Digital Teaching and Learning Ecosystem (DTLE): A Theoretical Approach for Online Learning Environments.

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NPS: Better choices, better health

Abstract

Reviewing the literature on digital 'ecosystems' applied to computer science, a gap has been identified. This analogy has never been used to describe the complex interactions between student-interface, student-teacher, student-content and student-student. These interactions are crucial to gaining an in-depth understanding of online learning environments and to promoting effective e-learning practices. The aim of this research is to develop a theoretical framework to describe these interactions by using the DTLE model based on the 'ecosystem' approach. For educators the model will help to design, describe and evaluate current online learning practices. For learners, it will help to explain how teaching and learning occurs in their studies and will assist them to seek greater value from their learning experience. Additionally, the DTLE model will provide a practical methodology to rank online units in terms of design layout, navigability and accessibility, content, interactivity, assessment, and student engagement.

Keywords: Digital ecosystem, ecological approach to learning, ecosystem analogy.

Background information

An analogy can provide a means of building theory, a meaningful way to understand complex situations and scenarios. Analogy can and should be used to inform the analysis of findings in educational research in general, and science education in particular. The merit of analogy in research lies not in any absolute measure of the similarity between the target and the analogue. Rather, the worth of analogical analysis lies in the mental inquiry it promotes, the knowledge produced by this inquiry, the cognitive engagement of researcher and others, and the communication produced. To be productive, the analogy should be contentious enough to provoke and challenge thinking but agreeable enough to resonate with others' experience of the phenomenon under study (Aubusson, 2006).

Biomimicry is a discipline that seeks solutions by emulating nature's designs and processes, where there is considerable opportunity to learn elegant solutions for human-made problems (Benyus, 2002). In this regard, the ecological approach, combined with information technology, can open a new way to understand online learning. The key concept is the idea that teaching and learning can be seen as a process of transformation of information into knowledge. The subject, interface, content (abiotic factors), the teacher, e-learning officer, and the students (biotic factors) are embedded in a content

where complex interactions occur and shape the quality of the learning outcomes.

The term "Digital Ecosystem" has been used to describe a variety of concepts in the area of Information Technology (IT), Information and Communications Technology (ICT) and also in e-learning. In IT the term refers to an existing networking infrastructure on the Internet (Chang and West 2006; Boley and Chang 2007; Briscoe and De Wilde 2008; Bo 2009; Briscoe and Marinos 2009), while several companies offer a Digital Ecosystem service or solution which involves enabling customers to use existing e-business solutions (Bennett, 2006; Kulkami and Kreutzer, 2006; Vandenberghe, 2006). In the ICT area it is used for e-business and e-commerce, to create so-called business ecosystems (Iansiti and Levien, 2004; Nachira, 2002; Papazoglou, 2001). In e-learning, our major focus, "Digital Ecosystem" or "Digital Learning Ecosystem" has been cited as an ecological model of learning and teaching (Frielick 2004), understanding e-learning infrastructure (Gütl and Chang 2008; Gütl and Chang 2008) and implementation (Uden, Wangsa et al. 2007), and recently has been proposed as an aid when designing new learning tools (Ficheman and de Deus Lopes 2008).

The ecological approach has never been used to describe the complex interactions between student and interface, student and teacher, student and content, and student and student, which shape learning outcomes. Analysis of these interactions is crucial for the in-depth understanding of online learning environments, and to standardise and promote effective e-learning practices.

Aims of the study

To further develop the Digital Teaching and Learning Ecosystem (DTLE) theoretical framework based on the 'ecosystem' analogy. Our model will use the ecological approach in order to gain in-depth understanding of online learning interactions and how they affect the quality of learning.

To standardise e-learning design practices by describing a model to assess and rank the quality of online learning environments, taking into account elements such as design layout and navigability, accessibility, content and interactivity, assessment and student engagement.

Research Questions

(1) Is the ecosystem analogy in e-learning a valid tool to gain in-depth understanding of the complex interactions which occur in online learning environments?
(2) Is it feasible to describe a model that evaluates and ranks online learning environments based on elements such as design layout, navigability, accessibility, content and interactivity, assessment and degree of engagement of learners?

The DTLE Model

Digital Teaching and Learning Ecosystem (DTLE) is an analogy with what in ecology is called an "ecosystem". An ecosystem consists of all the organisms living in a particular area (biotic component), as well as all the nonliving, physical components of the environment with which the organisms interact, such as air, soil, water, and sunlight (abiotic component). The entire array of organisms inhabiting a particular ecosystem is called a community (Campbell and Reece, 2008). This model will use ecological terms like *abiotic* and *biotic components*, *niche*, *populations* and *communities*, *biodiversity* and *environment*. The principles to be used will be: *symbiotic relationships*, *balance* and *adaptation.*

The Digital Teaching and Learning Ecosystem (DTLE) model (Figure 1), as an analogy with 'ecosystem' in ecology, has two major components: the biotic and the abiotic component. The biotic component comprises two subcategories: organisms cohabiting in the Teaching Niche (lecturer, tutor and e-learning officer) and; organisms cohabiting in the Learning Niche, (students enrolled in the unit or course). The abiotic component comprises the physical devices that students use to access content (desktop computers, laptops, netbooks, tablet computers, mobile devices, etc); the internet connection (broadband, Wi-Fi, 3G, etc); the e-learning interface or portal, and ; the content, which can be static or dynamic (communication tools, collaborative tools and assessments). The source of energy which powers the DTLE is Teaching and Learning, which can be seen as a transformative process where information generates knowledge.

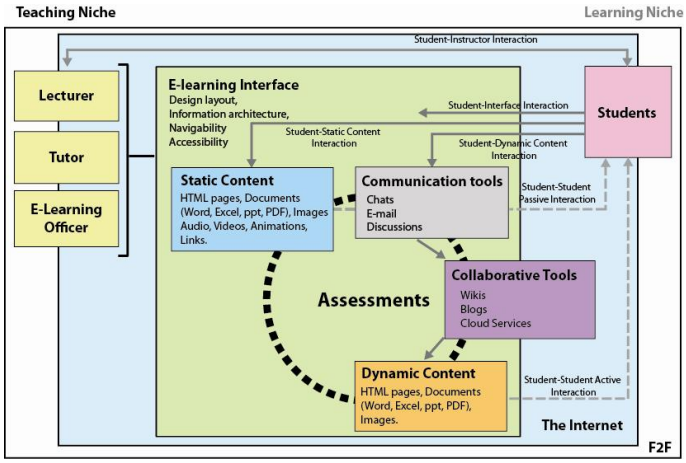

Figure 1: Digital Teaching and Learning Ecosystem (DTLE)

Roles of each of the components of the DTLE

The biotic components of the ecosystem have specific roles. The Lecturer is responsible for the unit and has direct input in terms of approaches to be used, as in face-to-face (F2F) lectures and online delivery. In contrast, the Tutor is responsible for executing approaches suggested by the Lecturer. The E-learning officer is responsible for maintaining a consistent layout across the entire site and also making sure good practices for e-learning sites are followed. The Students' role is to learn and to follow recommendations from Lecturers and Tutors, to understand the unit outline and learning guides, and to ensure they meet the requirements to pass the unit.

Abiotic components also have roles which contribute to the organisation of the system. Electronic devices like desktop computers, laptops, netbooks, tablet computers, mobile devices etc., in conjunction with the Internet, allow access to online content. The internet connection could be a 56k modem (very rare these days), broadband internet, Wi-Fi or 3G network, and it will make content more or less accessible for students. The e-learning interface or portal is the virtual place where lecturer, tutor, e-learning officer and students log in to browse the content. The content is the source of knowledge for the DTLE and has two categories: static content and dynamic content. Communication tools make it possible for students to interact while working online. These tools can be asynchronous like e-mail, message boards, forums and discussions threads, or synchronous like chats, skype, instant message services, etc. Collaborative tools, (wikis, blogs, cloud services) are vital to create interactive and engaging e-learning sites, as they allow the students to work in teams. The student assessment ring can be included inside the interface if academics use online quizzes. Otherwise it can be included in face-to-face teaching. This can be seen as a process of transformation of information (static and dynamic content) and interaction (communication and collaborative tools) into knowledge.

Interactions between components.

The DTLE as an ecosystem in ecology is complex and involves biotic-biotic and biotic-abiotic interactions. The following interactions can be identified in our model:

Biotic-biotic interactions: Interactions within the Teaching Niche (lecturer - tutor, lecturer - e-learning officer, tutor – e-learning officer). Interactions within the Learning Niche (student - student interaction). Interaction between Teaching Niche and Learning Niche (student - tutor, student - lecturer and student - e-learning officer).

Biotic-abiotic interactions: Interactions across Teaching Niche and Interface (lecturer - interface, tutor - interface and e-learning officer - interface). Interactions across Learning Niche and Interface (student interface and student - content).

From the point of view of online collaboration, the student –student interaction is crucial. At this point we can further apply the analogy with symbiotic relationships. Symbiosis means living together. It describes a close and often long-term interaction between different biological species within an ecosystem. These relationships can be defined as mutualism, commensalism and parasitism (Campbell and Reece, 2008). In online collaborative environments, a team may exhibit one or more of the

following relationships: (1) Mutualism will occur when all the students from the group have a 'benefit'. In other words, a group where all students collaborate evenly and they all learn from each other in a constructive manner; (2) Commensalism will occur when some of the students from the group have a 'benefit' and the others are not significantly hindered or helped; (3) Parasitism will occur when some students from the group have a 'benefit' while others are hindered or 'harmed'. E.g., one student works hard and the others contributed with trivial comments. This case can constitute what is described as "social loafing in online collaboration" (Wagner and Prasarnphanich, 2007). The students who work hard do not get anything from their peers in terms of the stimulation of ideas and the development of critical thinking, as the group environment does not promote active learning for them. All these interactions will be further developed with the development of this model, and tested in online learning environments.

Methodology

This study will use a mixed methods (Tashakkori & Teddlie, 2003) design, which is a procedure for collecting, analysing and "mixing" both quantitative and qualitative data at some stage of the research process within a single study, to understand a research problem more completely (Creswell, 2002). The main theoretical framework to be used will be analogical interpretation (Abusson, 2006). The analogy will be made in two parts, the first part is the target to be explained (online learning environments), and the second part is the analog (ecosystem). Target and analog will be compared, to test for a match of the key relational features (initial mapping). The well understood analog, if judged as suitable on the basis of the initial mapping, will be extended to identify more of its potentially salient attributes and then used to reinterpret the target, seeking similarities, differences and ambiguous relationships. This information will fully develop the DTLE model (Figure1). The final model will be tested in a real scenario. This could be a faculty or school which is currently working extensively to improve students' experiences using e-learning and a wide range of technological tools.

This analysis will help to gain in-depth understanding of: (1) how academics are using technological tools within their units; (2) what challenges and difficulties they are facing; (3) how they can improve the current use of these tools across their units; (4) how students learn and interact online with their peers; and also (5) evaluating the experience of learning. Investigating students' perspectives on what they learn has been proved to be effective when evaluating the effect of curriculum innovation on students' learning. This data will identify variations between groups of learners, and will allow conclusions to be drawn about the quality of students' learning. This systematic analysis is known as phenomenography and has been described in educational research (Ellis et al., 2007; Matthew *et al*., 2007; Marton and Booth, 1997; Prosser & Millar, 1989).

Additionally, the DTLE model will be used as a methodology for assessing and ranking online units based on the following elements: design layout, navigability, accessibility, content and interactivity, quality of assessments, and user experiences. For design layout, navigability and accessibility, principles and elements of design will be applied in conjunction with quality web design practices and accessibility, following the standards recommended by the World Wide Web Consortium (W3C). For content and interactivity, cognitive load theory (CLT) will be used as the theoretical paradigm to provide guidelines to assist in the presentation of information in a manner that encourages online learner activities that optimise intellectual performance. To evaluate the quality of online assessments, this study will use the methodology proposed by Hayes in 1999, which consists of a list of expectations for online assessment. To evaluate user experiences, an online survey will be designed which will cover all the elements we have discussed.

Further development

The author would like to further develop and test this model as a PhD candidate and he is currently seeking a Supervisor to undertake this project.

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