Abstract—E-Learning systems and tools are known and applied in both academia and industry. The interest in E-learning is shared by many stakeholders and from different views. Researchers and designers, however, have not, yet, agreed about a standard definition regarding e-learning. The systems for e-learning have a common target to deliver specific material/knowledge to predefined users via a remote electronic media. However, the detailed structure and communication tools divert widely according to several parameters and requirements. Accordingly, e-learning systems could be categorized into several facets. One natural perspective of these facets is that of systems engineering. It is a triangular perspective that considers e-learning system from three different, but, interacting angles of view. Those angles are shaped by the three triangle’s edges, namely: the raw materials (Knowledge and literatures), the technology (software and/or hardware tools) and the learner as the ultimate user. Designers manipulate raw materials through the utilization of the technology to provide users with the best possible systems for learning acquisition.

The objective of this study is to provide a higher view on E-learning tools and techniques by categorizing them depending on their interrelationships. The study gathered various tools and their characteristics and uses. It also surveyed different views of interest in those tools. Accordingly, the study represented tools, education techniques, together with relationships in an integrated structure. It is our belief that providing such a global vision should help designers, users, and researchers for better realization of the tools in the field and to assist in finding gaps as well as providing grounds for integrating tools to reach higher level service.

Keywords--- E-Learning, E-learning, E-learning Technology, Learning theories, Learner, LMS and Triangular perspective

I. INTRODUCTION

Electronic learning (e-Learning/online learning), is a type of education where the medium of instruction is the computer technology. While, "E-learning" refers to computer-enhanced education, it is extendable to emerging technologies such as mobile computing (m-learning) and Personal Digital Assistants (PDAs). E-learning may include the use of web-based technologies, including blogs, polls (electronic voting systems), simulations, games, and Wikis.

The concept of e-learning has different interpretation among the different institutes and schools of thought. (Universities, Industries, companies and users). Even, within its diverse disciplines, e-learning has different meanings to different people. For instance, in companies it often refers to the utilization of local network strategies to deliver training courses to employees. In most universities e-learning is used to define a specific mode of education, in which a student attend a course or program of study, on-line, across the campus network [1].

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It, also, has different understandings with respect to the encountering roles. For an instructional designer e-learning, often, means courses materials that were directed to meet a specific objective within the larger scope of program development. A corporate trainer may view e-learning as a combination of courses and knowledge management. Neither the industry, nor the academic professionals, however, view e-learning with the same perspective [2]. In a general term, e-learning stands for all forms of Internet-enabled and/or computer supported learning [3]. It refers to the use of computers, mobile devices and network technologies to create, deliver, manage and support learning. E-learning service, therefore, may be attained independent of neither specific locations nor predefined time schedule. It may involve complete online courses, with all aspects of learning (From enrollment to tuition and support) or, merely, the learning resources available in digital format online or offline.

A triangular perspective for the e-learning system may accommodates the need of the industry as a market tags, companies as training/development domain and the academia as domains of education and research. Fig. 1, illustrates the triangular perspective of e-learning.

The following sections are targeted to classify the different systems and approaches of e-learning from the triangular perspective with respect to different views. Section II, discusses the ultimate and the base of the triangular perspective; the users. Section III, discusses e-learning technology, as the brick of building tools and equipments. Section IV, presents knowledge as the third edge of the triangular perspective of e-learning systems. Section V, demonstrates the e-learning activities and features of the current e-learning systems over the e-learning triangle. Conclusion is presented in sections VI followed by references.

II. USERS OF E-LEARNING

Focusing on the learners, three major trends of learners can be distinguished; formal academic students, self learners and employee trainees. These categories share major needs of accessing required material and possessing tools that enhance studying process and self assessment. Yet, learning types have different scopes and various levels of learner engagement and interaction. Therefore, each type of learners has its own needs that are listed as follows:

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1. **Formal Student**: Enroll & access courses as set by the academy and the tools needed to facilitate students’ participation. The needs of students to be engaged with instructors and peers to achieve the activities set by the instructors within the targeted academic domain.

2. **Work Trainees**: have similar needs to those of a formal student regarding satisfying organization objectives from the program besides achieving required activities. Real time collaboration, however, is of more interest in corporate training programs. Also, the learning domain is more specific as set by the organization.

3. **Self learner**: Which is a very generic type as self learning occurs at any time anywhere and for various reasons within any domain. That enforce the emphasis over enhancing search process and personalized tools. The level of learner-instructor’s interaction, however, is minimal if any.

Users, includes learner, instructors, trainee and systems administrators targeting at acquiring knowledge to satisfy learning process objectives via different technologies.

### III. E-LEARNING TECHNOLOGY

Technology, comprises the second edge in the suggested triangular perspective of the e-learning system. This edge includes the tools and equipment being utilized in the learning process. (books, papers, blackboard,…, cassette, tapes, CDs, mobile phone,…, e-book). Focusing on the electronic technologies, however, there are three main elements; software, hardware, network protocols and security measures. Those elements are to be discussed in subsection A. The technology side of the e-learning triangle, impacts and influences learning theories, which is the ground of the pedagogical science [4]. Therefore, technological advances should be regulated with the pedagogical learning theories in order to obtain a reliable learning environment. A chronological illustration for the progress in pedagogical theories and the technological impacts is presented in subsection B.

#### A. E-Learning Technological Elements

The main elements of e-learning technologies are:

1. **Software**: Different software technologies are available to present required contents; various digital formats, graphical simulations and a variety of delivering tools and enhancing programs. Those tools includes, Learning Management Systems (LMS), Learning Content Management Systems (LCMS), Virtual Classrooms (VC), Course Authoring Tools (CAT), Courseware vendors and infrastructure and supporting tools. These software tools may be vendor related or developed within an open source community. They are oriented, either, towards corporate training, or academic education. The categorization of the software tools proposed here is adopted to an extent from Don McIntosh views [5], and Trimeritus [6], which provides a comprehensive list for these tools. They cite some of the most famous products, a list of current vendors and open source products that are available in the market to date and updated regularly [7]. The functional features of each category of these tools are discussed thoroughly and presented within the triangular view in section VI. These tools and programs are implemented to manage the learning process depending on the organization nature, user needs, hardware and the available protocols.

2. **Hardware**: Are the utilized devices, whether to host the e-learning system, or to host the user. PCs are the default clients whether desktops or laptops. Recently, however, m-learning has been in focus using smart phones and mobile devices. The main parameters here, set by the accessing device, are storage and processing capabilities.

3. **Network Protocols & Security Measures**: Different types of the network connections and protocols are available to host platforms. The mode of connection and security level defines the domain and the access limitation (local area networks vs. physical location of users).

SAAS (Software as a service) is a recent trend that combines designing the required service and hosting it externally at a third party. Security measures are based on the organization policies, that determine which users are allowed access and what data to reveal.
B. Learning Theories and E-learning Technologies

Not only, Technologies sustain e-learning progress, but, it also, impact and influence the learning theories. The pedagogical studies have introduced several learning theories [8]. The major learning theories could be specified as follows:

1. Behaviorism or Individualism: Where learning is regarded as an Instructor oriented process.
2. Cognitive orientation: Where learning process is more involved with cognition - the process of knowing.
3. Constructivism: Where learner is viewed as the ultimate user with more emphasis on student engagement and interaction.
4. Connectivism or Socialism: The new evolving theory by Siemens [9], where learning is regarded as a social process happening all the time everywhere.

Tracing of the history of the pedagogical learning theories combined with the features regarding technologies achievements and their impacts and interactions, revolve around the following:

- Instructor-Led Training Era (*ILT*) (Pre the 1980’s)
  
  Before computers were widely available, *Behaviorism* learning theory instructor-led training (*ILT*) was the primary training method. *ILT* allows students to focus on their studies and to interact with their instructor and classmates. *ILT*, however, meant high costs and downtime, which motivate training providers to search for better ways for training.

- Multimedia Era (The 80’s & early 90’s)
  
  GUI operating systems (Windows 3.1, Macintosh), CD-ROMs, presentation programs (PowerPoint) marked the technological advancement of the Multimedia Era. In an attempt to make training more transportable and visually engaging, courses were delivered via CD-ROM. The *Cognitive orientation* of CD-ROM, provided time and cost savings (over *ILT*) and helped to reshape the training industry. Despite these benefits the CD-ROM courses lacked instructor interaction and dynamic presentation.

- Web Infancy (UP to 1997)
  
  As the Web evolved, training providers adopt this new technology to improve and enhance the learning/training process. The advent of email, newsgroups, web browsers, HTML, media players, low fidelity streamed audio/video and simple Java changed the face of multimedia training. Basic mentoring via email, intranet Computer Based Trainings (CBT), with text and simple graphics, and web-based training, allowed the emerging of asynchronous online courses and distant learning. The *Constructivism learning* approach was established by involving the learners in the learning process.

  
  Technological advance including Java/IP network applications, rich streaming media, high-bandwidth access, and advance Web site design, radically, changed the training industry. Today, live instructor led training (*ILT*) via the Web...
can be integrated with up-to-date technology to create effective and multi-dimensional learning environment. That is achievable by utilizing real-time mentoring, improved learner services and up-to-date engaging content.

The current era can be divided into two main intervals, each of which has 2 major characteristics regarding the industry:

- **Learning management systems, content management and standards. (1997-2004)**

  Evolution of learning management systems where webCT and blackboard [10], were founded in 1997 and 1998 respectively. This evolution are enhanced and demonstrated in several open source projects and vendor related programs. These sources include, but not limited to, moodle [11], claroline [12], and sakai [13]. Virtual classroom and collaborative tools were born (online presentations delivered live) as an online learning platform and classroom. These tools crafted the Constructivism learning approach, because they enforce more learners' engagement. Fig. 2 illustrates the transition-in the learning process - from individualism to constructivism through e-learning system.

- **E-learning 2.0 (2005 and going on)**

  Evolution of web2.0 leading to what is currently being known as e-learning 2.0. The increased interactions in social networks, blogs, wikis and other features of web 2.0 are injected into the learning process. And, hence, into the industry of e-learning paving the way for the emerge of the Socialism learning theory. Graphical technologies are, continuously, advanced allowing for the practical usage of 3D-Learning. Life excessive usage and simulation of real life environments is a current research topic. There are great expectations about the impact of web2.0 and 3D technologies in the e-learning field.

  - Excessive usage of mobile devices is overtaking integrated desktops. These sophisticated training solutions provide greater cost savings and higher quality learning experiences. It, also, formulates the standards for the education of the future. M-Learning is the term for mobile learning, which, is considered as a trend of its own in the industry.
IV. KNOWLEDGE IN E-LEARNING

Learning, generally, aims at passing a theme of knowledge to learners. Knowledge content varies with objective of the theme, and modulated according to the learner and the available technologies. Therefore, knowledge as raw material should be amenable to be represented internally and demonstrated externally, under predefined rules of encounter as discussed in the following subsections.

In particular, e-learning, has several mode of attendance. It could be through life interactions of several collaborative groups (synchronous/asynchronous) e.g., through video conference or discussion board. It could, also, be via a hosted e-learning system or it could be embedded as help/illustration tags.

A. Internal Representation:

Internal representation specifies the hierarchy and the categorization of the knowledge (learning resources) and how to store, access and retrieve its contents. It depends on the specific subjects under study and the mode of delivery. It may be static, dynamic or reactive body of knowledge.

It may be represented and stored as a data base system [18], a rule based driven system, an expert system, a set of indexed files, set of web pages with a search engine, knowledge management system or as an ontology based system. These repositories and managing systems are targeted to facilitate indexing, retrieving and accessing the learning resources as per request.

B. External Demonstration:

External demonstration declares how the teaching process is accomplished, and what are the media being used to demonstrate and explain the required content to the learner. It includes user interface, types of connection, types of web networks and graphical technologies. The external demonstration is, largely, impacted by the organization objectives and learner type. The external demonstration of an LMS in academia will differ to a great extent from a corporate making use of a real time collaborative system (virtual meeting programs). It differs, also, from ubiquitous e-learning theme which is the main theme adopted by a self study learners.
C. Rules of encounter:

Rules of encounter are concerned, mainly, with the pedagogical rule, the specific user (learner), and the organization’s policies. It includes, but, not limited to:

- Abstraction: Level of knowledge abstraction,
- Pedagogy: Strategies or the styles of teaching
- Authentication rules: rules that guarantees persons identification, information validation and the originality of the resources.
- Timing Constraint: constraints that determine when a specific material is to be published, for who and for how long.
- Policies of Interaction and Assessment Tracking: rules that define the scope and complexity level of the materials depending on the learner, and the pedagogical rules. It also defines the rules of assessment and evaluation of the learner.
- E-learning Standards Compliance: complying to one of the current e-learning standards mention previously. It may be adopted by the organization to ensure interoperability and reusability
- Privacy and Security: It specifies the privacy of critical information, the security of the knowledge and its authentication.

It is worthy, to refer to the work presented by Siemens [19], where he classifies e-learning -from a learning point of view- into seven categories.
1. Courses
2. Informal learning
3. Blended learning
4. Communities
5. Knowledge management
6. Networked learning
7. Work-based learning (EPSS)

These categories could, rather, be viewed as knowledge acquisition modes.

V. E-LEARNING SYSTEMS: TRIANGULAR PERSPECTIVE

E-learning systems are the systems that encompasses all learning processes. It comprises all three sides of the triangular perspective. In this section, the main features of the e-learning systems are presented along with its venue in the e-learning triangle. The status of every feature is checked within each side of the proposed triangle as shown in Table I. Considering the technology side of the triangle to be the current available tools, Table II, illustrates their capacity regarding e-learning features. Table III, however, illustrates the reflection and impact of those technological tools in the other two sides of the e-learning triangle; learners & knowledge.

A. E-Learning Features In the Triangular Perspective:

The following are the features of the e-learning systems and its mapping into the proposed triangle perspective of e-learning systems as illustrated in Table 1.

- Content development and authoring: knowledge is externally demonstrated within available technologies.
- Content management and storage: knowledge is internally represented as digital files of some format that is convenient for storing and retrieval.
- Libraries and repositories: knowledge is stored internally using the appropriate technology
TABLE 1
E-LEARNING FEATURES WITHIN THE TRIANGULAR PERSPECTIVE OF E-LEARNING

<table>
<thead>
<tr>
<th>Feature/Triangle perspective</th>
<th>Learners</th>
<th>Techs</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content development and authoring</td>
<td>0</td>
<td>1</td>
<td>Ext.(^a)</td>
</tr>
<tr>
<td>Content management and storage</td>
<td>0</td>
<td>1</td>
<td>Int.(^b)</td>
</tr>
<tr>
<td>Libraries and repositories</td>
<td>0</td>
<td>1</td>
<td>Int.</td>
</tr>
<tr>
<td>Calendar</td>
<td>1</td>
<td>0</td>
<td>Rules(^c)</td>
</tr>
<tr>
<td>Participation &amp; communication requirements</td>
<td>1</td>
<td>1</td>
<td>Rules</td>
</tr>
<tr>
<td>Real time collaboration</td>
<td>1</td>
<td>1</td>
<td>Rules</td>
</tr>
<tr>
<td>Assessment activities</td>
<td>1</td>
<td>1</td>
<td>Rules</td>
</tr>
<tr>
<td>Monitoring activities</td>
<td>1</td>
<td>1</td>
<td>Rules</td>
</tr>
<tr>
<td>Personalized study tools</td>
<td>1</td>
<td>1</td>
<td>All aspects</td>
</tr>
<tr>
<td>Interface &amp; navigation</td>
<td>0</td>
<td>1</td>
<td>Ext.</td>
</tr>
<tr>
<td>Administration specs</td>
<td>0</td>
<td>1</td>
<td>Rules</td>
</tr>
<tr>
<td>Supporting standards for interoperability purposes</td>
<td>0</td>
<td>1</td>
<td>Int.</td>
</tr>
<tr>
<td>E-commerce or other enhancing features (not directly related to learning objective)</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^a\) External Demonstration, \(^b\) Internal Representation, \(^c\) Rules of Encounter, ‘1’: Active, ‘0’: Passive agent

- Calendar: which govern, schedule, and time the interactions between the triple set of courses, learners and events. Those interactions are supervised under some rules of encounter.
- Participation and communication: this feature involves learners interaction with each other through technology (whether synchronous, like instant messaging and chat, or asynchronous, like forums, emails and discussion boards). This activity is, also, subjected to the rules of encounter.
- Real-time collaboration: which is a virtual classroom that involves high level of technologies in order to simulate learners’ interactive environment (Class). It is, also, subjected to rules of encounter.
- Assessment activity: It involves assessing knowledge gained by learners through assignments, exams and quizzes. Which are delivered through the system tools (technology). It is, also, governed by the rules of encounter.
- Monitoring activity: It keeps up a log for learners activity records (knowledge) and monitor their usage of the system (technology). Therefore, rules of encounter are essential.
- Personalized study tools: Namely, bookmarks, search facilities and noting tools. It involves all three knowledge aspects; how internally stored and externally represented and rules of encounter for using those tools.
- Interface and navigation: It is an essential feature of any system. It utilizes a web development tools to represent the main external frame. Through this main frame, knowledge themes are transferred.
- Administration specifications: it is not available for a self study learner type and doesn't involve academic or corporate learners. Technologies, however, are utilized to satisfy system administrator needs to enforce rules of encounter as per organization policy.
- E-learning standards compliance: It is supporting standards for interoperability & durability purposes. Here, the technological leg is concerned with how learning resource as knowledge in focus is internally represented.
Extra enhancing features that are, not directly, oriented towards learning process objective. Yet, it facilitate the learning process by adding appropriate plug-ins and tools to the system.

Table II
E-Learning Features and Software Tools

<table>
<thead>
<tr>
<th>Feature/Tools</th>
<th>LMS</th>
<th>LCMS</th>
<th>VC</th>
<th>CAT</th>
<th>CWV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content development and authoring</td>
<td>A-Os</td>
<td>A-Os</td>
<td>0</td>
<td>Main</td>
<td>Preset main</td>
</tr>
<tr>
<td>Content management and storage</td>
<td>A-Os</td>
<td>Main</td>
<td>0</td>
<td>A-Os</td>
<td>0</td>
</tr>
<tr>
<td>Calendar</td>
<td>Main</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Participation &amp; communication</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Real time collaboration</td>
<td>A-Os</td>
<td>0</td>
<td>Main</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Monitoring &amp; assessment activities</td>
<td>Main</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Personalized study tools</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Add-ons'. '1': Feature is mandatory. '0': Feature is not included

B. E-Learning Features and Software Tools:
Each of the current available software tools are carved to provide a set of e-learning features. In some of these tools, however, the features are not sufficient to cover all the facets of e-learning. Table 2, illustrates a mapping of the main features of the e-learning system into the current five categories of software tools. Namely: LMS (Learning Management Systems), LCMS (Learning Content Management Systems), VC (Virtual Classes), CAT (Course Authoring Tools) and CWV (Courseware Vendors). Table II, shows the main functional features of each software tool, the mandatory features, those features that may be appended as an add-ons' and those that are not included.

C. Software Tools in the Triangle:
The effectiveness of the proposed triangular perspective may be demonstrated via the mapping of the technology edge of e-learning (tools) with the aspects of the other two edges of the triangle (learners and knowledge). Table III, shows the technology tools versus user types and knowledge representation within each of those tools. The technology edge is demonstrated through the five categories of software tools plus internet. It can be summarized as follows:
- LMS: It involves both academic and corporate learners. It helps in tracking and managing the knowledge transfer process externally, while, enforcing the rules of encounter.
- LCMS: It involves both types of learners. It helps in triggering some rules of encounter that are related to the content. This software category focuses on managing the knowledge as contents, which is the analogy of knowledge internal representation.
- VC: Real time collaborative tools are applicable among corporate rather than academic organization (where normally physical class attendance is a must). These tools trigger a set of rules of encounter that are directed for external demonstration of knowledge.
- Authoring Tools and Courseware: Vendor tools are similar in targeting external demonstration of knowledge. They supply the required content in a digital format. They, both, are amenable to be used by self learners. Yet, courseware vendor tools are
adopted by corporate, while, authoring tools are adopted by academia. Naturally, academia community would prepare and author its own courses, while, corporate buy preset training courses.

- Internet (The cloud): Typically, involves all kinds of learners as searching and locating resources from the internet is a default activity. Knowledge is represented externally within located resources. Internal representation, however, is embedded within the cloud structure. Rules of encounter would be applied whenever necessary to guarantee data integrity, security and authentication.

### TABLE III

CATEGORIES OF SOFTWARE TOOLS VS. THE ASPECTS OF THE TRIANGLE PERSPECTIVE

<table>
<thead>
<tr>
<th>Tech. as Tools</th>
<th>Learners</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMS</td>
<td>Academic/corporate</td>
<td>Rules(^a) and Ext(^b).</td>
</tr>
<tr>
<td>LCMS</td>
<td>Academic/corporate</td>
<td>Int. and Rules</td>
</tr>
<tr>
<td>VC</td>
<td>Corporate rather than academic</td>
<td>Rules and Ext.</td>
</tr>
<tr>
<td>Authoring Tools</td>
<td>Self &amp; academic rather than corporate</td>
<td>Ext.</td>
</tr>
<tr>
<td>Courseware</td>
<td>Self and corporate rather than academic</td>
<td>Ext.</td>
</tr>
<tr>
<td>Internet</td>
<td>Academic, corporate and self learners</td>
<td>Ext., Int., and Rules when applicable</td>
</tr>
</tbody>
</table>

\(^a\)Rules of Encounter. \(^b\)External Demonstration, \(^c\)Internet representation

### VI. CONCLUSION

A good understanding was needed for the interrelationships between technologies, knowledge as raw material and learner types. Accordingly, this paper presents new perspective for the definition of e-learning systems. It presents triangular perspective that classifies the processes of e-learning according to user types, knowledge under study and the tools provided to introduce such knowledge to the specified user.

This perspective, constructs a framework that could help designers in specifying a precise prototypes that satisfies design requirements. It may, also, assist organizations’ decision makers in determining the set of tools that, best, meet learner’s needs and organization vision. Users and self learners could benefit from this perspective, as well.

The effectiveness of the proposed triangular perspective is demonstrated via:

- The integration of the e-learning features within the angular perspective as presented in Table I.
- The mapping of triangular perspective into the current technology, and its interrelationships within the categories of the available software tools, as presented in Table III.

It is our belief that providing such a global vision should help designers, users, and researchers for better realization of the tools in the field and to assist in finding gaps as well as providing grounds for integrating tools to reach higher level service. It also provides common grounds for interaction among technical and pedagogy teams through common understanding of tools and their roles in the educational process.
REFERENCES


