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An Evaluation Instrument for E-learning Ecosystem

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Abstract— E-learning is now an acceptable medium of teaching and learning. The research development in this area has focused considerably in the technological and learning cognitive aspects such as assessing learning styles for individualized learning. These past work are vital to ensure continuous improving in e-learning systems. Given the long-standing research and development in e-learning, it is also necessary now to closely examine and evaluate the appropriateness of e-learning as a learning environment. In order to design a more effective learning environment, educators must now equip themselves with proper evaluation instrument. This paper will discuss the up-take of e-learning systems and e-learning ecosystems. A sustainable framework for e-learning ecosystems will be discussed. An instrument consisting of 4 elements or scales of Access, Interaction, Response and Results to evaluate e-learning systems is also discussed. This paper concludes with discussion regarding further work in this area.

Index Terms—e-learning, e-learning ecosystem, e-learning evaluation, e-learning model

I. INTRODUCTION

In today's educational context, the delivery of education via e-learning is widely implemented and accepted. This mode of education delivery is sought after by learners and many educators now accept and use this learning environment. As e-learning and technologies advanced significantly, educators are developing sophisticated e-learning systems. In the past, research development in this area was focused mainly on technological aspects, e-learning for individualized learning, and frameworks or models to support e-learning. These past research work are important and necessary in order to continuously improve and enhance e-learning systems. Given the development and advancement of e-learning, the opportunity now exists for educators to look closely at the effectiveness and appropriateness of an e-learning environment. Educators need to equip themselves with learning instruments that allow the effectiveness of e-learning to be evaluated.

E-learning is crucial to the success of institutions and businesses if the desire is to remain competitive. The ultimate goal of e-learning is to impart knowledge and skills that the business needs in a productive and cost-effective way. To develop effectual e-learning, organizations need guidance and feedback from users to improve their e-learning systems. Continuous improvement is critical to ensure the viability of any e-learning systems. A successful e-learning

system is designed on a sustainable framework which includes pedagogical frameworks, technical platforms, and organizational structures.

This paper discusses the various components required for a successful e-learning system. To start off with, Section II provides a brief overview of e-learning systems, followed by an overview of e-learning ecosystems in Section III. Section IV describes a dynamic and flexible model which underpins an e-learning ecosystem. This will be followed with the learning elements required for an e-learning course in Section V and a rationale for a learning instrument to examine the effective usage of the e-learning system in Section VI. This paper concludes with discussion regarding further research in this area.

II. E-LEARNING SYSTEMS

E-learning is a terminology that is synonymously associated with learning technology [14]. It is the use of networked information and communications technology (ICT) to extend, enhance and enrich learning activity.

With the maturity of e-learning, many organizations have spent a considerable amount of resources, time and money to design the content and integrate a variety of learning systems in order to impart knowledge and skills to learners. Some organizations have found the implementation of e-learning systems a challenge [2].

If e-learning is to be effective in providing greater access to education and support educational programs that reflect broader strategic goals, it is important that the e-learning systems are designed based on a sustainable framework with sound learning pedagogy and a networked of information and communications technologies. In addition, it is also vital that the e-learning systems are assessed and evaluated. As learned from past research, the feedback gained from learners is valuable and important.

III. ECOSYSTEMS

An *ecosystem* is defined as a “*complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space.*” [6]. The term ‘ecosystem’ was originally coined by British ecologist A.G. Tansley, who defined it as ‘*a biotic community or assemblage and its associated physical environment in a specific place*’ [14].

The definition implicitly highlights the existence of *interactions* among the biotic (living) and abiotic (non-living) components, as well as intrinsically within various highly-complex components.

A. Digital Business Ecosystem (DBE)

A natural ecosystem is a biological community of interacting organisms and their physical environment [6]. Conversely, a business ecosystem is a network of buyers, suppliers and makers of related products or services and their socio-economic environment that includes institutional and regulatory framework. A digital ecosystem is a self-organising digital infrastructure aimed at creating a digital environment for networked organisations that supports the cooperation, the knowledge sharing, the development of open and adaptive technologies and evolutionary business models. Figure 1 shows a multi-layer of digital business ecosystem (DBE).

According to Nachira [7, 8], the key elements of a business ecosystem (top-most layer) include 1) governance, regulations and industrial policy, 2) human capital, knowledge and practices, 3) service and technical infrastructure, and 4) business and financial conditions.

B. Learning Ecosystem (LES)

Pickett & Cadenasso's [17] insights on the applicability of the ecosystem concept to 'any system of *biotic* and *abiotic* components *interacting* in a *particular spatial area*' led Chang & Guetl [18] to leverage the power of Tansley's generic definition and apply the idea of the ecosystem to the learning domain. The resulting learning ecosystem framework (see Fig. 2) stands out as a generic model that is useful in identifying the key contributors to organisational learning processes.

The LES is valuable as a conceptual framework for identifying and examining the relationships and interactions among people and technology within a firm, to expose the extent of the effectiveness of collaboration, information flow and knowledge transfer. The key to maintaining a positive learning environment is to 'improve the ecosystem as a whole', which in practice, refers to incorporating user-centric collaborative learning, technological innovation, content and learning design and environmental conditions to help learners respond to uncertain conditions [18].

C. E-Learning Ecosystem (ELES)

An e-learning ecosystem is the learning community, together with the enterprise, united by a learning management system (LMS) [2]. According to Looi [1] a learning ecosystem was formed by different communities interacting within and between individuals and groups, other key aspects (environment as well as tools and artefacts) are addressed implicitly. The principle of ELES focuses mainly on the learning environmental aspect around a group of participants

concentrating on the learning process. The fundamental of ELES is to also address an evolutionary learning community ecosystem in the context of learning and design conversations. ELES also focuses on the technological viewpoint. The components of ELES are further explained in Section IV.

D. Integrating ELES and DBE

Moore first introduced the concept of a business ecosystem as a strategic plan [11]. Moore indicated that organisations form part of a business ecosystem and as such should be viewed as a collective rather than an individual entity. In a business ecosystem that crosses a variety of industries, organisations cooperate, compete, and co-evolve capabilities around a new innovation, support new products, satisfy customer needs, and eventually incorporate the next round of innovation. It is this 'business ecosystem' that a sustainable framework for a dynamic e-learning ecosystem model is based upon.

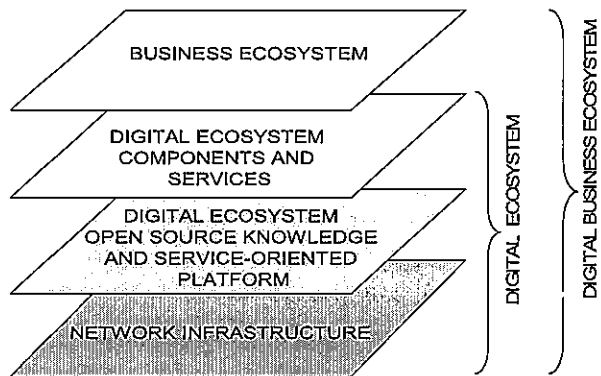


Fig. 1 Multi-layer digital business ecosystem (after Nachira [7])

For a dynamic e-learning ecosystem model to be sustainable in any institutions or organizations, it must consider aspects of a DBE that include (1) a variety of industries, (2) co-evolve capabilities of the e-learning system, (3) continuous support of the e-learning system, (4) customers or users' satisfaction, and (5) evolutionary learning that will lead to the improvement of the e-learning system. A dynamic model incorporating 1, 2, 3 of the above will be discussed in the Section IV and points 4 and 5 in Section VI.

IV. SUSTAINABLE FRAMEWORK FOR A DYNAMIC E-LEARNING ECOSYSTEMS MODEL

According to Brodo [10], the term e-learning ecosystem is used to describe all the components required to implement an e-learning system. These components, as shown in Fig 2, fall into three categories: content providers, consultants, and infrastructure.

Chang and Guetl [18] refined Brodo's components of e-learning ecosystem by delineating a comprehensive building block required for e-learning development.

The elements as shown in Figure 3 are (1) the *learning communities and other stakeholders* (referred to as biotic units) such as teachers, tutors, content providers, instructional designers and pedagogical experts (2) the *learning utilities* (referred to as abiotic units) or the *learning environment* includes the learning media (content and pedagogical aspects), technology, and tools applied in traditional teaching methods, (3) the *learning environmental borders* of physical and logical boundaries of the e-learning system, and (4) the *learning ecosystem conditions* of external and internal influences, such as evolution of knowledge, educational goals, learning tasks, cultural and sociological aspects, and expectations by society, private industry, profit and not-for-profit organizations, and the government.

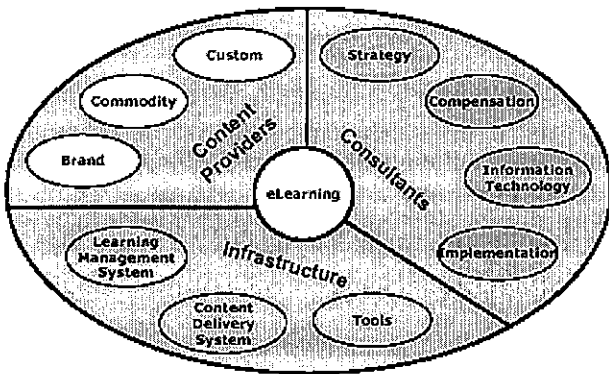


Fig.2 Brodo's e-learning ecosystem component [10]

It is the author's view that Fig. 3 constitutes a sustainable e-learning ecosystem model that considers and satisfies all aspects of a digital business ecosystem. A description of each component of the dynamic model of (1) the learning communities and other stakeholders, (2) the learning utilities, and (3) the learning conditions as shown in Fig 3 is as follows:

A. The Learning Communities and Other Stakeholders in E-Learning Ecosystem

The learning communities can either be individual or groups of individuals who can interact and collaborate synchronously and asynchronously with one another. The individual's learning attributes include the learning styles, learning strategies, learning preferences, learner's pre-knowledge and competency level, and other learning characteristics specifically related to the individual. Other stakeholders are those who play significant roles related to teaching and learning, specifically they are the teachers, tutors, knowledge experts, content providers and pedagogical experts who oversee the pedagogical aspects of learning and the instructional designers who handle the information and design of the content. Associated with these stakeholders

are the IT support group who provide the IT infrastructure and platform for the e-learning activities. They also administer and manage the IT to support the teaching and learning group.

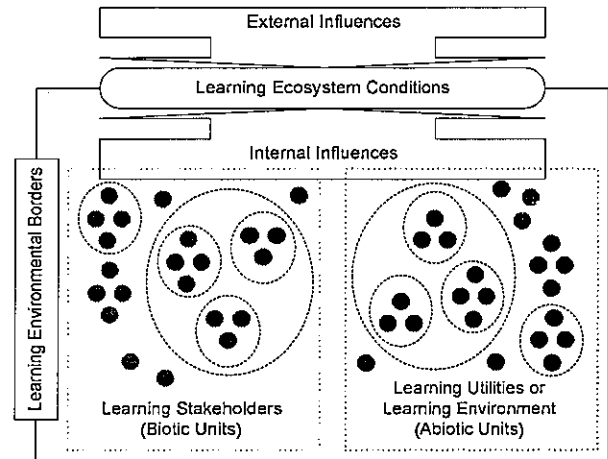


Fig.3 A dynamic model for the e-learning ecosystem [18]

B. The Learning Utilities in E-Learning Ecosystem

The learning utilities include the static and dynamic learning media that contain the content and pedagogical aspects. In addition, background knowledge in the form of external sources such as wikipedia, digital libraries, and others are also part of the learning utilities. The technology may include the infrastructure and learning platform for the management, delivery and tracking of e-learning in the form of learning content management system (LCMS), learning management system (LMS) and content delivery system (CDS). Laptops, desktop computers, podcasting, PDA are also examples of some of the learning utilities.

C. The Learning Ecosystem Conditions of E-Learning Ecosystem

The learning ecosystem conditions characterize important parts of an ecosystem learning system and they are affected by external and internal influences. In general these conditions are dynamic and ever-changing, but potential impacts on the system depend on the lifecycle of the examined system. The conditions may be driven by the industry to employ workers with outstanding skills, influenced by domain knowledge and government policy such as changes to the educational learning strategy or changes in course curriculum. Challenges that affect the core of the e-learning ecosystem must be addressed. There are also other factors such as cultural and sociological influences that must be considered.

V. E-LEARNING COURSE MATERIALS

According to Cowley, et al [3], a successful e-learning course requires taking the following contextual elements into consideration:

- **Environment** – learners need a certain environment (PC, connection, software) and some preparation needs to be done to make sure that the student has that
- **Teaching of skills** – learners need to know something about how to use whatever learning system exists
- **Subject matter skills** – learners need to have some pre-requisite skills to benefit from the course
- **Support** – there has to be a mechanism to get support when learners encounter problems
- **Content** – must be designed for interaction
- **Instructor** – aware of learners' needs/concerns and involvement levels, attempts to draw learners into discussion early, organises schedule, provides resources for learners in need of additional learning (remedial)
- **Technology** – should play a servant role
- **Organization** – focused on learning, time and resources made available, learners supported through help-desk

Norris, Mason and Lefrere [5] identified the following potential range of activities now available within e-learning environments:

- Access to searchable repositories of online resources;
- New, richer means and patterns of interactivity between and among learners, faculty, mentors and other experts;
- Genuinely new learning experiences based on combinations of physical and virtual resources and interactivity (blended learning);
- Deep learning experiences that develop conditionalised and contextualised knowledge and the ability to reflect on one's level of understanding through communities of inquiry and/or communities of practice;
- Use of knowledge management tools to share explicit and tacit knowledge, bring just-in-time knowledge into learning experiences, add value to learning experiences and increase the efficiency/reduce the cost of learning content.

As advances in e-learning continue, achieving integration and interoperability in digital systems is important. According to Singh [9] for organisations to integrate e-learning services, content and applications effectively, a software infrastructure must be deployed that meets the following key requirements:

- **Accessibility.** The e-learning framework must provide access to knowledge and related data on a cross-enterprise, anytime, anyplace basis.
- **Flexibility.** The e-learning environment must provide a flexible workflow and process model that can be fine-tuned and configured to meet the organisation's needs.
- **Extensibility.** The e-learning framework must allow for additional components to be integrated easily using open and component-based software architecture as technology and requirements evolve.
- **Reusability.** Content should be created in components that are indexed, based on standardised metadata that would allow them to be reused by developers.
- **Interoperability.** The e-learning framework must allow content and other data to be exchanged and shared by separate tools and systems connected via the Internet.

- **Scalability.** The e-learning framework must achieve scalability by permitting access to potentially hundreds of thousands of users and large-content repositories.
- **Security.** The e-learning framework should not compromise the security of data, information or knowledge.
- **Standards compliance.** Adoption of standards is important in ensuring robust development of infrastructure.
- **Leveraging of existing corporate infrastructure.** While linking to external websites and content repositories, the e-learning framework must leverage existing corporate IT infrastructure containing relevant human resource and financial data.

Lastly the e-learning framework must allow for the integration of components coming from various vendors or providers in order to provide a seamless interface for end users.

VI. E-LEARNING ECOSYSTEMS INSTRUMENT

There are two main aims of the development of this instrument. Firstly, it was designed to capture users' perceptions and satisfaction of the e-learning environments. Secondly, feedback received from the users will be used to improve the e-learning system.

Apart from demographics and background information sections, there are four scales in the instrument. The first three scales of Access, Interaction, and Response are adapted from Tobin's [12, 13] work on Connecting Communities Learning (CCL) and the final scale of Results focuses on information structure and the design aspect of the content of the e-learning system. These scales were validated and had been used to evaluate learning in a web-based learning environment [19]. The four scales are shown in Fig. 2. Each of these aspects is explained in the following section.

A. Scale I: Access

Access is required to any e-learning system. Three main categories of convenience, efficiency and autonomy are included in Access; they are convenience, efficiency and autonomy [12, 13]. Convenience is achieved when students can access the learning activities at convenient times. Efficiency is described as being able to access the system anywhere and at any time which allow for efficient use of time. Autonomy is described as allowing the users to decide when and how to access the e-learning system.

B. Scale II: Interaction

Interaction includes a *co-participatory* association between two or more learners. This implies that the interaction takes place in the presence of a shared language which can be accessed by all participants to engage the activities of the community, with a goal of facilitating learning. As shown in the directional flow of the arrow in Fig 4, this Interaction Scale can only be invoked as a result of the Access Scale.

Included in interaction are six categories of flexibility, reflection, quality, interaction, feedback and collaboration

[12, 13]. Flexibility is described as allowing participants to meet their goals. Reflection is noted as asynchronous interactions which encouraged reflective interactions. Quality is linked to the learning reflected in the level of activity undertaken by each participant. Interaction is described as enabling participants to interact with each other asynchronously. Feedback is described as the availability of feedback from participants. Collaboration enables participant to collaborate in a variety of activities.

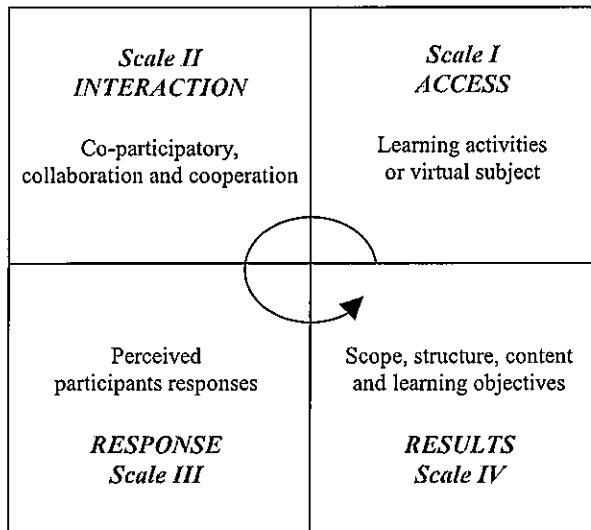


Fig. 4 E-learning ecosystem instrument scales

The focus of this Interaction Scale is on the learning activities that the participants will participate in. This includes structuring of activities in which participants use their existing knowledge to apply to the present subject and build new understandings from the present subject. This interaction or co-participatory aspect is aligned with Laurillard's [4] analysis of how learners 'come to know' through (1) active learning, (2) feedback, and (3) reflection.

C. Scale III: Response

The Response scale is included to gauge the participant's perception of the e-learning system. This scale is used to describe knowledge which is considered "as embodied in neural networks as vectors of electric charge that reflect life experiences of individuals" [12]. According to Churchlands [15] and Churchlands [16] neural network theory conceptualises knowing in terms of electronic loadings on a matrix of neurons that tightly couples perception and cognitive ways of knowing.

There are six categories of Response, which are enjoyment, confidence, accomplishments, success, frustration and tedium [13]. Enjoyment is associated with success and mastery of technology. Confidence is associated with successful learning and support for learning. Accomplishments are described as allowing participant to display their accomplishments regularly and publicly. Success has two dimensions - use of technology and conceptual aspects of the pro-

gram. Frustration is associated with the use of technology and the conceptual aspects of the program. Tedium is associated with posting and responding to reviews on a regular basis.

D. Scale IV: Results

The final scale concentrates on the outcomes of using the e-learning system. The focus is on the information structure and design of the e-learning system. It deals with how the e-learning system is structured and organized, and whether the materials presented follow accepted pedagogical and instructional design standards, such as stating its purpose, describing its scope, incorporating interactivity, and providing a variety of formats to meet different learning styles. Included in this scale are relevance and scope of content, validity of content, accuracy and balance of content, navigation, and aesthetic and affective aspects.

The rationale for selecting these four scales is represented in Fig. 4. To start off with, it is necessary to have access (Scale I) to some e-learning system or a virtual subject. This scale is necessary to ascertain the convenience of accessing the learning activities, the efficiency in terms of accessing the learning materials at a location suitable to the participant and the autonomy of accessing the learning materials and activities at a time convenient to the participant.

Once access (Scale I) to the learning materials is established, it is vital that participants interact with one another to achieve the learning outcomes set out in the learning materials. In Scale II (Interaction), participants are required to participate actively, and work in a collaborative and cooperative manner with other participants in order to achieve the learning outcomes.

Once participants have access (Scale I) to the learning materials and that they are actively participating (Scale II) in the learning activities, participants should be able to indicate how they feel (Scale III: Response) in using this type of learning environment. Participants will be able to respond by indicating their perception of this learning environment and whether they have accomplished any learning objectives through this learning environment.

Having gone through all the learning activities, from access (Scale I) to interaction (Scale II) to response (Scale III), participants should be able to determine whether they have gained (Scale IV: Results) from learning in this environment.

VII. CONCLUSIONS AND FUTURE WORK

The importance of a sustainable e-learning framework for evolutionary learning and the need for an e-learning instrument is the main focus of this paper. An instrument of Access, Interaction, Response, and Results assesses the participants' perceptions of an e-learning environment. This instrument can be used by educators or trainers to evaluate their e-learning courses. This instrument incorporate four

scales which include accessing the e-learning materials (Scale I of Access), the interaction and participation of all parties involved in the on-line learning (Scale II of Interaction), the responses and perceptions of students learning in this environment (Scale III of Response), and finally, the participants' learning outcome and achievement in this learning environment (Scale IV of Results). The availability of this instrument will allow researchers and developers to evaluate their e-learning environments in accordance with the suggested scales.

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