved comprehension
  - Contains note taking features like in text highlighting and commenting
  - Bookmarking and electronic navigation.

Works with

Adobe Reader and text-to-speech programs such as: Read: OutLoud, Kurzweil 1000 and 3000, Read and Write: Gold.

3.3.4.16 Rich Text Format (.rtf)*

Rich Text Format (RTF) is a simple document file of text and graphics developed for easy transfer between applications, platforms (e.g.: MS-Windows, OS/2, Macintosh), and different output devices. RTF files are directly converted from NIMAS files with all original NIMAS features built in.

Accessibility features

- RTFs can be opened by using a variety of programs on the computer as well as many mobile devices
- Requires a compatible text-to-speech program to have the text read aloud
- Easily editable size and color.

Works with

Notepad, MS-Word, and other basic word processing software.

3.3.4.17 Audio

The audio format provides content as speech to which the student listens. The audio format may be presented as recorded human speech or synthesized electronic speech. If the audio format is created flexibly — for example, aligned to NIMAS or DAISY standards — there are many ways in which the speech output can be adjusted. Depending on the technology used, changes in the pitch, volume, and speed at which the speech is presented can be made. Depending on the tool the student uses to access the recording, they must learn how to navigate. The student must learn how to go forward and backward, and jump to page numbers, chapters, titles, etc.

3.3.4.18 Audio Recording

Recorded Audio Books are human voice recordings provided to students through Learning Ally (formerly known as RFB&D). While most of the books are audio only, a select number of books have been converted to the VOICE text format, which provides highlighted text that is followed while the audio is played. Learning Ally is a national nonprofit provider of books in an accessible format for people who cannot read standard print due to visual, perceptual or physical disabilities. It provides thousands of titles available on digitally recorded audio books, DC, and computer disk, including textbooks.

Accessibility features

- Learning Ally books are read by content matter specialists and are designed to be clear and understandable, with students who have disabilities in mind
- Speed controls allow students can speed up or slow down the rate at which the book is read
- Students can easily click to navigate by pages, chapters or sections as well as add their own digital bookmarks
- Can be read on DAISY players or PC, Mac, IOS, and Android devices using the free downloadable software or apps provided by Learning Ally
- Content is "Reflowable", meaning the text is optimized to fit the page regardless of font size
- For audio recordings in the “VOICEtext” format, the text will be highlighted as it is read which reinforces word recognition, improves fluency, builds vocabulary and develops decoding skills.

Works with

- Free Learning Ally Audio App (IOS and Android)
- Free software from Learning Ally called ReadHear by gh

- DAISY Devices (Cost depends on device; device can be ordered through Learning Ally)

3.3.4.19 Closed Captioning

Captioning translates the audio portion of a video presentation by way of subtitles, or captions, which usually appear on the bottom of the screen. Captioning may be closed or open. Closed captions can only be seen on a television screen that is equipped with a device called a closed caption decoder. Open captions are “burned on” a video and appear whenever the video is shown. Captioning makes television programs, films and other visual media with sound accessible to people who have hearing disability or are hard of hearing.

3.3.4.20 Media alternatives

Transcripts, captions and text transcript with description of visuals must be provided so that those who can't see or hear can still experience the content.

3.3.4.21 Signed films and videos

The spoken word is transferred to sign language on the screen.

3.3.4.22 Descriptive narration

Video description (also called audio description) makes television and other visual media accessible to people who are blind or visually impaired. With described video (also known as descriptive audio) all relevant action scenes and on-screen text (such as credits) in video, TV programming, Web-based multi-media or movies is described and read by a narrator.

3.3.4.23 Digital Audio

Can be in MP3 format, with human voice, no navigational features or Daisy which stands for Digital Accessible Information System. The DAISY/NISO Standard is the Digital Talking Book (DTB) specification for accessible digital textbooks. This format includes ability to find and go to specific chapters and pages.

3.3.4.24 Online courses with telephone conferences

Sometimes, on-line courses include telephone conferencing opportunities for discussion in small groups. Instructors who use telephone conferencing for small group discussions should allow alternative communication (e.g.: e-mail) that is accessible to everyone in a specific group. Or, a student who is deaf might be able to participate in a telephone conference by using the Telecommunications Relay Service (TRS), where an operator types what the speakers say for the deaf student to view on his text telephone (TTY) and translates his printed input into speech, however this system might be too slow to allow participation in

lively conversations. Another accommodation involves setting up a private chat room on the Web. A transcriptionist types the conversation for the deaf student to view. The student can also type his contributions into the chat room and they can be voiced by someone in the group who is monitoring the chat room. Various options should be discussed with the student who has a need for an accommodation.

3.3.5 Proposed formats for accessible content in DE

Based on the above analysis and our long-term experience, we propose the formats in Table 4 to support accessible content in DE in the framework of the InSIDE project.

Table 4. Proposed formats for accessible content in DE

	Blind students	Students with LowVision	Deaf and hard of hearing students	Students with Dexterity impairment
Web pages (.html, .xml)	+	+	+	+
Rich Text Format (.rtf)	+	+		+
PDF accessible (.pdf)	+	+		+
Digital Talking Book DAISY3	+	+		+
ePUB 3.x	+	+		+
Large print (.docx)		+		
Braille Ready File (.brf)	+			
Tactile Diagrams (.jpeg, .psd)	+			
Plain text (.txt)	+	+		+
MS-Word (.docx)	+	+		+
MS-Power Point (.pptx)	+	+		+
LaTeX (.tex)	+	+		+
Video with captions (.srt)			+	
Signed video			+	
Video with transcript (.txt)			+	
Video (or audio) description	+	+		
MathML	+	+		
MusicXML	+	+		

ChemML	+	+		
R data (.rdata, .rda)	+	+		+

3.3.6 Web 2.0 Tools

Ajjan and Hartshorne (2008) argued that Web 2.0 tools are a new trend of internet technologies which have many characteristics that support teaching and learning. There have been many studies about technology usage in education though and in particular DE, majority of them are limited to delivery of content and teaching course subject. Although they underlined that it is important to explore student and faculty awareness and use of Web 2.0 technologies, there have been limited studies about it.

Blogs: Blogs are also called online diaries which enable users, without requirement of any technical skill, to create, publish and organize their own web pages that contain dated content, entries, comments, discussion etc. in chronological order (Alexander, 2006; Castenade, 2007). People can publish information which they collect from various resources and establish relation between them in blogs. Additionally, RSS and the possibility to post comments make blogs also a collaborative and social-interactive software application (Petter et al., 2005).

As blogs are very easy and flexible tool for using, they are being utilized in various fields with various purposes. Especially, since blogs have various educational advantages, number of researches and studies in educational usage of blogs increased. It is suggested that blogs enhance writing skills, facilitate reflecting themselves, encourage critical thinking with collaborative learning, and provide feedback and active learning (Seitzinger, 2006). Blogs are well suited to serve as online personal journals because they enable students sharing files and resources and publishing blogs on the Internet and students has the possibility of writing for reader beyond classmates (Godwin, 2003). In addition, blogs can be used as e-portfolios that keep records of personal development process, reflections and achievement (Lu, 2007).

Wikis: According to Leuf and Cunningham, creators of the original wiki concept, “a wiki is a freely expandable collection of interlinked Web pages, a hypertext system for storing and modifying information- a database where each page is easily edited by any user with a form-capable Web browser client” (Schwartz et al., 2004). Users can visit wiki, read and add content to wiki or update and organize content (text, image, video, link…) or structure of wiki (Augar et al., 2004). As wikis are free open source software, no one authorizes the creation of wiki pages and everyone is automatically authorized to write, edit and publish (Fountain, 2005).

As blogs, wikis are also attracted attention in educational field for their advantages and usability, and studies about using wikis in education have increased. Wikis are considered to be effective tools for learning and teaching as they facilitate collaborative learning, provide

collaborative writing, support project-based learning, promote creativity, encourage critical searching, support inquiry based and social constructivist learning (Cress & Kimmerle, 2008; Guzdial et al., 2001; Yukawa, 2006). Schwartz et al. (2004) has listed selection criteria of wikis for educational uses under 6 heading; cost, complexity, control, clarity, common technical framework, features. Some of other educational usage of wikis are also suggested as classroom websites, easy course administration and timetabling, easy online updating content, online dictionary, student feedback and self-assessment, bibliographically organized class or group projects, virtual classes for online collaboration, creating frequently asked questions (FAQ) for classroom or students (Konieczny, 2007; Lamb, 2004; Zeinstejer, 2008).

Podcast: The term of podcast is constituted of words of iPod (portable digital audio player form apple) and broadcasting and they are basically digital audio programs that can be subscribed to and downloaded by users via RSS and listened to on either a variety of digital audio services or desktop computer (Petter et al., 2005). With on demand nature and portability features, podcast allows users to catch up on audio content while completing other tasks without having to sit at a computer. They also have some limitations as being linear and one way, which is why they need to be integrated with blogs, online simulations and other more interactive channels (Kaplan-Leiserson, 2005).

Especially as podcasting is being used with mobile devices, it can be viewed as another variant of mobile learning. Because of the time and cost resources are limitations for mobile learning, podcasting can be an alternative (Kaplan-Leiserson, 2005). Although podcasting is not a synchronous activity, it provides students information that will help them feel connected to learning community and this may be even pedagogically appropriate in some courses to allow students to create their own podcasts for the rest of the class members (Beldarrin, 2006).

Social Networks: Social networks are software that support collaboration, knowledge sharing, interaction and communication of users from different places who come together with a common interest, need or goal (Pettenati & Ranier, 2006; Brandtzæg & Heim, 2007). Social networks are also known as range of applications that augments group interactions and shared spaces for collaboration, social connections, and aggregates information exchanges in a web-based environment (Bartlett-Bragg, 2006).

Social networks can also be viewed as pedagogical tools that stem from their affordances of information discovery and sharing, attracting and supporting networks of people and facilitating connections between them, engaging users in informal learning and creative, expressive forms of behavior and identity seeking, while developing a range of digital illiteracies (Lee & McLoughlin, 2008).

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