Using Socio-Technical System Methodology to Analyze Emerging Information Technology Implementation in the Higher Education Settings

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Abstract: In this paper, we will explore how such a Socio-Technical System methodology can be used to examine emerging information technology implementation strategies in higher education environment. Educational eco-systems and the socio-technical system approaches depict essentially the correlations of emerging technologies with the processes and functions of the higher education organizations, including how IT supports and enables educational information system and services, such as instructional content design, development, and assessment in a learning environment. The paper provides the authors' vision and experience in strategizing and utilizing emerging learning technology and services. The radical changes for higher education systems are in rethinking and reengineering the traditional instructor led education and monolith IT resources, and advancing them with analysis on technology enhanced learner-centered educational environment with eco-systematic lens.

Key words: Emerging technology, higher education learning system. IT eco-system, socio-technical system.

1. Introduction

Increasingly we have witnessed how higher education success and competing opportunities steadily depend on information technology (IT) enabled capabilities and adaption of emerging technologies. In today's global digital economy and networked society, information technology in higher education settings specifically plays critical and inseparable while it's evolved day by day. The IT and especially emerging information technologies profoundly change how higher education (HE) settings create value both within traditional education learning experience, and through new transformational educational modes in a global horizon.

Although higher education institutions (HEI) today are facing increasing pressures with respect to innovations, operational excellence, and performance efficiency, the economic difficulties and cautiousness are keeping the costs for novel technology at an absolute minimum. In actuality, the radical changes for higher educational organizations are in rethinking and reengineering their traditional IT architectures to one with a creative digital business mindset. These transformations require new advanced knowledge and skill sets with emerging technologies, particularly, distance education, hybrid, traditional, F2F-combined with online education delivery models.

In the paper we will analyze the connection of emerging learning technology within socio-technical

system [1], explore eco-systems derived from social ecology, and discuss technology enhanced hybrid delivery learning modes related eco-system approach, and management considerations in the higher education operations.

2. Higher Education System as Eco-Systems

Educational research has offered advice and direction on how best to integrate information technology into traditional education [2]. Whatever the focus, the dominant research paradigm has separated mind from matter, or separated learners from environment [3]. Zhao and Frank [4] promoted the examination of technology integration from an ecological perspective. The ecology metaphor [5] is used here to emphasize that understanding a complex IT in higher education learning environment requires a framework that is active, interdependent and adaptive as a single ecosystem [6]. As Frielick put it: "The emerging ecological paradigm proposes a unified view of mind, matter and life" (p. 40). Indeed, Anderson and Mohr [7] suggested that the ecological perspective could meet the need for a comprehensive conceptual framework to guide research and assessment. Such a perspective posits that even in higher education setting, individual learning occurs within a set of nested contexts [8], which fit together somewhat like the levels in a socio-technical ecosystem [1]-[9]. Such information needs to be synthesized into a total system picture in order to gain a fuller understanding of people as learners and their attitudes.

2.1. The Ecosystem of the IT Implementation in Higher Educational Settings

An eco-system has been employed in a number of contexts: using data to improve education as knowledge ecosystem [10]; and making sense of strategic within an organizational ecology with learner-centered approach. All of these approaches try to demonstrate that the ecological framework extends the traditional concepts of higher educational settings to consider a holistic perspective that includes a wide variety of interconnected fields.

2.2. Eco-System Framework

The ecosystem framework was developed in the field of social ecology. Social ecology describes a host of perspectives associated with many academic disciplines and theories [11]. The ecosystem approach describes activities in an environment consisting of levels within the systems: microsystem, mesosystem, exosystem, and macrosystem. Such "nested contexts" can be visualized this way (Fig. 1):

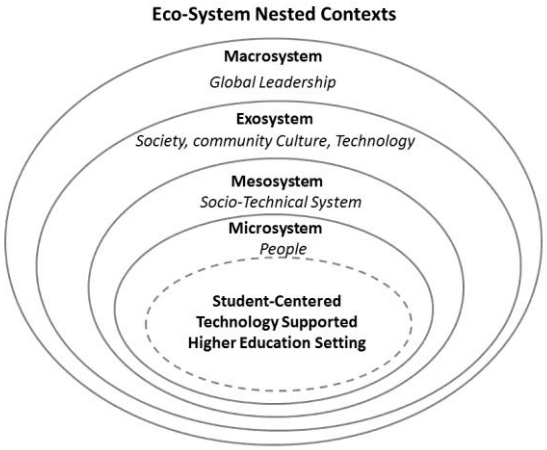

Fig. 1. Eco-system.

The innermost level, the microsystem, attends to the reciprocal relationship between the learner and the

immediate learning environment [12]. It examines individual person and his/her selected demographic characteristics, such as age, gender.

The mesosystem refers to the reciprocal relationship between individuals and their immediate two or more microsystem learning environments [8]-[11]. Within the mesosystem, diverse IT levels are related in higher education settings can be connected through the Internet [13]. According to Smith and Stirling [14], socio-technical systems form a meso level of analysis.

The so-called "zone of proximal development" as one component of an ecological approach to information systems refers to multiple zones of academic IT implementation. In Frielick's ecological model of teaching and learning, the inner or inter/intro-personal zone represents the technology enhanced communication relationships between students, subject matter expert, instructional designer, and individual learner. Attention here is paid to the learners' physical education settings, such as, university, home, access to library, and other resources.

The exosystem refers to the dynamic interrelationships between the higher education settings and informal settings such as a student's home or office [11]. The complex social-ecological system put emerging information technology as an exogenous factor in a conceptualized form [14]. Often individuals' attitudes about learning reflect their current interests and perceptions based on their own prior experiences. Thus, results of any learning assessment, prior and progression learning should include its ecological characteristics – such as an individual's attitude. The identified factors at the exosystem level would include the virtual community, attitudes, and more broadly, the cultural context in which an individual is situated, and social networked technology context like family members and friends.

The last outermost context, macrosystem, encompasses the first several contexts (exo, meso and micro systems), and considers factors in the general environment in a higher education organization as governed by global networking, political, cultural, human resource, ever changing emerging technology, and symbolic environments [14].

Leadership practices deal with emerging technology at various dimensions [15], [16] and shape new organizational IT structures to transform the institutional culture. Thus, one can see that to achieve maximum results at macro level, leaders cannot single-handedly lead educational institutions; instead, they need to promote distributed, shared, and strategic leadership to build empowered support systems [17] within a much larger higher education ecosystem. Finally, leadership practices, IT governance, emerging technology implementation policies and decisions, and support from higher education administrators form part of the macro level.

3. Higher Education Systems as Socio-Technical Systems

To explore the complexity of the problems and to avoid unrealistic expectations when employing new technologies and emerging models, a formal methodology of examining and evaluating higher education IT in the socio-system context within a higher education setting ecosystem can be applied. The contemporary approaches to Information Systems, and more specifically IT, encompass multidisciplinary theories and perspectives with no dominance of a single discipline or model. Gabriele Picolli [18] features IT as a critical component of a formal, sociotechnical information system designed to collect, process, store, and distribute information [19]. Kenneth and Jane Laudon define Information Systems as Sociotechnical Systems incorporating two approaches: Technical and Behavioral, with several major disciplines that contribute expertise and solutions in the study of Information systems [20].

The IT Sociotechnical approach not only visualizes the concept, but reveals the impact of new technologies and processes –the technical subsystem- on the entire work system, and the dependencies and interactions between all other facets and components of the socio-technical system. According to Picolli,

any organizational Information System can be represented as a Socio-technical system which comprises four primary components that must be balanced and work together to deliver the information processing functionalities required by the organization to fulfill its information needs (Fig. 2) [19]. The IS Socio-technical model validates the most important components, and at the same time primary driving forces, within organizations: structure, people, process, and technology. The first two – people and structure – shape the social subsystem, and represent the human element of the IS. The latter two - process and technology - (more specifically Information Technology) contour the technical subsystem and relate to a wide range of IT resources and services intertwined with a series of steps to complete required business activities.

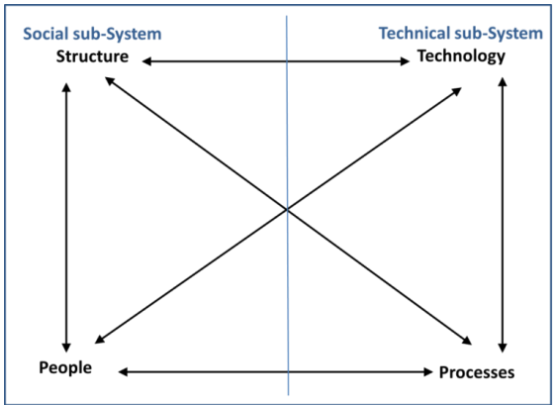

Fig. 2. Information systems primary components as a sociotechnical system.

The Sociotechnical system approach validates the four critical components of the Information system interdependency and proves that none of them works in isolation. They all interact, are mutually dependent, and consequently are subject to "systemic effects," defined as any change in one component affecting all other components of the system. The process of changes and reciprocal adjustment of both technical and social subsystems should continue to interplay and grow closer until mutually satisfying results are reached [20]. However, the model in reality could not be with equal subsystems' changes. It should evolve from micro to macro level as eco-systems to reflect crucial influences of the external environment, including regulatory requirements, social and business trends, competitive pressures, interoperability with partnering institutions, especially when it analyzed the role and the strategic development of the IT domain.

The specifics of educational organizations' sociotechnical system can be understood better through analyzing the main mission of the HE institutions. While missions are diverse in many ways for different HEIs, all they include three major sets of activities: Educate, Research, and Support (Academic and Administrative Processes).

Every educational organization emphasizes on one or another primary set of activities or keeps them in a fair balance based on their type, status and / or market positioning. Nevertheless, all HEIs need to run and support a good variety of IT systems, applications and resources to satisfy the constantly growing stakeholders' requirements. In addition, IT systems and resources in HEIs typically exceed the required range of services, as it is anticipated they to provide supplementary capacities for local communities, partnering institutions, or creative initiatives [21].

The IT strategic decisions should reflect not only individualized HEI constrains based on the mentioned above sets of activities, but the sociotechnical critical components. In the managerial process of new technology implementations, HEI must furthermore consider current trends, important constraints and challenges "that are common to institutions and the educational community as a whole" [22]. In the 2011

edition of the Horizon Report, the Advisory Board members defined four common key technology trends as follows:

- Revisit the roles of educators in sense-making, coaching and credentialing.
- People expect to be able to work, learn, and study whenever and wherever they want.
- The world of work is increasingly mobile and collaborative, giving rise to reflection about the way student projects are structured.
- The technologies we use are increasingly cloud-based, and our notions of IT support are decentralized.

Economic pressures and adoption of new models of education, mainly based on technology advancements, are presenting unprecedented competition to traditional academic models. In the distance education survey results from March 2010, U.S. based colleges reported a 22 percent increase for distance education enrollments, substantially higher than the average 2 percent for overall national campus enrolments [23]. This increase in distance education enrollment continue in the last years especially as large state education systems have embraced IT enabled online and hybrid modes of course and program delivery.

A possible approach to analyze the implication of existing and new systems and services to the core sets of HEI activities is to employ an IT Strategy Map - (Fig. 3) [21]. Every specific or integrated IT application, system or service can be evaluated and positioned on the map according its strategic importance to the Educate, Research and Support core activities in the institution. The decision discussions when planning new learning management systems and / or adopting new modes of students' learning should include people involved in the processes such as faculty, instructional designers, professional staff and students. Some of the systems or applications could be integrated and their strategic importance to improve efficiency and productivity will be greater.

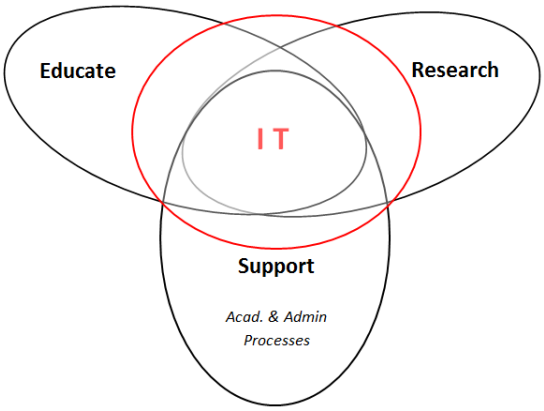

Fig. 3. IT coverage on primary sets of activities in HEI.

Subsequently to completing the IT Strategy Map the Return on Investments (ROI) and/or Return on Assets (ROA) should be calculated and evaluated when new technology and service models are employed. Some emerging technologies have the potential to deliver a superior ROA especially cloud based IT services and systems, however simply comparing ingredient costs of pay-per-use services vs. capital expenditures and operational overheads could create an unrealistic approximation in a long term (Fig. 4)[24].

The ROI / ROA phase is very institutional specific and it will require an honest and true costs assessment within a five- to six- year baseline of comparison. A scorecard approach with customizable spreadsheet calculations will provide an accurate representation of the true value of on-premises and off-premises IT solutions.

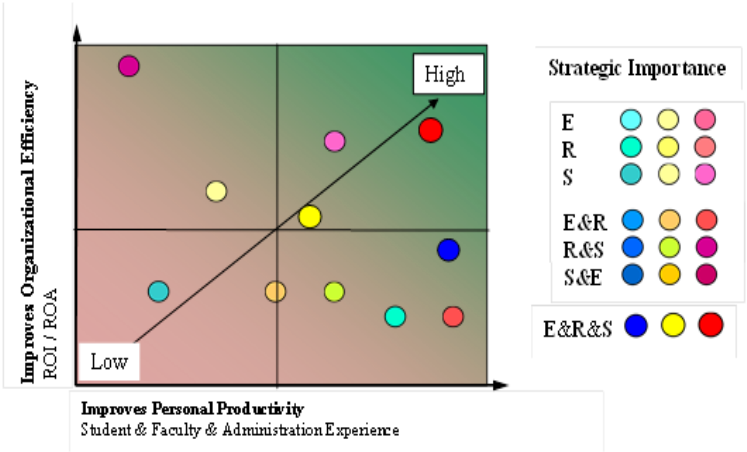

Fig. 4. IT strategy map.

4. Socio-Technical System for Learning in Higher Education Setting

Use Over the last decade, learning outcome has received much attention in educational research literature and college mission statements [19]. This particular domain focuses on personal and interpersonal relationships and analyzes attitudes that are affected by the educational system as a whole, and supported by information technology system. The notion behind this is that individuals learn best if they are placed at the center of the learning experience and required to construct their own knowledge through conversation, exploration and reflection.

According to Hannafin [25], student centered approaches encourage interactive behaviors that provide learners with opportunities to express their individual interests and needs, draw learning from each level of an eco-system, and supported by socio-technology system in HEIs. Hannafin believed that a technology enhanced virtual classroom provides an efficient means for learning. In a student-centered learning environment, it is necessary to access information; yet, access alone is not a singularly sufficient condition for effective learning. For real blended learning, the individuals have to become both a navigator and driver in the artificial superhighway on route to exploring and manipulating knowledge through dynamic ecological interaction within socio-technical systems.

The visual image would look like this:

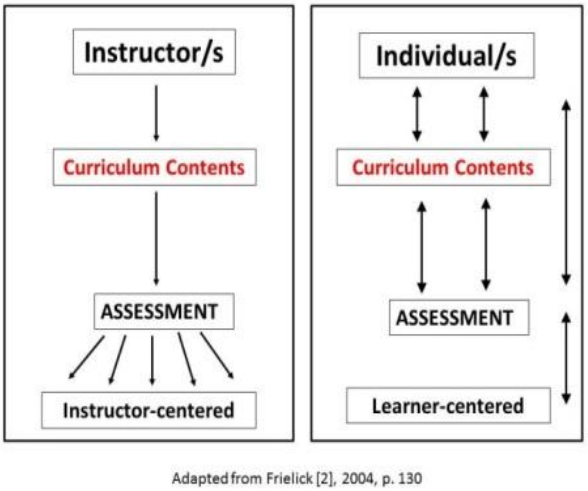

Fig. 5. Learner-centered information system.

Within such a learner centered perspective, McCombs [26] argued that the process of assessing the roles

of information technology in designing teaching and learning process are changing. There is an increased trend toward examining learning from a more holistic and integrative perspective within the ecosystem framework. In such a fast-changing world, the focus of learner centered practices need to be balanced with emphases on individual learners and their ecological and technical needs, which address the personal and educational environment domain of socio-technical ecosystems.

In the case of learner-centered online learning instruction, the ecosystem and socio-technical system perspective suggests that instructional designers, work with subject matter experts, look at the immediate physical, social, political, technical, and economic environments to gain an understanding of what the learners' attitudes are toward the emerging technology and how to implement information technology to learning. A basic postulate is that, even when provided with information technology resources, ecosystem and socio-technical factors can affect the decisions a learner makes about how to survive in the technology enabled higher education environment.

5. Conclusion

A primary goal of this paper has been to introduce socio-technical system methodology to analyzed emerging information system in higher education settings. Eco-system perspectives relates to socio-technical system are also examined. There is an argument here. It is that in setting up or examining the outcomes of any blended learning experience (for example, comparing it to learning in a classroom environment) an ecosystem analysis should be utilized to understand, support and evaluate the success of the project. It is only by remaining attentive to such a holistic view that researchers can locate and more carefully examine the true web of factors that influence a student's learning. The HE organizational commitment would be to use the technology innovation to stretch the institutional core activities and to make the educational resources openly accessible at reasonable expenses.

Further work based on the described above complex approaches is planned towards risk analysis of the fast evolving IT transformations in a relatively conservative higher educational eco-system, and to map a sustainable performance improving model for higher educational settings.

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