Online technology acceptance for university STEM program relevance: A PSU case study

Technology Assessment & Acquisition – ETM 531/631

Professor: Tugrul U. Daim Ph.D.

Fall 2013

Authors: Elizabeth Gibson
Nina Chaichi
NertilaBregaj

Table of Contents

1.0 EXECUTIVE SUMMARY

The traditional university model that has successfully balanced and integrated research, education and governance for over a century is no longer relevant. Today, the increasing pace of technological innovation coupled with the lagging conceptual models of university governance is causing imbalance. This widening gap has allowed online technologiesto become a disruptive force in the market. Online educationprograms do not necessarily offer students a higher quality degree, but they are offering increasing value to students in the form of cost reductionsand convenience. Students have more choice, the value proposition of an education has decreased and low cost substitutes continue to enter the market. Many are beginning to question the relevance of the traditional degree. Technological innovation has also driven changes in the educational environment creating different online environment models. A studyat Portland State

University (PSU) uses the hierarchical decision model (HDM)to evaluate criteria forcurrent online technology alternatives. Alternate modes of education delivery are evaluated using criteria from the student perspective at the highest level, criteria evaluated by expert educators. The weighted criteria is then considered by administrators to aid with selection of alternatives.

2.0 INTRODUCTION

Universities are dedicated to the creation and dissemination of the knowledge obtained from their research[1]. The traditional business model of educating students on a campus where they can attend classes to earn degrees must be re-evaluated. With the growing emphasis on a knowledge-based economy and the emergence of huge, open online courses by leading universities, traditional universities are beginning to question their true value and relevance of their degree programs and research outcomes[2]. Research supports that disruptive technologies have impacted the production of knowledge[3]. Therefore the question of relevance is important in the face of a new paradigm shift in this knowledge based economy.

The concept of relevance must be considered in relationship to an ecosystem. It is an important but elusive concept. Researchers have found that the “relevance of knowledge depends on its usefulness to achieve specific goals”[4]. Ideally, these outcomes should result in the application of acquired knowledge through technology commercialization or graduates entering the workforce. In general, researchers measure the success of a university either through competition or commercialization. Competition is often measured through subjective top rankings, student attendance and degrees granted. From a students’ perspective, commercialization is the ability to get a job upon graduating and the value they perceive for their return on investment.For the purpose of this paper, relevance is measured by student preference and ability to obtain a master’s degree from a STEM (Science Technology Engineering Mathematics) program at Portland State University (PSU).

Portland State University (PSU) is a traditional university.This university, situated in the heart of an urban city, is Oregon’s largest and most diverse public university. With more than 100 programs, PSU offers more than 225 bachelor’s, master’s and doctoral degrees[5]. However, decreasing governmental funding coupled with increased competition has PSU concerned about their ability to remain relevant in this global economy. They have a particular concern about the importance of their science, technology, engineering and management (STEM) programs. PSU fits the profile of a traditional US urban university in the position of re-thinking their business model for educational degree programs. Faced with an $18M shortfall to the budget, PSU turned to their community for innovative ideas by challenging them to compete for over $1M in grant funding in a program they called “Re-Think PSU”[6]. The top grant recipients used online technologies to re-design their educational delivery using an emporium model. Other online technologies at PSU were researched to determine alternatives for the model. Examination of the criteria using a hierarchical decision model (HDM) explores online technology alternatives. The problem is framed in the context of evaluating online education alternatives based upon a set of criteria gleaned from research to increase the global relevance of PSU's STEM program from a student perspective.Data collected from experts in the PSU ecosystem is used to analyze the question of global education relevance for a working adult wishing to obtain a STEM degree.

3.0 METHODOLOGY

Through a review of literature obtained from databases specializing in software engineering and education, the current state of knowledge around the key drivers for online education technology adoption is determined. A taxonomywas created to identify the key criteria. This data was organized into three perspectives for the purpose of a gap analysis. A second literature search was performed to establish further criteria used a hierarchical decision model (HDM).Figure 1 shows the framework created for the study.

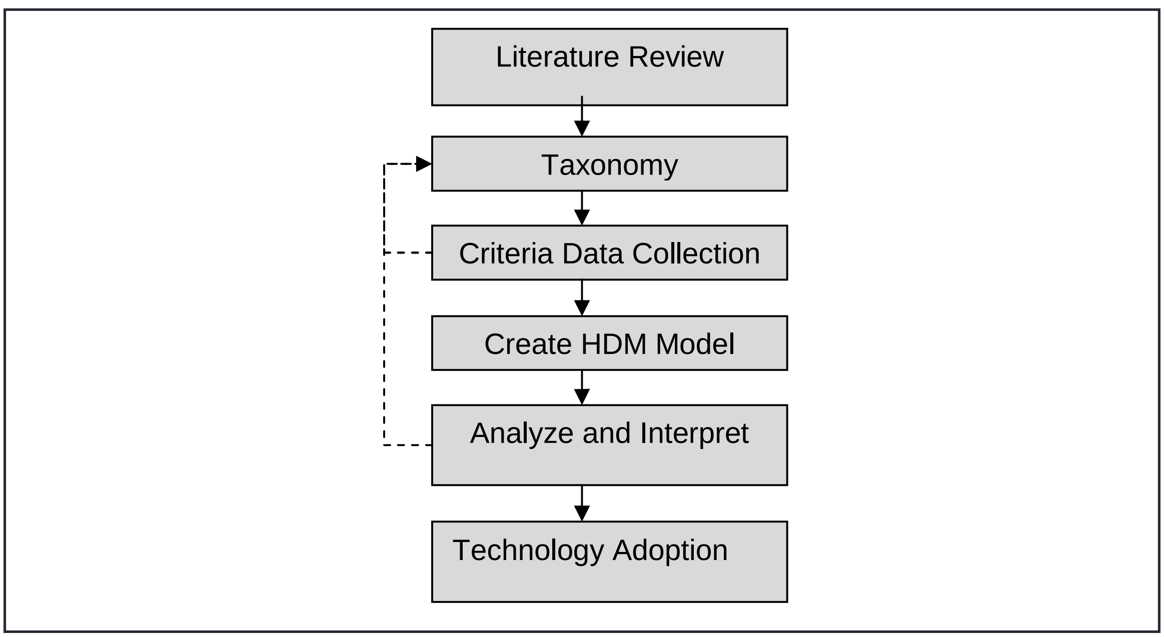

Figure 1: Research Methodology

4.0 LITERATURE REVIEW

4.1 Online education

E-learning can be defined as "the use of electronic media and information and communication technology (ICT) in education"[7]. While distance learning programs were one of the first programs to widely adopt online technologies, online technologies have been integrated into almost all aspects of educational organizations. Distance education is not new. In the past it has been delivered through correspondence, radio, videos and television. What is new is the evolution from distance teaching to the acceptance of online education. Undergraduate and graduate degree programs are offered through learning management systems (LMSs) on the Internet as an alternative to the traditional on-campus programs of traditional universities. Since the first online undergraduate courses and programs were offered in the 1980's [8], they have gained popularity. An increasing number of educational institutions began to offer online courses and programs allowing new models of educational delivery modes to emerge. New methods for teaching and learning developed as well as processes to support them.

4.2Technology Assessment and Decision Models

Online technology has been recognized as an effective method to improve the flexibility and availability of education in the university system. However, there are various modes and models to consider when designing programs for an online environment. There are many more factors to consider for these technologies to be accepted by the students and educators who will use them. Researchers have developed different models that can be useful tools for decision makers re-designing courses.

4.3. HDM MODEL

First, the hierarchical decision model (HDM) is a comprehensive and logical tool, which produces multi-level decisions under multiple criteria. Many authors have been using HDM modeling in order to compare between multiple technological options [9][10][11][12]. While other authors have effectively applied different multivariate analytical techniques to problems in online education[13][14], the HDM was selected for this study. A hierarchical decision model consists of three main tiers: a goal, criteria, and alternatives [15]. Criteria of the same level are compared in a one-to-one, pairwise-comparison process with respect to the overall goal. The alternatives are evaluated for how preferred they are with respect to each criterion at the very last level, the farthest from the goal level [16]. The HDM tool provides a better understanding of complex decisions and allows the problem to be structured into a hierarchal tree.

The objective of the decision is represented at the top level of the hierarchal tree. Next the criteria and all possible sub-criteria are represented in the middle levels. Lastly, the decision alternatives are placed at the lowest level of the hierarchal tree. Figure 2 below is a general representation of the Hierarchical Decision Modeling tool (HDM).

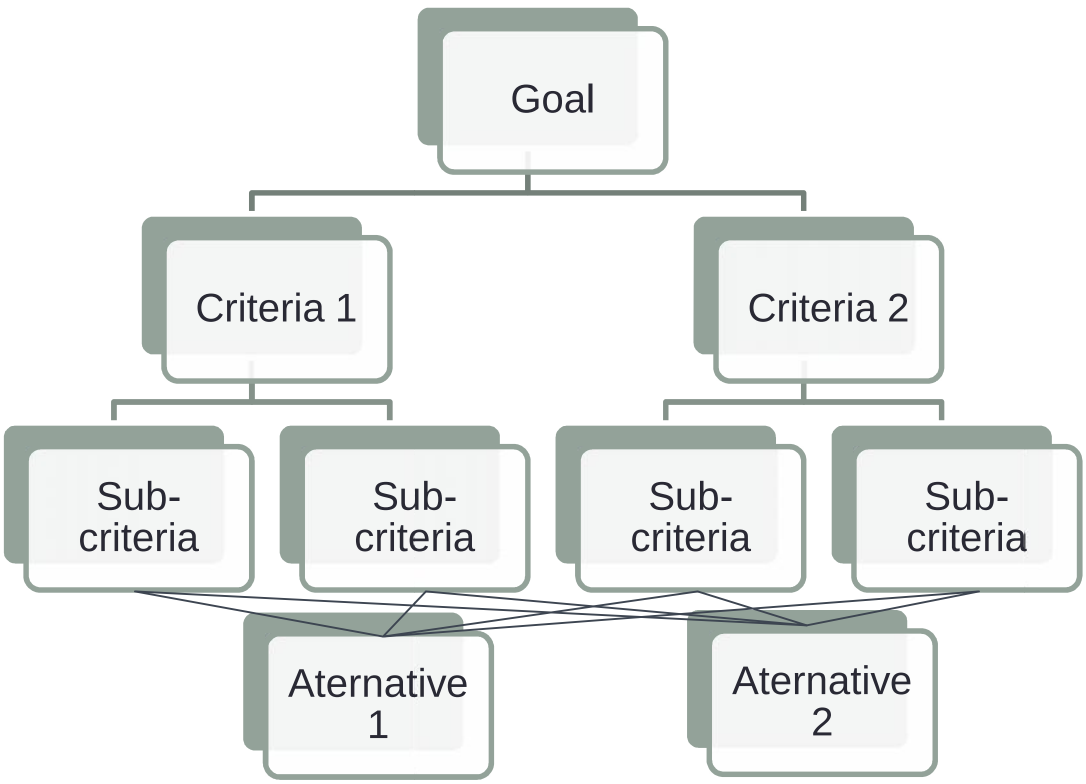

Figure 2 - HDM Format

There are other models tohelp decision makers understand how the technology will be accepted once it is adopted. Often, technology that is adopted is not widely accepted by an organization. This can be complicated and confusing to technologists because other factors are involved that go beyond the technical perspective. Students and instructors are the users and tend to reflect a personal perspective (P), the researchers are the creators and developers with a tenancy to have a technical perspective (T) and the university administratorslook at the program re-design from an organizational perspective (O). A leading researcher in the field of technology adoption has identified this as the TOP model[17]. The technology acceptance model (TAM) is the most widely used model to study adoption of online technologies from a user's perspective[18][19][20][21][22][23][24]. Other models such as the theory of planned behavior and the unified theory of acceptance and use of technology have also been effectively applied by researchers in this field[25][26]. For the purpose of this study, perspectives are loosely equated to the three tiers in the HDM with student perspective at the top, the educator perspective representing the middle tier, and administrators evaluating the alternatives.

5.0 LITERATURE ANALYSIS

Technology has driven significant changes in the market and learning environments. Researchers have shown that online technologies are disrupting the traditional university business model [27]. From the market perspective, students now have more choices. With the advent of the Internet and eLearning environments, universities with online programs can extend their reach to a global market. US based universities are becoming more international and mobile, attracting a wider variety of foreign students.

A series of key word searches were performed in the Compendex and EBSCOhost data bases to obtain criteria for a hierarchical decision model (HDM) based upon global education relevance from a student perspective. Combinations of the key words were combined to form a Boolean search query. The search only included articles published in journals and conference proceedings from the selected databases to focus on higher education.The search returned numerous and varied articles written from different perspectives by authors represented in countries throughout the world.As stated by one researcher the Internet has become “the dominant infrastructure for knowledge”[28]. Key word searches were used to evaluate criteria for the second level of the model. All criteria must support the main goal. For clarification the goal is restated below:

Analyze online technologies that enable a global student to obtain a master’s degree from a STEM program at Portland State University (PSU).

5.1 The Criteria

There have been many studies published investigating technology acceptance criteria from a student’s perspective. Studies have ranged from perceived availability of online resources [29] or adoption of online learning in a classroom[18] to acceptance of open courseware and massive open online courses (MOOCs) [30]. Other researchers have studied students preference of learning management systems[31] their importance of mobility devices[32] and their control factors[33]. A review of the literature showed that student concerns could be grouped into two categories: the educational component in terms of curriculum and the structure and availability of the program. It was not surprising to find that studies focused on student selection of universities provided the most clarity of this grouping[34]. Once the first level of criteria was established, the literature was reviewed to determine sub-criteria. Students perceived the relevance of the educational curriculum in terms of fit to their interests, the reputation ranked by external sources, their perceived ability to get a job upon graduation and the overall cost in terms of return on investment.

Educators are responsible for the creation of program curriculum and the quality of the delivery of the education. Knowledge creation byresearchers and faculty impacts the overall ranking of a university. The number and variety of courses was found to be a major influence on student choice[35]. Reputation of the university as recognized in rankings, publications and other qualifications stated by the institution or others was another criteria identified in multiple research studies[34][35].Educators design courses to meet objectives from a technical perspective.

The other group of criteria in the second tier includes safety, time flexibility and availability. Safety concerns primarily addressed copy rite and validation issues. Several studies found that more online students were older, highly motivated, and self-disciplined. Many were working and valued time and flexibility over face-to-face interactions[36]. Another study found that working professionals prefer “self-paced instruction in a convenient/comfortable location” and referenced taking online classes at home[37]. The result of the literature review is shown in taxonomy in figure 3.

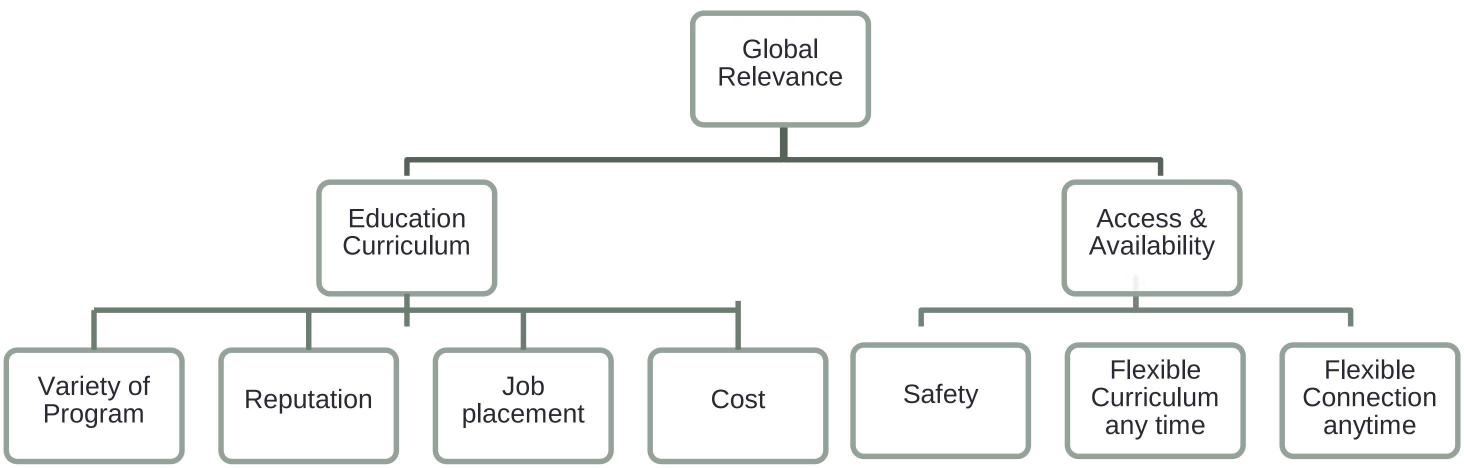

Figure 3 – HDM Model Criteria & Sub Criteria

5.2 Alternatives

In general, there are three modes of online educational delivery: synchronous, hybrid and asynchronous. Decision makers for the selection of the alternatives are administrators in the university organizational structure. The synchronous model uses networking to enhance the traditional face-to-face or other distance education program. A hybrid mode is a combination of learning in a classroom and through a learning management system. Improvements in technology, student use of the Internet through devices and applications, and their increasing need for flexibility has led to wide spread adoption of online degree programs. The results of an extensive study performed in

2001 by the National Center for Education statistics reported that 56 percent of the institutions surveyed offered distance education courses[38]. In 2012, over 62 percent of colleges and universities offered fully online programs doubling the amount from ten years ago. The majority of these programs, offered in the science, technology, engineering or management (STEM) degree programs[39], have been widely accepted and adopted by universities and students alike.

Today there are many content management systems such as WebCT, Blackboard and Moodle that offer different features.For the scope of this paper and based on the literature review described, we used four alternatives: synchronous, asynchronous, hybrid, and fully online synchronous and asynchronous as shown in figure 4. (Please refer to Appendix B for more detail).

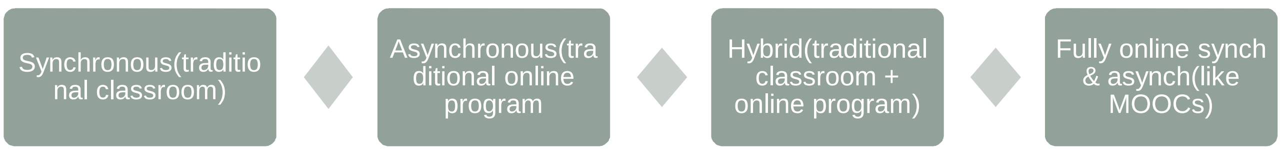

Figure 4 - Alternatives

6.0 Analysis

The primary objective of this study is to present a systemized model to evaluate the online education alternatives at a major urban university, Portland State University. The HDM has the goal of ranking a set of key driver alternatives for online education by assigning a score to each one of them. The scores will be the results based on objective specifications compared against a predefined set of weighted criteria deemed necessary to make a selection. The alternative with the highest score is recommended as an applicable road to move the university toward more online programs.

6.1 Expert Selection

To acquire an accurate pairwise evaluation of the HDM criteria, the pool of experts must be carefully selected. Each level of HDM model needed different expert opinions. The top levelused pairwise comparisons from 4 students in the Engineering Technology Management major who were considered representative of different countries. The students compared their preference between education curriculum and access ability of the program. Instructors from the ETM department were asked to compare sub criteria to evaluate the variety and flexibility and so forth and their contribution to criteria.PSU administrators familiar with online technologies were asked to evaluate the alternatives. In other words, students were selected to compare criteria at the second level; instructors were selected to compare sub-criteria. Then, administrators contributed to the model at the third level by compare comparing four alternatives against the sub-criteria.

6.2HDM RESULTS

Table 1-10 show the result of each group of expert answer for each level, for example, Table 1 shows the given weight for education Curriculum and access & Availability by four students. Table 11 shows the combination of mean of each level to generate the mean result for HDM Model. Since HDM software just create the mean result and this study intended to understand the effect of each expert's opinion in more detailed way, it's decided to create all possible combination to extract more information to have better conclusion.

Global Relevance	Education Curriculum	Access & Availability	Inconsistency
S 1	0.35	0.65	0
S 2	0.56	0.44	0
S 3	0.55	0.45	0
S 4	0.25	0.75	0
Mean	**0.43**	**0.57**	
Minimum	**0.25**	**0.44**	
Maximum	**0.56**	**0.75**	
Std. Deviation	**0.13**	**0.13**	
Disagreement			**0.13**

Table 1- Criteria contributions to Global Relevance

Access & Availability	Safety	Flexible Curriculum any time	Flexible Connection any time	Inconsistency
Inst. 1	0.2	0.42	0.38	0.03
Inst. 2	0.08	0.46	0.46	0
Mean	**0.14**	**0.44**	**0.42**	
Minimum	**0.08**	**0.42**	**0.38**	
Maximum	**0.2**	**0.46**	**0.46**	
Std. Deviation	**0.06**	**0.02**	**0.04**	
Disagreement				**0.04**

Table 2- Sub criteria contributions to Access & Availability (2nd level criteria)

Education Curriculum	Variety of Program	Reputation	Job Placement	Cost	Inconsistency
Inst. 1	0.27	0.18	0.41	0.15	0.01
Inst. 2	0.14	0.35	0.29	0.22	0
Mean	**0.21**	**0.27**	**0.35**	**0.19**	
Minimum	**0.14**	**0.18**	**0.29**	**0.15**	
Maximum	**0.27**	**0.35**	**0.41**	**0.22**	
Std. Deviation	**0.07**	**0.08**	**0.06**	**0.04**	
Disagreement					**0.06**

Table 3 - Sub criteria contributions to Education Curriculum (2nd level criteria)

Variety of Program	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	0.15	0.18	0.24	0.43	0.01
Admin. 2	0.1	0.1	0.41	0.39	0.08
Mean	**0.13**	**0.14**	**0.33**	**0.41**	
Minimum	**0.1**	**0.1**	**0.24**	**0.39**	
Maximum	**0.15**	**0.18**	**0.41**	**0.43**	
Std. Deviation	**0.03**	**0.04**	**0.09**	**0.02**	
Disagreement					**0.04**

Table 4 - Comparing alternatives against Variety of Program (3rd level sub criteria)

Reputation	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin.1	**0.18**	**0.21**	**0.25**	**0.36**	**0.01**
Admin.2	**0.06**	**0.1**	**0.48**	**0.35**	**0.03**
Mean	**0.12**	**0.16**	**0.37**	**0.36**	
Minimum	**0.06**	**0.1**	**0.25**	**0.35**	
Maximum	**0.18**	**0.21**	**0.48**	**0.36**	
Std. Deviation	**0.06**	**0.06**	**0.12**	**0**	
Disagreement					**0.06**

Table 5 - Comparing alternatives against Reputation (3rd level sub criteria)

Job Placement	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	**0.16**	**0.22**	**0.28**	**0.34**	**0.01**
Admin. 2	**0.04**	**0.09**	**0.57**	**0.3**	**0.02**
Mean	**0.1**	**0.16**	**0.43**	**0.32**	
Minimum	**0.04**	**0.09**	**0.28**	**0.3**	
Maximum	**0.16**	**0.22**	**0.57**	**0.34**	
Std. Deviation	**0.06**	**0.07**	**0.15**	**0.02**	
Disagreement					**0.07**

Table 6 - Comparing alternatives against Job Placement (3rd level sub criteria)

Cost	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	0.16	0.2	0.26	0.38	0.01
Admin. 2	0.1	0.45	0.34	0.11	0
Mean	**0.13**	**0.33**	**0.3**	**0.25**	
Minimum	**0.1**	**0.2**	**0.26**	**0.11**	
Maximum	**0.16**	**0.45**	**0.34**	**0.38**	
Std. Deviation	**0.03**	**0.13**	**0.04**	**0.14**	
Disagreement					**0.08**

Table 7 - Comparing alternatives against Cost (3rd level sub criteria)

Safety	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	0.16	0.24	0.27	0.33	0
Admin. 2	0.07	0.43	0.2	0.3	0.02
Mean	**0.12**	**0.34**	**0.24**	**0.32**	
Minimum	**0.07**	**0.24**	**0.2**	**0.3**	
Maximum	**0.16**	**0.43**	**0.27**	**0.33**	
Std. Deviation	**0.05**	**0.1**	**0.04**	**0.02**	
Disagreement					**0.05**

Table 8 - Comparing alternatives against Safety (3rd level sub criteria)

Flexible Curriculum any time	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	0.13	0.21	0.27	0.39	0.02
Admin. 2	0.03	0.5	0.15	0.32	0.01
Mean	**0.08**	**0.36**	**0.21**	**0.36**	
Minimum	**0.03**	**0.21**	**0.15**	**0.32**	
Maximum	**0.13**	**0.5**	**0.27**	**0.39**	
Std. Deviation	**0.05**	**0.15**	**0.06**	**0.04**	
Disagreement					**0.07**

Table 9 - Comparing alternatives against Flexible Curriculum any time (3rd level sub criteria)

Flexible Connection any time	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Admin. 1	0.12	0.21	0.28	0.39	0.02
Admin. 2	0.17	0.32	0.22	0.3	0.02
Mean	**0.15**	**0.27**	**0.25**	**0.35**	
Minimum	**0.12**	**0.21**	**0.22**	**0.3**	
Maximum	**0.17**	**0.32**	**0.28**	**0.39**	
Std. Deviation	**0.02**	**0.05**	**0.03**	**0.05**	
Disagreement					**0.04**

Table 10 - Comparing alternatives against Variety of Program (3rd level sub criteria)

Global Relevance	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
Composite	0.11	0.26	0.29	0.34	0.06
Mean	**0.11**	**0.26**	**0.29**	**0.34**	
Minimum	**0.11**	**0.26**	**0.29**	**0.34**	
Maximum	**0.11**	**0.26**	**0.29**	**0.34**	
Std. Deviation	**0**	**0**	**0**	**0**	
Disagreement					**0**

Table 11 - Combination of mean of each level

Following the table below, it shows all possible combinations of 4 students, 2 instructors, and 2 administrative expert answers:

Global Relevance	Synchronous (traditional classroom)	Asynchronous (traditional online program)	Hybrid(traditional classroom + online program)	Fully online synch &asynch(like MOOCs)	Inconsistency
combine 1	0.14	0.21	0.27	0.38	0.01
combine 2	0.15	0.21	0.27	0.38	0.01
combine 3	0.15	0.21	0.27	0.38	0.01
combine 4	0.14	0.21	0.27	0.38	0.01
combine 5	0.14	0.21	0.27	0.38	0.01
combine 6	0.15	0.21	0.27	0.38	0.01
combine 7	0.15	0.21	0.27	0.38	0.01
combine 8	0.14	0.21	0.27	0.38	0.01
combine 9	0.09	0.33	0.28	0.3	0.02
combine 10	0.08	0.28	0.34	0.3	0.02
combine 11	0.08	0.28	0.34	0.3	0.02
combine 12	0.09	0.35	0.25	0.3	0.02
combine 13	0.08	0.32	0.29	0.31	0.02
combine 14	0.08	0.27	0.35	0.31	0.02
combine 15	0.08	0.27	0.35	0.31	0.02
combine 16	0.08	0.35	0.26	0.31	0.02
Mean	**0.11**	**0.26**	**0.29**	**0.34**	
Minimum	**0.08**	**0.21**	**0.25**	**0.3**	
Maximum	**0.15**	**0.35**	**0.35**	**0.38**	
Std. Deviation	**0.03**	**0.05**	**0.03**	**0.04**	
Disagreement					**0.04**

Table 12 - All possible combination of expert opinion

With regards to the results, the fully online synchronous and asynchronous(like MOOCs) was rated the highest preferred alternatives. The majority of the individuals comparative results, as well as the total mean, show that the fully online mode of delivery was the highest weighted alternative. Another observation was that the first administrative expert opinion was in a manner that smoothed out other opinions towards a consistent outcome (combine 1-8) but the second administrative expert opinion didn't have the same effect where the majority of preferences diverted toward the third alternative (Hybrid).

Following charts elaboratethe difference between first 8 combinations and second half:

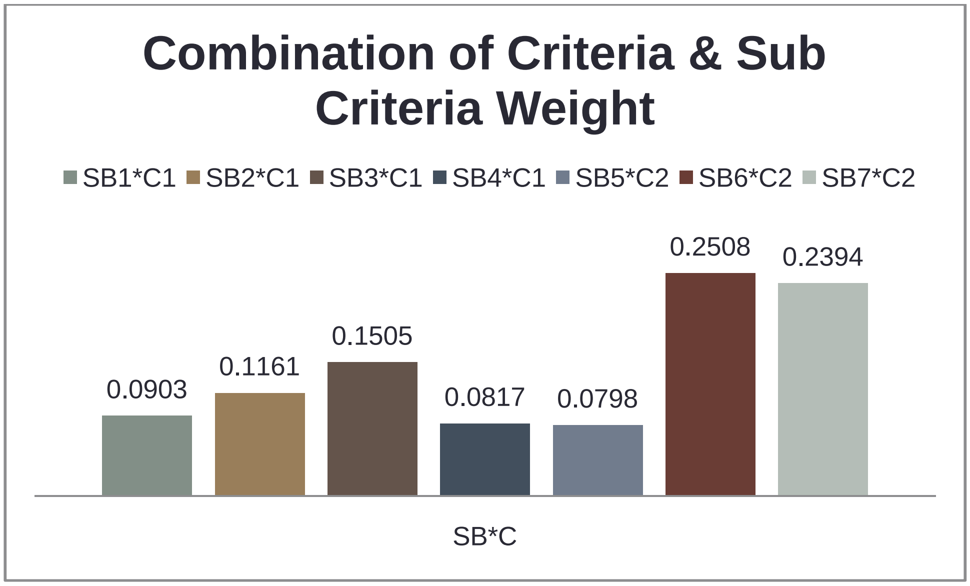

Figure 5 – Combination of HDM's Level 2 Criteria with Level 3 Sub Criteria

The above chart shows combined weight of each sub criteria (SB) with its corresponded criteria (C), where the sum of all the combination is equal to 1.

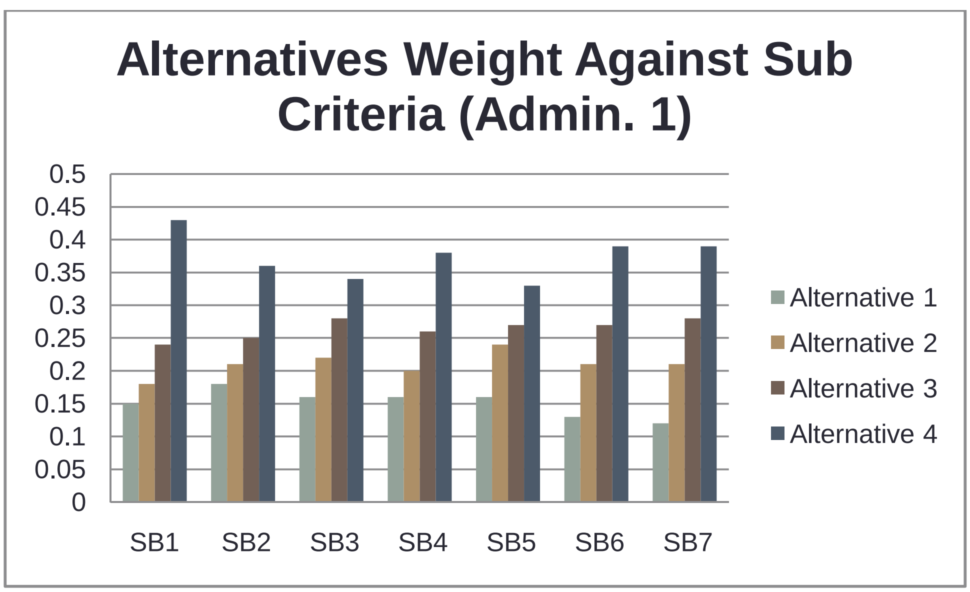

Figure 6 – Alternatives Weight Against HDM's level 3 Sub Criteria for First Administrative Expert

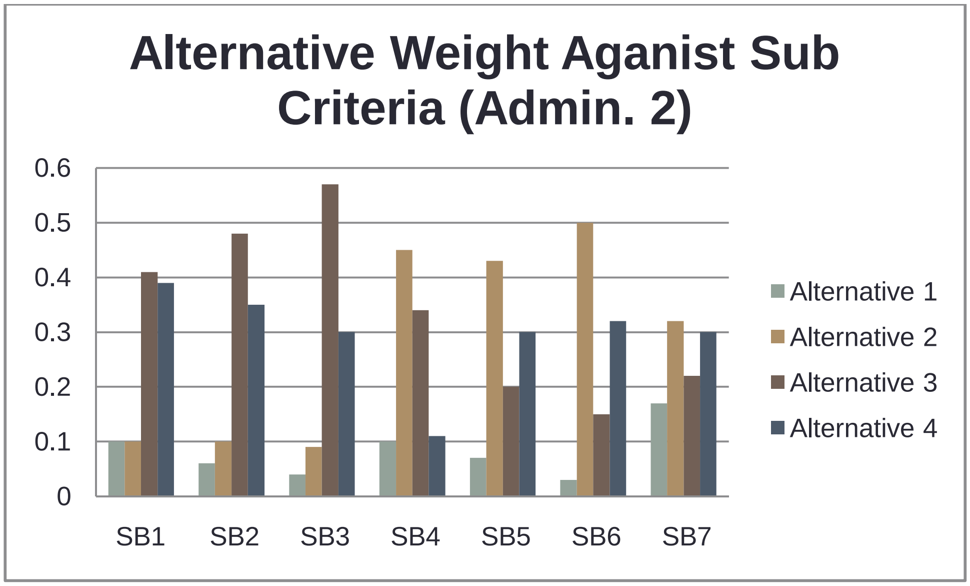

Figure 7 - Alternatives Weight Against HDM's level 3 Sub Criteria for Second Administrative Expert

According to figure 5-7, since first administrative expert was completely positive toward fully online mode, the result of the first combination overall is in favor of that alternatives. The results completely differ in the case of second administrative expert, he or she hasn't had positive opinion toward one alternative when comparing alternatives against sub criteria, because of that variation, it led to different results. More on, at the end the combination of criteria weight and alternative weight in relation to different criteria did not change the dominant administrative opinion.

7.0 Discussion and Limitations

Technology has shown in the last several years that distance learning has become more popular as a result of the internet where more people have access more easily, to more and better learning resources than they could in the past, when they had to accept only what was locally provided, if they could access even that. As the use of online distance education spreads, previously disadvantaged populations, such as rural and inner-city students, can take courses from the same institutions and same faculty that were previously only available to students in privileged, mainly suburban areas. Adults who need specialized training for career enhancement or basic skills can take courses without having to be away from home or their current jobs. Students in one country can learn from teachers and fellow students in others. Courses can be accessed whenever the student wants at his preferred pace, from almost any location. We are in a middle of a revolution as it becomes even more apparent that the learner constitutes the center of the university ecosystem, and that teaching no longer drives learning; instead, teaching responds to and supports learning. Such freedom and opportunity, however, means that students must accept the consequence of assuming more responsibility for managing their own learning.

For graduate studies at PSU’s Engineering Technology Management department, as the results indicated, it’s necessary for PSU’s graduate STEM programs start to consider new ways of teaching to students. As distance learning becomes more popular, PSU being the largest urban university in the state of Oregon, must be flexible to adopt new ways of teaching and learning as part of a combination of fully online asynchronous and synchronous programs.

Meanwhile, there were a few limitations to our results. Though PSU admnistartive expert used for alternative level, the other expert limited to ETM department, so it seems necessary to use instructor and student from other STEM program and department to be able to generalize the result. The other limitation is hard to make sure about expert quality of chosen students. To overcome this problem, it would be beneficial to have a broader poolat that level. It would be interesting to see, how the results would turn out from a bigger pool of experts from PSU. Second limitation to our study is that administrative experts were not up to date to the technology alternatives, thus not having visibility to technologies. These shows how there are a lack of technology method teachings at PSU.

8.0 CONCLUSION and RECOMMENDATIONS

Higher education must innovate to remain viable. Research has suggested collaborations between colleges, more centralized management, more efficient use of facilities, the reduction of tenured faculty and geographic and demographic expansion of course offerings[40]. A public opinion survey found that 80% of students shared that the education received is not worth the cost at many institutions[41]. This leads us to the past five years which have witnessed a transformation in the availability of educational opportunity at all levels, from the university graduate school to the kindergarten classroom, from the corporate training network to the professional development of doctors and nurses, and training of military personnel. Technology continues to advance at breakneck speed, taking with it transformation of thinking about how we learn, and forcing revision of thinking about how we teach. These changes in turn offer opportunity to forward-thinking educational administrators, and they compel others to reconsider how their institutions are organized and their budgets are allocated.

Several explanations can be suggested why so many individuals and institutions have abandoned long-held prejudices against learning that occurs outside the campus and the classroom, but nobody would deny that the principal stimulus for change has been the emergence of new technology. It is the arrival and expansion of new communications technology that has brought distance education to the attention of millions of potential distance learners in America and around the world, frequently marked as “e-learning” and “online learning.” This same technology—a combination of personal computers, the Internet, and World Wide Web, now sitting on the desks, or increasingly, as personal communications devices in pockets and purses, of almost every professor, teacher, and trainer in the developed world and beyond—has drawn millions of these educators to experiment with ideas and techniques of distance teaching.Would our results change, or would faculty and graduate students still agree that we need to focus on different methods of teaching and learning?

REFERENCES

[1] R. Henderson, A. B. Jaffe, and M. Trajtenberg, “Universities as a Source of Commercial Technoogy: A Detailed Analysis of University Patenting, 1965-1988,” 1998.

[2] N. Blom, “SA universities battle for relevance as global competition intensifies,” *Business Daylive*, 2013. [Online]. Available: http://www.bdlive.co.za/national/education/2013/07/18/sa-universities-battle-for-relevance-as-global-competition-intensifies. [Accessed: 13-Nov-2013].

[3] M. Gibbons, “Higher Education Relevance in the 21st Century.,” 1998.

[4] B. Hjørland, “The foundation of the concept of relevance,” *J. Am. Soc. Inf. Sci. Technol.*, vol. 61, no. 2, pp. 217–237, 2010.

[5] “Portland State University | Portland State University Facts.” [Online]. Available: http://www.pdx.edu/portland-state-university-facts.

[6] PSU, “Opportunity and Competitiveness for the Region : Portland State University Strategic Plan 2011-2014,” 2011.

[7] “Association of University Technology Managers - Wikipedia, the free encyclopedia.” [Online]. Available: http://en.wikipedia.org/wiki/Association_of_University_Technology_Managers.

[8] L. Harasim, “Shift happens: online education as a new paradigm in learning,” *Internet High. Educ.*, vol. 3, no. 1–2, pp. 41–61, Jan. 2000.

[9] D. Kocaoglu and N. Gerdsri, “A Quantitative Model for the Strategic Evaluation of Emerging Technologies,” *PICMET ’04 Conf. Proc. CD-ROM*, 2004.

[10] N. Gerdsri, V. Attavavuthichai, G. Ficek, W. Leesirikun, S. Waraich, and N. Wathanachinda, “Applying Technology Value (TV) Model to Replicate NASA’s Decision on Selecting the 2nd Generation of Reusable Launch Vehicle (RLV) Technology,” *PICMET ’05 Conf. Proc. CD-ROM*, 2005.

[11] R. A. Taha, B. C. Choi, P. R. Chuengparsitporn, A. Cutar, Q. Gu, and K. Phan, “Application of Hierarchical Decision Modeling for Selection of Laptop,” in *Management of Engineering and Technology, Portland International Center for*, 2007, pp. 1160–1175.

[12] A. H. I. L. He-Yau Kang, “Priority mix planning for semiconductor fabrication by fuzzy AHP ranking,” *Expert Syst. Appl.*, no. 2, pp. 560–570.

[13] J. B. Arbaugh and a. Hwang, “Uses of Multivariate Analytical Techniques in Online and Blended Business Education: An Assessment of Current Practice and Recommendations for Future Research,” *J. Manag. Educ.*, vol. 37, no. 2, pp. 229–260, Aug. 2012.

[14] N. Cavus, “The application of a multi-attribute decision-making algorithm to learning management systems evaluation,” *Br. J. Educ. Technol.*, vol. 42, no. 1, pp. 19–30, Jan. 2011.

[15] T. Turan, M. Amer, P. Tibbot, M. Almasri, F. Al Fayez, and S. Graham, “Use of Hierarchal Decision Modeling (HDM) for Selection of Graduate School for Master of Science Degree Program in Engineering,” *IEEE Explore*. .

[16] R. Bidasaria, J. Nambwenya, M. Nickeson, and K. Blommestein, “HDM for Single-Person Transportation,” *Portl. State Univ.*, Jun. 2012.

[17] H. Linstone, *Decision making for Technology Executives*. Boston: Artech House, 1999, p. 222.

[18] T. U. Daim, S. Blanton, a. N. Basoglu, and A. Ding, “Exploring information technology adoption in the classroom: case of online learning technology,” *Int. J. Bus. Inf. Syst.*, vol. 7, no. 3, p. 327, 2011.

[19] H. S. Chumley-Jones, A. Dobbie, and C. L. Alford, “Web-based learning: sound educational method or hype? A review of the evaluation literature.,” *Acad. Med.*, vol. 77, no. 10 Suppl, pp. S86–93, Oct. 2002.

[20] C. De Smet, J. Bourgonjon, B. De Wever, T. Schellens, and M. Valcke, “Researching instructional use and the technology acceptation of learning management systems by secondary school teachers,” *Comput. Educ.*, vol. 58, no. 2, pp. 688–696, Feb. 2012.

[21] Y. Gao, “Applying the Technology Acceptance Model (TAM) to Educational Hypermedia: A Field Study,” *J. Educ. Multimed. Hypermedia*, vol. 14, no. 3, pp. 237–247, 2005.

[22] S. G. Gibson, M. L. Harris, N. Carolina, S. M. Colaric, and S. Leo, “Technology Acceptance in an Academic Context : Faculty Acceptance of Online Education,” *J. Educ. Bus.*, no. August, pp. 355–360, 2008.

[23] M. K. Hsu, S. W. Wang, and K. K. Chiu, “Computer attitude, statistics anxiety and self-efficacy on statistical software adoption behavior: An empirical study of online MBA learners,” *Comput. Human Behav.*, vol. 25, no. 2, pp. 412–420, Mar. 2009.

[24] J.-W. Lee, “Online support service quality, online learning acceptance, and student satisfaction,” *Internet High. Educ.*, vol. 13, no. 4, pp. 277–283, Dec. 2010.

[25] J. Cheon, S. Lee, S. M. Crooks, and J. Song, “An investigation of mobile learning readiness in higher education based on the theory of planned behavior,” *Comput. Educ.*, vol. 59, no. 3, pp. 1054–1064, Nov. 2012.

[26] S. Lakhal, H. Khechine, and D. Pascot, “Student behavioural intentions to use desktop video conferencing in a distance course: integration of autonomy to the UTAUT model,” *J. Comput. High. Educ.*, vol. 25, no. 2, pp. 93–121, Jun. 2013.

[27] C. Christensen, H. J. Eyring, and B. Y. University-idaho, “The Innovative University : Changing the DNA of Higher Education,” *Forum Futur. High. Educ.*, pp. 47–53, 2011.

[28] D. R. Garrison and T. Anderson, *E-Learning in the 21st century a framework for research and practice*. Open University Netherland.

[29] Y.-C. Lee, “The role of perceived resources in online learning adoption,” *Comput. Educ.*, vol. 50, no. 4, pp. 1423–1438, May 2008.

[30] T. R. Liyanagunawardena, A. A. Adams, and S. A. Williams, “MOOCs : A Systematic Study of the Published Literature 2008-2012,” vol. 14, no. 3, 2012.

[31] D. Mueller and S. Strohmeier, “Design characteristics of virtual learning environments: state of research,” *Comput. Educ.*, vol. 57, no. 4, pp. 2505–2516, Dec. 2011.

[32] L. F. Motiwalla, “Mobile learning: A framework and evaluation,” *Comput. Educ.*, vol. 49, no. 3, pp. 581–596, Nov. 2007.

[33] K. Rita and H. Fournier, “New Dimensions of Self-Directed Learning in an Open-Networked Learning Environment,” *Int. J. Self-Directed Learn.*, vol. 7, no. 2, pp. 1–20, 2010.

[34] L. Gomes and J. Murphy, “An exploratory study of marketing international education online,” *Int. J. Educ. Manag.*, vol. 17, no. 3, pp. 116–125, 2003.

[35] T. Shanka, V. Quintal, and R. T. Medman, “Factors Influencing International Students ’ Choice of an Education Destination – A Correspondence Analysis Factors Influencing International Students ’ Choice of an Education Destination – A Correspondence Analysis,” *J. Mark. High. Educ.*, no. November 2013, pp. 37–41, 2008.

[36] M. H. Ginn, A. Hammond, and A. State, “Online Education in Public Affairs : Current State and Emerging Issues,” vol. 18, pp. 247–270, 2009.

[37] S. Young, “American Journal of Distance Student Views of Effective Online Teaching in Higher Education,” no. December 2013, pp. 37–41, 2010.

[38] T. Waits and B. Greene, “at Degree-Granting Postsecondary Institutions : 2000-2001 Distance Education at Degree-Granting Postsecondary Institutions : 2000 – 2001,” 2003.

[39] K. Sheehy, “U.S. News Ranks 2013 Best Online Education Programs - US News and World Report,” *US News Education Online*, 2013. [Online]. Available: http://www.usnews.com/education/online-education/articles/2013/01/14/us-news-ranks-2013-best-online-education-programs.

[40] A. Kirkwood and L. Price, “Technology-enhanced learning and teaching in higher education: what is ‘enhanced’ and how do we know? A critical literature review,” *Learn. Media Technol.*, no. September, pp. 1–31, Feb. 2013.

[41] Unknown, “No,” *Time Magazine*, p. 37.

[42] N. Dabbagh and A. Kitsantas, “Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning,” *Internet High. Educ.*, vol. 15, no. 1, pp. 3–8, Jan. 2012.

APPENDIX

APPENDIX A: Technology Cycle

Linfield[17], argues that an evolutionary swing is occurring in the global university ecosystem. Figure 2 shows the evolution of online learning management systems technology.

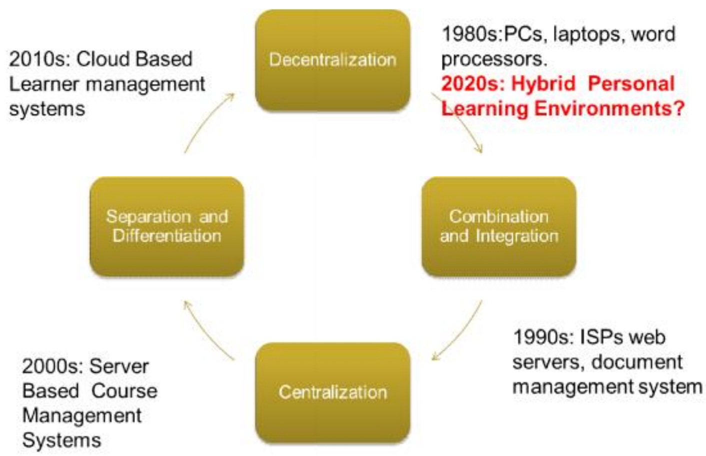

Figure A: Cyclical Technology Changes

Since the inception of the Internet, the impact of information technology on the university organization has followed an evolutionary growth model alternating from states of centralization and decentralization. Today, the higher educational industry is in the midst of a shift towards centralization. With the rapid increase of online technologies, tools and devices many universities have moved to a decentralized structure to support their online education programs. Figure A shows the impact of information technology on the university organizational structure. This case supports Linstone’s conclusion that information technology is driving “powerful possibilities of facilitating shifts between centralization and decentralization”[17] in complex systems. Applying this concept to the development of learning management systems (LMSs) provides context for further discussion.

In the early 2000s, LMSs were dominated by content management systems (CMSs). The primary function of a CMS was to organize and manage course materials. The student learning environment, built upon web 1.0 architectures, was used primarily as a CMS to post course content and assignments, communication through email and group posting directories. CMSs developed from proprietary file share and email platforms to commercially available options such as Blackboard and D2L. Development of these platforms influenced universities to centralize their technologies. Then, Web 2.0 architecture enabled social networking systems (SNS) to develop. Increasing tools and applications were adopted by students and integrated by some universities for collaborative studies and research. As these tools gained market acceptance the industry moved towards decentralization. Examples of these tools include Facebook for homework communication, wikis for group projects, Dropbox and Google docs for file sharing and team project collaborations. The variety of open educational resources (OERs), cloud based applications, mobile devices, and platform options have driven many institutions to make repeated changes in their platforms as they try to keep up with the industry.

Recently, there have been attempts at combination and integration showing signs of a movement towards centralization. Knowledge based learning environments have emerged to encourage synchronous online collaboration. Web 2.0 tools, has enabled more educators to adopt synchronous online learning pedagogy. Today, models are emerging that demonstrate a shift from decentralization back towards centralization with the use of hybrid virtual based learning environments. A virtual learning environment (VLE) incorporates collaborative knowledge and learning tools into the content management platform. Therefore, LMS technologies that drove universities to centralize in the 2000's were based upon read and post functionality. The need for synchronous learning environments coupled with technologies that allowed read/write and post functionality drove the environment towards decentralization. Currently, hybrid models are effectively being deployed as the industry is starting to swing back towards centralization.

Selection and adoption of these systems can be complicated and political in the university ecosystem. System software application packages have different strengths and weaknesses. In general, CMS solutions are designed with read and post functionality that includes student registration, course event management, course certification management and course authoring functionality. VMS functionality is template-driven for collaborative content development, has content facilitation tools, integrates workflow and interfaces easily with web 2.0 tools and applications. Other LMS selection criteria include cost and ease of integration. Most LMSs are web-based and use a database as a back-end. Systems can be developed internally, commercially purchased or leased. When purchasing an enterprise wide system it is important to understand compatibility issues with the existing information technology stack. For example, there are a variety of platforms such as Java/J2EE, Microsoft.NET or PHP and databases such as MySQL, Microsoft SQL Server or Oracle. LMSs can be developed in-house or purchasing and integrating a commercial or open source product. Popular LMS products include commercially available Desire2Learn, eCollege, WebCT, and Blackboard. Moodle is a popular open source platform.

APPENDIX B: Delivery mode criteria and perspectives

	Delivery Mode	
Perspective	Synchronous	Asynchronous
Student	Scheduled, fixed time Dedicated time – continuous Lower technology skill Higher social interaction	Time flexibility Student self-paced Advanced technology skill Lower social interaction
Educator	Controlled class size Complex courseware Instructor led	Flexible class management and size Structured courseware Instructor supported
Administration: IT support, operations, processes	Higher Interaction Face to face tutorials Flexible learning platform	Lower Interaction Podcasts and broadcasts Structured delivery platform

APPENDIX C: Architecture Comparisons

CMS	**Web 2.0**	**PLE (ONLE)**
Top down Management led	Bottom up – individual led	
Costly	Mostly free	
Server based enterprise	Cloud based web	
Wide spread buy-in	Scales – individual to enterprise	
Integrated training and support	Easy to learn and use	
Integration issues	Easy mash-up standards	
Controlled hard to modify (read and post)	Open access easy (read and write everything)	
Mature market declining choices	Lots of growth and choice	
Traditional power and IT structure controlled	Social, collaborative empowers individuals	

APPENDIX D: Course Re-design

Course Model	**PSU Use**	**Best Practice Example**
The **traditional classroom model** does not use online technologies	Majority of classes (ETM department)	
The **supplemental model** supplements the traditional lectures and textbooks with technology-based, out-of-class activities or changes what goes on in the class by creating an active learning environment within a large lecture hall setting.	**New Venture Mgt** Supplement lecture and textbook with MOOC-business model generation.	**Carnegie Mellon University: Introductory Statistics:**An automated, intelligent tutoring system monitors students' work during lab exercises, providing feedback when students pursue an unproductive path, providing an individual tutor for each student.
The **Reduce class-meeting times** from 3 to 2 per week. Move grammar instruction, practice exercises, testing, writing, and small-group activities focused on oral communication to the online environment. Use in-class time for developing and practicing oral communication skills. Reduces the number of in-class meetings.	**Introductory Spanish**. Reduce class-meeting times from 3 to 2 per week. Move grammar instruction, practice exercises, testing, writing, and small-group activities to the online environment. Use in-class time to develop and practice oral communication skills.	**Tallahassee Community College: English composition**: Reduce class-meeting times from 3 to 1 per week. Use online resources to provide diagnostic assessments resulting in individualized learning plans; interactive tutorials; and discussion boards to facilitate the development of learning communities. Use in-class time to work on writing activities.
The **emporium model** replaces lectures with a learning resource center model featuring interactive computer software and on-demand personalized assistance.	**Algebra** Open flexible lab based on ALEX software scheduling work in the emporium around their other course responsibilities.	**Louisiana State University: College Algebra**Mandatory weekly group meetings enable instructors to follow up where testing has identified weaknesses or emphasize particular applications. Group activities help build community among students and with instructors.
The **fully online model** eliminates all in-class meetings and moves all learning experiences online, using Web-based, multi-media resources, commercial software, automatically evaluated assessments with guided feedback and alternative staffing models.	Masters in Global supply chain management	Colorado State University

The **buffet model** customizes the learning environment for each student based on background, learning preference, and academic/professional goals and offers students an assortment of individualized paths to reach the same learning outcomes.	Could not find example.	**Ohio State University: Introductory Statistical Concepts**
The Linked Workshop model provides remedial/developmental instruction by linking workshops that offer students just-in-time supplemental academic support to core college-level courses.		**Austin Peay State University: Algebra**