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Application of Lean Management Techniques in Support of Improved Online Learning: A Baseline Study of Deterministic Factors Related to Instructional Design and Course Development Efficacy

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Abstract

Various lean management techniques (e.g., Ishikawa Diagrams, Total Quality Control, and Just-in-Time) can be applied to improve the efficacy of online instructional systems. Problems with online pedagogy and errors or defects in course design can be analyzed by directed processes through techniques such as root cause analysis (RCA), resulting in determination of secondary and primary causes of a given problem or defect. In cases where active pedagogy should align with instructional design techniques such as course activities, discussions, exercises, and stated learning objectives, misalignments with pedagogical practices can be resolved by real-time intervention strategies. In this baseline study, the authors report on the results of an online course quality improvement strategy involving two deterministic techniques to provide for a quality controlled e-Learning environment. Anonymous data from 103 online courses at Georgia Military College Online Campus were used in this investigation. The data were captured by the college's adjunct faculty leadership team during the process of course level review for one term. Problems and defects as determined from parsing the data were manually entered into the head of an Ishikawa Diagram and subsequently followed with regression analysis involving the learning management system to determine its secondary and primary efficient causes. As a result, 228 problems and defects were determined using RCA and documented on an errata sheet. Outcomes of this process were used to reach conclusions regarding the use of lean manufacturing techniques and tools in improving the quality of online learning.

Keywords: Business Intelligence, Lean Management, Online, e-Learning, Root Cause, Diagram, Ishikawa, Fishbone

1. INTRODUCTION

The term electronic learning (e-Learning) refers to a delivery mode of instruction now vastly used in higher education to extend the reach of the institution and increase access to courses and programs in a variety of disciplines. With the consistent growth over the past decade of e-

learning, learning conducted online using World Wide Web (WWW or Web) resources, certain focus has increased regarding improved efficacy and quality of instruction and course development (Ibrahim, 2012). In this baseline study the authors want to know what impact, if any, use of certain lean management techniques can have in improving e-Learning in higher education. Use of lean management techniques in teaching and learning environments is evidentiary and nascent researchers (e.g., Pei-Chen, Ray, Glenn, Yueh-Yang, & Dowming, 2006) note that e-learner satisfaction is not solely related to quality of applied technologies. Moreover, lean management techniques, such as cause-effect analysis, have long been used to determine qualitative factors in e-Learning implementations (Rovai & Jordan, 2004). As a result, this study is conceptually valid and by abstraction adds to the body of knowledge by examining expanded use of lean management techniques, namely regression analysis via Ishikawa diagramming, to improve e-Learning in higher education.

The authors present findings and conclusions through the lens of a qualitative ontology and interpretivist epistemology via case study methodology. Data were collected from online courses currently offered through Georgia Military College (GMC). Qualitative data collected through structured assessment in the form of a checklist are interpreted using heuristics and standards related to pedagogical and instructional design theory. The framework for this study, supported largely by Pei-Chen et al. (2006), allows for synthesis of relevant literature with qualitative data collected in live online courses. No personally identifiable data were used, thus negating institutional review board approval; however, the data collected were sufficient to reliably achieve findings and conclusions in the study. Following a supportive literature review, the authors describe the methodology and provide a qualitative data example to support analysis and discussion. Findings and conclusions also include suggestions for follow-on examination of this baseline study. Instructional designers, course developers, academic administrators, and faculty who teach online will find this study of interest and value.

2. LITERATURE REVIEW

The term *lean management* represents the core values, attributes, and attitudes of management organizational components intended to sustain long-term value and provide for continuous improvement. This management philosophy is derived primarily from the Japanese manufacturing industry, more specifically the Toyota Production System (TPS). Although the term was not refined to its present form until the 1990's, its roots can be traced to the waste management processes developed and implemented by Henry Ford, who according to his own writings gleaned the first principles of such philosophies from Benjamin Franklin's work *Poor Richard's Almanac*. Lean management minded leaders developed this strategy further by bringing about the emergence of root cause analysis techniques (e.g., Ishikawa Diagrams) in hope of tracing defects to their secondary and primary efficient causes. The traditional method of identifying, selecting, and then repairing a defect or problem within online pedagogy, course design, administrative processes, or professional development is conventionally managed via a standardized operating manual with procedures that are established by a centralized authority. E-learning leaders suggest a more dynamic approach to continuous improvement that will aid in real-time delivery of solutions.

This dynamic approach, as described by Wu and Shih-Chieh (2007), explains that the world of enterprise for the most part use IT such as data warehousing, business portal through internet, and knowledge management systems which were created for the enterprise by taking advantage of internet technology. Using a centralized approach of providing formal on-the-job education programs has possible drawbacks due to job variation (i.e., position, responsibility, and projects). Therefore, more dynamic learning approaches are required to offer real-time knowledge configuration during routine activities (Wu & Shih-Chieh).

The method of collecting real-time units of data demonstrating defects or problems within routine online pedagogical activities effectively work in concert with the continuous improvement methods of total quality management (TQM). Lean management techniques follow traditional industry standards of implementing root cause analysis via Ishikawa diagrams, errata sheets, team leaders, as well real-time identification and intervention, yet it has the resting potential to support e-learning paradigms technologically, managerially, and pedagogically. Knowing who your customers are

and what they value helps you see what parts of your process delivers that value. A deep understanding of value can guide your decisions (MacIntyre, Meade, & McEwen, 2009). Quality concerns should be paid attention during the development of the whole product life cycle…the concept and activity of TQM then becomes an important discipline for an enterprise to train its employees during their routine tasks (Wu & Shih-Chieh, 2007).

Efforts to apply TQM in an organizational context are geared toward customer satisfaction, which is perceived as the optimal measure of quality (Guzman & Torres, 2004). E-learning systems can reduce the expense of development and provide more flexible learning in terms of time and space as compared with traditional training methods (Wu & Shih-Chieh, 2007). Academic institutions seeking to embrace new paradigms such as lean management seek to do so as a means of: (a) continuously improving pedagogical efficacy; (b) improving technology infrastructure; (c) improving professional development of staff and faculty; (d) enabling interactivity, interconnectedness (i.e., connectivism), and interdependence among faculty and administrators; and (e) fixing problems at their source and in real-time. As noted in Sakarya University's (2012) study, use of root cause analysis (RCA) can be a deterministic method of success or failure within education. RCA represents a kind of problem solving method which aims to identify the root causes of problems or events…an Ishikawa diagram which is one the most common RCA techniques to determine the sources of relative failure of co-education models and formal education model (Torkul, Acikgoz, Erdem, Cagil, & lyaas, 2012).

By determination, a framework for providing lean management within e-Learning is predicated on the management of the learning and instruction process, as opposed to managing strictly courses or technology. The more important questions are about how to use technology to leverage resources and group dynamics in new ways to make the fundamental changes in every part of the learning and instructional process (Ibrahim, 2012). As access to more technological tools in classrooms is possible, teachers are more likely to change their pedagogical practices from teacher-centric to student-centric or from content-focused to creativity- and process-focused…thus traditional conception of classrooms consisting of transmission from teacher to groups of students is no longer tenable. This phenomenon occurs in part because the technological world has changed rapidly, and access to information often is achieved instantly rather than being solely mediated by teachers; access is now mediated via digital and mobile devices (Wright, 2011).

RCA within online learning proves indispensable to continuous improvement of pedagogy and course design; the two being conjoined as one will necessarily affect the other's efficacy. Online faculty that do not effectively teach the student learning objectives will yield little or incorrect data on a real-time basis that could be used to resolve the problem or defects in real-time. The data will likely be mined after the finality of the course and implemented as part of the needs analysis during course review or gleaned by a course level assessment. To make lean work, different subcomponents of the school must get to the root causes of the problems/defects and permanently remove them (Maguad, 2007).

The notion that tracing problems and defects to their secondary and primary causes requires intervention by multiple curriculum and instruction managers is supported (Farooq, Akhtar, Ullah, & Memon, 2007). In an online learning paradigm, curriculum and instruction managers as well as faculty managers generally are separated by subject matter expertise, especially when tracing problems within pedagogy as they relate to performance, conditions, and criteria of the student learning objectives. However, when a problem or defect relates to possible causes within universally applied instructional objectives, or those not tied to the subject matter, any such curriculum and instruction manager is sufficient. Quality in the educational organization can be optimized by developing a sense of cooperation and collaboration among the members of the institutional groups (Farooq et al.). Moreover, strategies for the improvement of collaboration as a team should be adopted; this dynamic can be ensured by time management. Such a notion may give gravity to process innovations that focus RCA efforts on real-time data and interventions (Farooq et al.). This research data were used to develop appropriate interventions and strategies to correct defects in instructional design, information, and communication technology support, and/or related course preparation and pedagogical best practices.

Rationales for relativistic failure posit that student basis problems, faculty basis problems, as well process based problems exist (Torkul et al., 2011). Cognitive factors such as time management and low scores in university qualification exams correlate to faculty based problems such as inadequate support of time management or lack of process. All can be traced and rooted at their efficient cause using an Ishikawa Diagram. Ishikawa diagramming has proven a highly effective problem solving method aimed at identifying the root causes of defects within pedagogical events (Torkul et al., 2011).

Moreover, Ishikawa diagramming provides administrators and faculty with an initial categorizing of quality assurance (QA) problems and separates them out into several areas of process. A lead faculty member or administrator is able to choose and subscribe individually to the need by applying a real time intervention. The root cause data is noted on an errata sheet for faculty and managers to reference during a problem or defect in process to find the appropriate solution, thus demonstrating an implementation of TQM. An individual problem/defect is identified and recorded by a lead faculty member or administrator and is fed into the head of an Ishikawa (fishbone) diagram. A collaborative learning process represented as Ishikawa diagrams can provide faculty and staff with rapid guidance in searching for required assistance when they meet quality-related problems or defects in pedagogy and process (Wu & Shih-Chieh, 2007).

3. METHODOLOGY

GMC's Online Campus enrollments currently exceed 300 fully online students and more than 800 face-to-face students, each of who take at least one or more courses online. At present 75 distinct courses are offered in 14 lower division undergraduate associate degree programs. As a result of such rapid growth, GMC's Online Campus maintains a growing need for continuous quality enhancement in course development and instruction. Academic curriculum and instruction managers, known internally as *team leaders*, followed a structured approach based on needs analysis and human performance technology rooted in lean management techniques.

The approach incorporated regression analysis of data via Ishikawa diagramming techniques, with findings relayed to the Director of Online Education and the instructional design department. All course defect-problem analysis involved lean manufacturing best practices, techniques, and collaboration, which when synthesized effectively sustained and improved the quality of the online student learning experience. In sum, the approach achieved efficacy via course review, development, change in pedagogy, and improved technical support.

For this study, the authors prepared a checklist of items grouped into domains to serve as a rubric for identifying, analyzing, evaluating, and recording data, and to provide real time solutions to defects in six domains: (i) technology; (ii) management; (iii) best practices in online pedagogy; (iv) pre-term checklist process; (v) course content; and (vi) course design. Team leaders used this rubric in the collection of data. The checklist also accounted for three timelines in a linear and connected sequential order: before and during academic week 1; academic weeks 2-7; and (final exam) academic week 8. One example checklist item for each domain involved the following determinations: (i) Does the course shell in the learning management system, including all embedded HTML, experience problems rendering in specific (i.e., IE, Safari, Firefox, and Chrome) Web browsers? – *Technology*; (ii) Is the faculty member complaining of a general lack of support or assistance from academic administration? - *Management*; (iii) Is the faculty member engaging students and content in all discussion forums minimally five out of seven days per week, including one weekend? – *Best Practices in online pedagogy*; (iv) Does a random check of the faculty member's class indicate it is properly prepared to go live with a welcome message, relevant announcements, Turnitin™ configuration if needed, calendar, weekly assignments, and active student view, etc.? – *Pre-term checklist process*; (v) Is course content missing in accordance with and support of student learning objectives (e.g., in the syllabus, course calendar states learning objective week 1, but objective and related content is missing in the course shell); and (vi) Are assessments of learning objectives incorrectly or not aligned with measured learning objectives? – *Course design defects.*

In this study, team leaders were assigned to new faculty members based on subject matter expertise, almost ubiquitously. As determined by the academic leadership and prior

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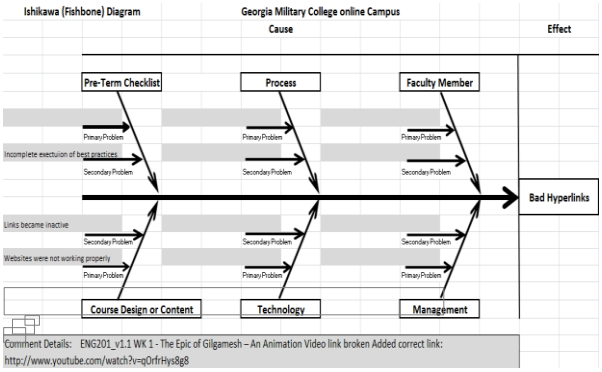
experiences with course defects, this study examined only courses taught by new faculty members, the population most likely to result in incidences of course errors and defects. Team leaders were provided access to each new faculty member's course so as to apply the checklist in the collection of data. Data were collected by team leaders via visual observation and inspection of the live course shells. Using a lean management regression analysis technique, team leaders fed listed each observed defect at the head of a fishbone diagram, and working backwards then analyzed all apparent cause-effect possibilities of the defect until the regression analysis led to the most probable root cause(s). The cause(s) of each defect were individually assessed against the rubric to determine alignment with one of the six domains and until no more cause(s) were observable.

The ultimate regressed cause was determined to be the primary root cause and was recorded along with ensuing causes noted in the aligned domain path of the Ishikawa Diagram. Secondary and tertiary causes were not always in the same domain path. Based on root cause analysis and outside of real-time interventions, team leaders digitally transferred required course defect corrections noted in the fishbone diagram to an errata sheet. The errata sheet was submitted to the appropriate individual or group of individuals (i.e., instructional designer, academic administrator, etc.) so the defects could be corrected in the master course shell, best practice defects and student learning objective defects, and other domain defects would be considered and corrected in the course review and development process.

Data were collected on defects such as broken hyperlinks; grammar, syntax, and spelling errors in course content and design; technical support process bottlenecks; problems in pedagogical efficacy, missing grades, untimely responses to students, and improper online netiquette. The data was collected from January 4, 2013 until March 19, 2013 (i.e., the online campus winter term 2013).

4. ANALYSIS AND DISCUSSION

Of all defects noted in this study, one best illustrates the use of Ishikawa diagramming, as a lean management technique, in online learning environments for improvement of instructional design, course development, and pedagogical efficacy. Figure 1 illustrates the Ishikawa diagramming techniques applied to a noted defect involving broken hyperlinks.



Comment Details: ENG201_v1.1 WK 1 - The Epic of Gilgamesh – An Animation Video link broken Added correct link: http://www.youtube.com/watch?v=qOrfrHys8g8

Figure 1: Ishikawa Fishbone Diagram

In concert with the study methodology, data led to notation of broken hyperlinks as an "effect". Using the rubric domains to analyze causes related to this effect, regression analysis revealed the following secondary and primary causes: (i) a secondary cause - incomplete execution of pedagogical best practices as part of the pre-term checklist domain; (ii) secondary cause - the link (URL) became inactive as part of the technology domain; and (iii) the efficient cause rooted in the external website which hosts the link not working properly. The perceived notion that the faculty member failed to execute a pre-term checklist action item was evinced not to be the case as the external host became non-operational after the term began. Without a thoroughgoing regression analysis, a likely scenario involves a bottleneck within process whereby the faculty member failed to meet a best practice and additional professional development may be indicated. As such, the faculty member was spared course interruptions related to the issue and management time was better spent by resolving the issue at its source in real-time, thus positively impacting future courses replicated from this shell. The Ishikawa Diagram (Figure 1) in this instance provided all data needed to procure the live course shell and created demand for a needs analysis and review of ENG 201 by the instructional design staff. Moreover, this event compelled the instructional design staff and others within academic affairs to streamline more efficient processes for continuous improvement within all online

courses, as many other courses were found to contain the same issue.

Regression analysis via Ishikawa diagramming represents an effective approach as a result of the complexity of e-Learning environments and the conditions, technologies, processes, and individuals involved. An ambiguous or non-systemic analysis of an online course could prove less effective as such an approach would be non-deterministic of primary and secondary causes. Thus, a systemic approach, such as Ishikawa fishbone diagramming, reveals specific cause-effect relationships to provide for continuous improvement, TQM, and QA of online learning. Additional value regarding data collected related to instructor pedagogical efficacy was used to advocate and promote the creation of a center for teaching excellence within the online campus and apply professional development needs through continuous improvement, as well as a revision of two online instructor training courses: PD 101 and PD 150. To conclude the study, a summative evaluation of the course was conducted and results from this approach were shared with all online campus faculties and staff as well IT senior leadership.

5. FINDINGS AND CONCLUSIONS

As a result of interventions related to Ishikawa diagramming via lean management methods of regression analysis, the GMC Online Campus subsequently experienced the following improvements: (i) a significant decrease in the number of student complaints; (ii) significant decrease in email traffic to the faculty manager and other academic administrators from adjunct faculty in regard to issues and requested assistance with online pedagogy; (iii) significant increase in the sum of identified course design defects, technology defects within the LMS, the existing service delivery model, and IT governance functional areas in support of the end users; and (iv) resolution in real-time of hundreds of problematic scenarios and defects within live courses.

A successful continuation of the study would involve two initiatives: (i) identify and discriminate between the problems/defects discovered via lean management techniques with those that occur normally under the traditional course review schedule, and (ii) discern whether the real-time interventions were necessary for the integrity of the online course pedagogy or if the interventions were merely a redundancy to an existing process of course development and review. For replication purposes the translation of lean management techniques via regression analysis may involve assistance from an instructional design staff or expertise from a center for teaching excellence. Involvement from these organizational components could serve to advance this study and improve the rubric assessment questions used in the regression analysis.

Based on findings in the study, the authors concluded that the impact of using lean management techniques within online learning, instruction, development, and review improves efficacy and quality within each of these respective areas, and also significantly reduces defects. Cause-effect analysis applied to an online learning environment via lean management techniques, such as Ishikawa diagramming, improves learner satisfaction and evinces that more than quality implementations of applied technologies are necessary to support vibrant and healthy online pedagogy.

The application of lean management techniques within online learning demonstrates that senior management must support and understand the importance of instructional design, and likewise must the instructional designers provide insight, support, design, and review competently. Applying lean management principles to online learning to achieve root causes through regression analysis via diagramming can provide determinations for areas of improved understanding of e-Learning environments. Moreover, senior academic management are informed if there exist bottlenecks within instructional design operational process or lack of due diligence within normal online course maintenance tasks and duties.

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