SEMANTIC MAPPING OF LEARNING ASSETS TO ALIGN CURRICULUM AND EVIDENCE LEARNING EFFECTIVENESS IN BUSINESS EDUCATION

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ABSTRACT

Ensuring the alignment of course content against desired goals and objectives has always been at the core of effective instructional course design—whether the instruction is delivered face-to-face, or via the support of distance technologies. Nonetheless, with the latter delivery of instruction, two distinct challenges have recently emerged, thus prompting the need to re-examine the term "quality" as it relates to accreditation. The first challenge lies within the ability to locate and/or create and align digital learning objects to course goals and objectives. The second challenge lies within the ability to demonstrate learning effectiveness from learning management system metadata. A research and development team at American Public University System addressed these challenges by employing an open source repository and semantic engine for analysis and alignment of content, materials, and learning activities to goals and objectives across all courses within the School of Business. The result was a highly detailed, accurate mapping of the programs' knowledge base to established goals and objectives. As an added benefit, resources were disaggregated to a very granular level and sorted into taxonomies that can be independently referenced and utilized for cross-curricular consumption.

JEL: I23, O31, O32

KEYWORDS: Accountability, Accreditation, Business Education, Quality, Excellence, Online Learning, Semantic Mapping, Semantic Analysis, Learning Assets, Learning Management Systems, Goals and Objectives

INTRODUCTION

Defining, assessing, and evaluating the term "quality" continues to be a challenging and evolving task for all sectors in society. Whether a good or service, defining quality has been heavily reflective of current economic and societal trends; therefore establishing definitions and associated indicators continues to be a highly fluctuant undertaking.

In recent years, however the field of higher education has been abruptly faced with the task of re-defining, re-assessing, re-evaluating, and re-evidencing quality in terms of: (1) online learning objects; and (2) accreditation. Ensuring the alignment of course content against desired goals and objectives has always been at the core of effective instructional course design—whether the instruction is delivered face-to-face, or via the support of distance technologies. Nonetheless, with the latter method of instructional delivery, the architecture of a Learning Management System (LMS) challenges online instructors and Information Technology (IT) departments to locate and/or create digital learning objects that align to goals and objectives.

This challenge is further compounded by increased pressure for accountability and demonstration of learning effectiveness at institutions of higher education. From the organizational perspective, the overwhelming amount of information stored within internal and/or external systems presents a significant

challenge when codification of tacit knowledge is required for accreditation purposes. While keyword and metadata strategies have provided some benefit, these methods suffer from a lack of robustness. As such, they provide only incremental improvements to what remains a highly manual process.

A research and development team at American Public University System addressed these challenges by employing an open source repository and semantic engine for analysis and alignment of content, materials, and learning activities to goals and objectives across all courses within the School of Business. The result was a highly detailed, accurate mapping of the programs' knowledge base to established goals and objectives. As an added benefit, resources were disaggregated to a very granular level and sorted into taxonomies that could be independently referenced and utilized for cross-curricular consumption.

The article is presented in the following sequence: (1) a review of research related to semantic mapping and accreditation; (2) the methodology used to collect and analyze the pertinent data; (3) a discussion of the results, followed by concluding comments and possibilities for further research in semantic mapping in terms of fulfilling accreditation requirements.

LITERATURE REVIEW

Accreditation and Quality

Developed over 100 years ago, accreditation has been a long-standing pillar in education. Narrowly defined, accreditation is a set of standards and competencies used to evaluate an institution's overall organizational effectiveness. Definitions of educational quality and measurement have historically evolved around changing socio-economic forces, thus prompting continual changes and adaptations in institutional practices and policies. It is likely these continuous transformations have contributed to negative perspectives of accreditation as being a cumbersome and obligatory process (Lejeune and Vas, 2009). Viewed in a more positive light, accreditation has the transformative ability to raise institutions to exceeding levels of excellence in teaching and learning.

Accreditation of institutions of higher education are governed by six regional accrediting bodies (Middle States Commission on Higher Education (MSCHE); New England Association of Schools and Colleges Commission on Institutions of Higher Education (NEASC-CIHE); North Central Association of Colleges and Schools Higher Learning Commission (NCA-HLC); Southern Association of Colleges and Schools (SACS); Western Association of Schools and Colleges Accrediting Commission for Community and Junior Colleges (WASC-ACCJC) ; and Western Association of Schools and Colleges Accrediting Commission for Senior Colleges and Universities (WASC-ACSCU) who grant accreditation against overarching criteria including: (1) Mission and Integrity; (2) Preparing for the Future; (3) Student Learning and Effective Teaching; (4) Acquisition, Discovery, and Application of Knowledge; and (5) Engagement and Service. Recent innovative developments against a grim economic backdrop have led to extensive policy changes regarding accreditation criteria. These policy changes have had far-reaching effects for higher education institutions and have also extended to organizations accrediting programs *within* an institution. For online programs, these policy changes have additional implications in terms of aligning content to goals and objectives and for evidencing learning effectiveness.

Online Content Alignment to Goals and Objectives

The rapid growth of a technologically-driven society has triggered limitless opportunities in the areas of teaching and learning—particularly in distance education. Online learning has increasingly become the preferred method of instructional delivery among learners worldwide (Allen and Seaman, 2011). Due to a myriad of components and tools that allow for effective teaching and learning, learning management

systems (LMS) have primarily been the platform of choice for online learning. Nevertheless, this disruptive technology (Christensen, Baumann, Ruggles, & Sadtler, 2006) has also prompted educational leaders who implement learning management systems to determine institutional best practices and policies for this mode of instructional delivery (Anthony, Johnson, Sinfield, & Altman, 2008). Moreover, the unique architecture of a learning management system, has presented new challenges in terms of defining and evidencing instructional quality that starkly contrast traditional definitions and measures.

At the program level, curriculum alignment has always been a critical component for effective face-to-face learning for centuries (Marzano, 2004; Merrill, 1994). Alignment of online learning assets to goals and objectives, however, has necessitated the exploration, evaluation of online learning content (Kay & Knaack, 2007; Krauss & Ally, 2005; Nesbit, Belfer & Vargo, 2002) and how this digital content can be matched to goals and objectives. Historically, this charge has been largely the responsibility of the instructor; however, considered a disruptive technology (Garrison & Kanuka, 2004), online learning has rapidly proliferated and become a priority for several--if not all, areas of higher education.

Online course creators have commonly labored over locating content pertinent to the course(s) they teach. Some may also opt to use packaged educational materials tailored to their specific discipline. Content, or digital objects used to deliver instruction in an LMS are commonly referred to as a *learning object*. The Institute of Electrical and Electronic Engineers broadly defines a learning object as "any entity, digital, or non-digital, which can be used, reused, or referenced during technology supported learning" (IEEE Learning Technology Standards Committee, 2002). Albeit there are many high quality learning objects available, learning objects designed within an institution's LMS are not reusable (as originally meant to be) as they are either stored privately and/or they are not visible to external systems (Mohammed & Mohan, 2007). The reusability issues, which are common to many IT departments have primarily been due to: (a) misaligned metadata standards (Mohan & Greer, 2003); (b) learning objects that are only reusable within the systems for which they were built and reside; and (c) the lack of semantic metadata. These issues require semantic analysis to efficiently and effectively manage and align digital content; however, this approach has been largely unexplored.

Semantic Mapping Analysis

In the Learning or Content Management System environments, content management frequently translates into a single-purpose allocation of content resources, with cataloging and meta-tagging being a haphazard affair. The amount of stored, yet accessible information is so substantial, that IT departments consistently seek efficient and effective ways to manage and make use of this abundance of information (Gartner Inc. Predicts, 2012). This focus has led to the need to efficiently and effectively design and update online courses. As with any pedagogically-sound instruction, a core requirement in course design must be the alignment of goals and objectives to formative and summative learning activities (Combs, Gibson, Hays, Saly & Wendt, 2008). By automating the meta-tagging and gap analysis process, semantic analysis allows one to not only smartly survey existing learning objects in a specific curriculum area, but also to examine more learning objects across unrealized curriculums. The ability to determine content interrelationships through the mapping of assets across the content universe enables one to effectively and efficiently facilitate object reusability towards curricular goal and objective fulfillment. This process allows for the actualizing of opportunities to locate learning objects to fulfill course level objectives for alignment across course level objectives, programmatic outcomes and industry standards. Improvement of instructional outcomes, through the ingestion of work products from implementation of content distillation and semantic analysis, ultimately increases return on investment and time on task.

Similar to contemporary object oriented programming language, semantic analysis is reliant on defining data in terms of classes with attributes and instances. The vision of the semantic aware applications builds upon this concept by refining these ontologies through comparisons of associated metadata. Currently,

there are two approaches for developing semantic applications; the bottom-up approach and the top-down approach. The bottom-up approach is problematic in that it assumes metadata will be added to each piece of content to include information about its context; tagging at the concept level, if you will. The top-down approach appears to have a far greater likelihood of success, as it focuses on developing natural language search capability that can make those same kinds of determinations without any special metadata (Johnson, Levine, Smith, 2009).

American Public University System (APUS) School of Business

American Public University System (APUS) is a regionally and nationally accredited, private, fully online university offering an extensive variety of fully online academic programs that do not require students to physically attend classes. Demonstrating a commitment to a high quality education for its students, APUS strives "to provide quality higher education with emphasis on educating the nation's military and public service communities by offering respected, relevant, accessible and affordable, student-focused online programs, which prepare them for service and leadership in a diverse, global society" (APUS website, 2012). The institution's core values support this mission in the following areas: (a) learning quality; (b) integrity; (c) diversity; (d) freedom of inquiry and expression; (e) accountability; (f) access to underserved; (g) adaptive and responsive; (h) innovation; and (i) collaboration. The institutional mission, vision, and core values support and guide all APUS academic programs, thus demonstrating a continual commitment to quality and excellence in student learning.

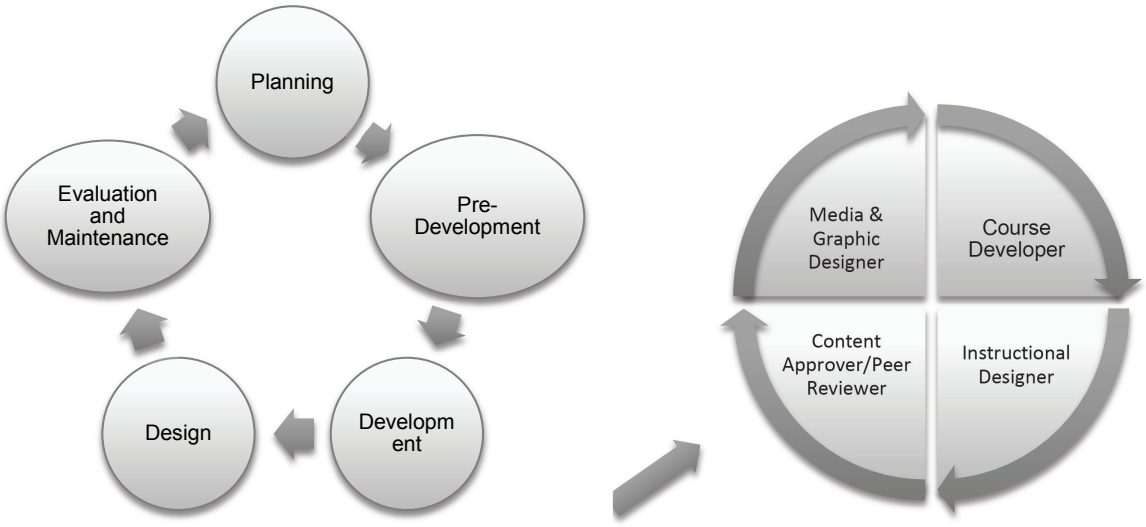
The APUS School of Business offers degrees at the Associate, Bachelor, and Masters levels in Business Administration, Marketing, and Accounting. Accreditation support for these programs is provided by both the Accreditation Council for Business Schools & Programs (ACBSP) and the North Central Association Higher Learning Commission (NCAHLC) in their Business Administration and Marketing academic programs. The ACBSP is a leading accreditation business education association that establishes standards and criteria for demonstrating excellence in baccalaureate/graduate degree programs and schools. Each of the 11 Common Professional Components (CPC) must receive at least the equivalent of two-thirds of an entire course to be considered compliant and include: (1) Learning-Centered Education: (2) Leadership; (3) Continuous Improvement and Organizational Learning; (4) Faculty and Staff Participation and Development: (5) Partnership Development: (6) Design Quality; (7) Management by Fact: (8) Long-Range View; (9) Public Responsibility and Citizenship; (10) Fast Response: and (11) Results Orientation (ACBSP, 2011).

The value of ACBSP accreditation is evidenced in the quality of the programs and the faculty who are attracted to accredited programs. For students enrolled in these programs, accreditation provides two overarching advantages, it: (a) creates the impetus for relevancy and currency of faculty, programs and courses to best serve students; and (b) enhances the ability to serve students by assuring a focus on quality performance. To ensure exceeding levels of academic quality, the APUS Instructional Design department commissioned an outside entity to provide an unbiased and rigorous assessment of Common Professional Components (CPC) coverage in two baccalaureate programs: Business Administration and Marketing. Specifically examined were program- and course-level estimates of instructional time spent on each CPC. In past years, providing evidence of student learning derived from online learning systems has typically been a difficult and time-consuming process—largely due to the inconsistencies in online course design and misalignment of course goals and objectives. Therefore, the results of this study could have substantial implications for managing, streamlining, and refining the process of providing accrediting entities with the required information they need to award initial or renewal accreditation.

APUS ID Process Model

At American Public University System (APUS) the Instructional Design and Development (IDD) Team created an Instructional Design Process Model to design and develop curricula. The APUS ID Process Model is a continuous course development process allowing for the collaboration with Subject Matter Experts (SMEs), Instructional Designers (IDs), Graphic and Media specialists, and Content Area experts both internal and external to the institution. A derivative of the ADDIE model (Molenda, 2003), the APUS Instructional Design Process Model also integrates the foundational principles of the Community of Inquiry (CoI) Arbaugh, Cleveland-Innes, Diaz, Garrison, Ice, Richardson, & Swan, 2008) and was applied to every step of the process; planning, pre-development, development, design, and evaluation, and maintenance as shown below in Figure 1.

Figure 1: APUS Instructional Design Model



This balanced, six-phase process model is an architecture which enables the team to focus on three important elements of the courseware development. First, the team implemented accepted best practices in online Instructional Design (ID) systems pedagogy, andragogy, and heutagogy modeling to structure overall courseware development. Next, the CoI was applied to the online learning framework in the courseware to ensure successful student outcomes. Finally, the team utilized agile project management principles to allow for collaboration and communication, both internally and with subject matter experts, while still maintaining discipline, quality, and rigor throughout the project's lifecycle (Staley, Gibson, Ice, 2010).

Three Issues, Three Solutions

Though highly efficient and effective in rapidly creating quality content across a network of over 130 geographically dispersed contributors, the APUS IDD team remains confronted with three problems consistently confounding the field. First, content and learning activities created with the premise that SMEs have a mastery of their area and will ensure that goals and objectives are met through tacit embedding of area knowledge within course structures. However, subject matter experts are human and prone to the same tendency to have expert blind spots; a phenomenon long noted in the traditional classroom (McKeachie, 1986). Second, meta-tagging data is a time intensive process that even when executed with a high degree of accuracy provides little more than key word associations. Finally, because all contributors have knowledge of the underlying taxonomies or common vernacular that the information

is based upon, it is difficult for organizations to survey their content universe for existing objects that can be incorporated into emerging workflows.

As with all institutions, APUS is also confronted with the issue of providing adequate data for accreditation by external entities. Within the accreditation process is the task of demonstrating that curricula fulfills both course level and program level goals and objectives. While the IDD process, described above, is designed to help expedite goal and objective alignment, the limitations previously described still limit the robustness of execution. To solve this problem, APUS investigated the feasibility of using semantic analysis to: (a) match program and course level goals and objectives to course content and activities; (b) create a gap analysis to note where additional resources should be applied to meet goals and objectives; and (c) create robust content repositories that have granular associations between course components and over-arching ontologies that can be applied in a cross-curricular fashion.

Interestingly, the NMC/ELI Horizon Report (2009) indicates that semantically aware applications are not likely to become standard for four to five years, however, a few innovative prototypes are currently being utilized. Even as these applications are still undergoing refinement, the prototypes demonstrate the potential power of semantic applications for both formal and informal learning. The IDD team at APUS vetted several of these cutting edge solutions, both open source and proprietary for the purposes previously described. The Common Library solution, an open source repository available under an Apache 2 license on Source Forge, was ultimately selected.

The Common Library

Developed from the ground-up to address specific needs in education, Common Library (http://commonlibrary.org) is the first standards-based content management system to enable true collaborative potential through the integration of content development and social networking. The Common Library latent semantic search engine defines a unique and powerful aspect of the application. In the current 2.0 implementation of the system, the metadata and content of each learning object are compared against defined standards systems. As shown below in Figure 2, the higher-order logic of the Learning Object Lifecycle enables the Common Library to dynamically suggest interconnections between content items and applicable state standards, providing immediate value for users in the K-12 educational market. This functionality also defines the potential for constructing dynamic relationships between state standard systems that evolve over time.

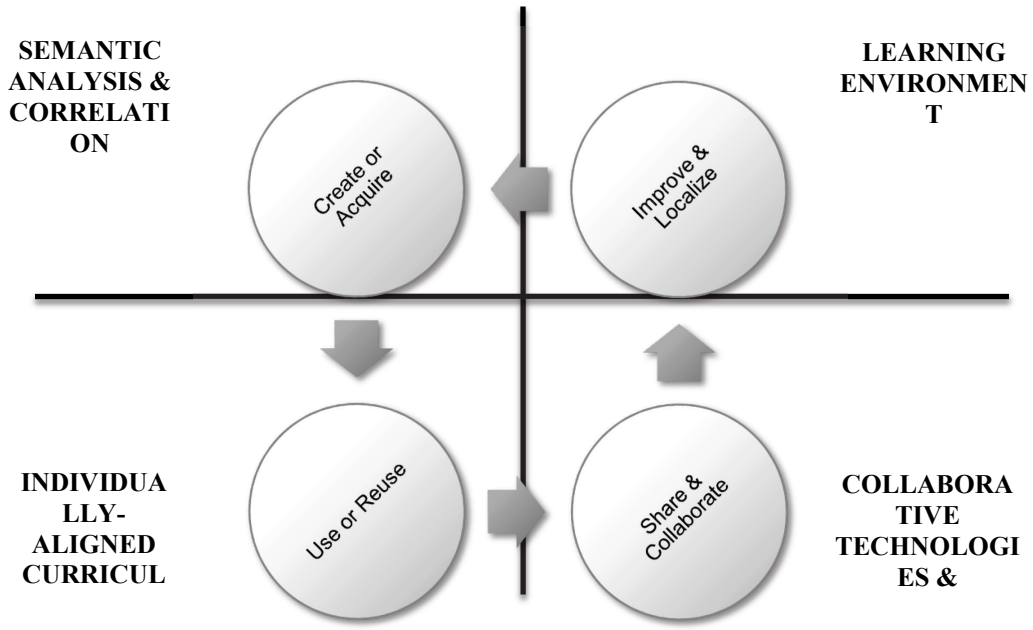
Implementation of search and aggregate technology generates references that feed new granularly addressable connections between content and curriculum structures as new knowledge of individual user requirements is acquired.

METHODOLOGY

An instance of this solution was stood up for the APUS IDD team and all course components for the APUS Business Program were federated during the fall 2010 academic semester. As semantic analysis is an emerging technology it is still considered somewhat suspect in the realm of higher education. To assess efficacy, random sampling of Common Library output--both matching and gap analysis, was compared against human to Common Library agreement, as well as human to human agreement. An interrater reliability analysis using the Kappa statistic (Landis & Koch, 1977) was performed to determine consistency among raters. The first test (human to Common Library interrater reliability was established at Kappa = .90 ($p < 0.001$). For the second instance (human to human agreement), the interrater reliability was established at Kappa = .93 ($p < 0.001$). Thus, following values of Kappa ranges: (a) 0.40 to 0.59

(moderate); (b) 0.60 to 0.79 (substantial); and (c) 0.80 (outstanding), the reliability of the Common Library analysis would be considered outstanding when compared to human analysis.

Figure 2: The Learning Object Lifecycle



This figure shows the processes of a learning object lifecycle according to the four areas in which each process correlates. The higher-order logic of the Learning Object Lifecycle enables the Common Library to dynamically suggest interconnections between content items and applicable state standards, providing immediate value for users in the K-12 educational market.

After disaggregation of the materials, a granular analysis was conducted using Common Library's underlying latent Dirichlet analysis engine (Neal, 2000; Ramamoorthi & Srikanth, 2007; Yu, Yu, Volker Tresp, 2005). The Granularity Model (Figure 3) demonstrates the full mapping of program goals and objectives that were created across the content universe. Where incidents of deficiency were noted, remedial action was taken to provide additional resources.

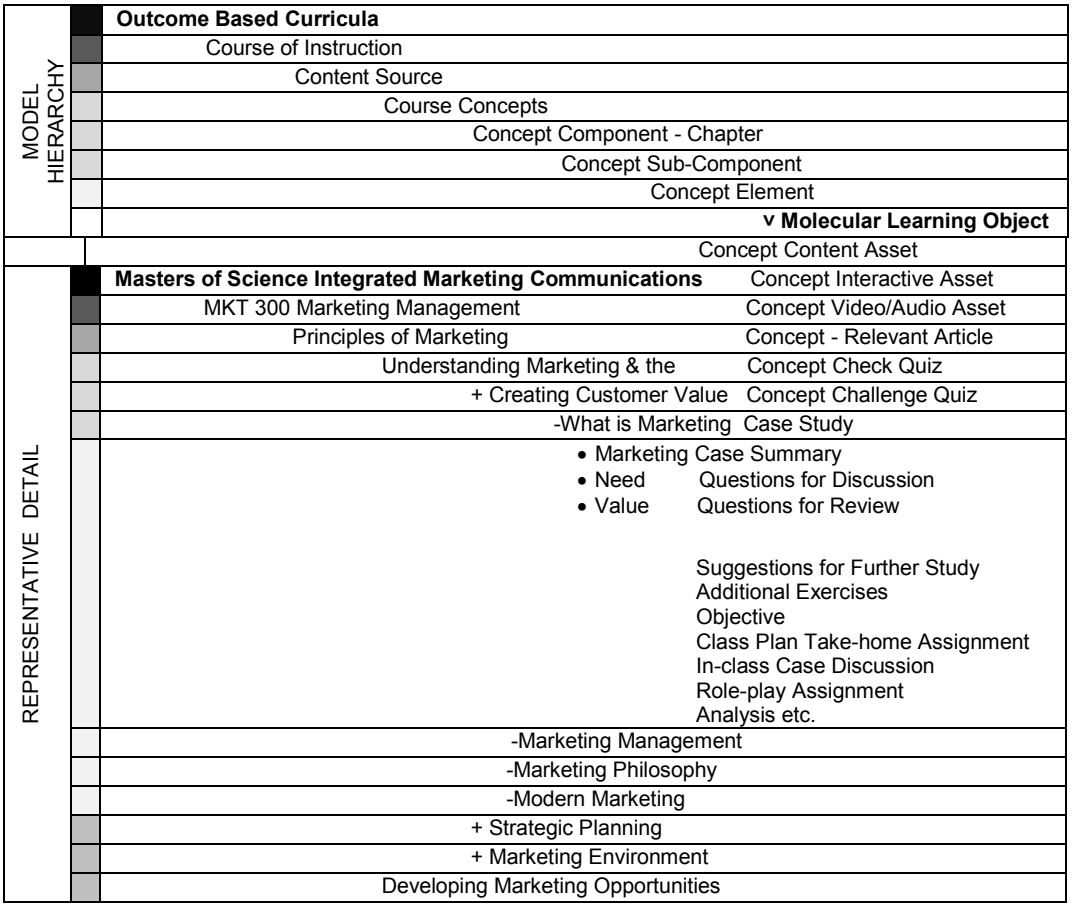
RESULTS AND DISCUSSION

Content and activities from 29 courses in the APUS Business Program were federated in Common Library. Disaggregation of content yielded 5227 granular level assets and ontological ordering, using Dirichlet analysis, was conducted and categorical structuring was implemented using an iterative, multi-pass approach. A total of 538 goals and objectives, from both the program and course level, were input into the system. Using a natural language approach, these goals and objectives were specified as being representative of over-arching ontological structures. From this point, information from the granular asset analysis was converged on the goals and objectives.

Of the 538 goals and objectives, matches were identified among 465 respective assets. The asset match ranged in scope from between two and 38 assets per goal. With respect to identification of gaps, 73 goals and objectives were identified for which there were no corresponding assets. These areas were noted and recommendations were made to the School of Business. Subsequent content development, which was added to the existing repository, resulted in a second run in which all but three goals and objectives could

clearly be mapped to corresponding course content and activities. Application of this technique allows for large-scale analysis of correlations between goals / objectives and associated course assets. In turn, the ability to identify areas of deficiency and construct learning pathways ensures that all desired goals / objectives are addressed in a timely and thorough fashion. While not yet implemented, the ability to aggregate student work products, as well as discussion threads, also exists. Using this approach the power of semantic analysis can be extended to include relating learning outcomes back to goals / objectives, providing a complete map of the learning cycle.

Figure 3: Granularity Model



The ability to rapidly map assets to goals and objectives is significantly more effective when using a semantic engine than when similar processes are implemented by human coders. For this implementation, 137 hours were required from the IDD Team, project management, and technical personnel. A corresponding test case revealed that mapping one course against goals and objectives required 64 hours. When expanded to the 29 course sequence that was reviewed the mapping process would have translated into 1856 hours. Thus, the application of semantic analysis resulted in a 92.7% reduction in human labor. Translated into monetary terms the savings, including fringe benefits would be approximately $80,000 (U.S.).

Notably, standing up the instance of Common Library required 32 hours which will not be required in future mapping initiatives. Given the demands of mapping for both internal and external purposes, and including multiple programs, it is easy to visualize how this technique could result in savings of over $200,000 per year while drastically streamlining institutional course review and development processes.

The ROI on this later aspect should be the subject of more comprehensive program evaluations for instance of implementing this technique.

Evidence illustrates that the ability to roundtrip content and goals / objectives is a key benefit of this process. In other words, a content universe can be checked for assets that are linked to goals and objectives or individual assets may be viewed and their correlation to goals and objectives are then identified.

CONCLUDING COMMENTS

From an ID perspective, semantic analysis of content allows for confirmation that all goals and objectives have been fulfilled, as well as identification of existing gaps and the need for generation of other materials. In addition, instructional designers can rapidly identify existing assets that can be repurposed for use in new courses or programs; thus delivering on the concept of highly reusable learning objects. This latter capability is especially useful in instances where unrealized cross-curricular content may have already been developed but not realized due to programmatic silo effects and the related lack of awareness on the part of subject matter experts.

At the institutional level, this technique provides administrators the ability to rapidly assess existing materials and effectively plan for future staffing and development needs. When approaching accreditation, either regional or program specific, institutions become empowered to designate only those resources necessary to insure success, as opposed to current models in which countless hours are spent by faculty and staff checking and rechecking documentation to avoid potential lack of compliance. Presently APUS has engaged full time staff to extend upon this study by systematically applying semantic analysis to over 1500 courses, with the intent of facilitating continuous quality improvement across the institution.

With respect to the accreditation process itself, governing bodies can leverage semantic analysis to make processes far more transparent and efficient. On demand any goal or objective can be produced and corresponding content reviewed, alleviating the need for countless hours of spot checking manually compiled materials. However, it should be noted that this process also brings with it virtually unlimited transparency into any organization, thus increasing the level of scrutiny evaluators may apply.

Moving forward, semantic analysis has to potential to allow for round-tripping of student data. In other words, student work products could be ingested into semantic engines in the same fashion as content. Goal matching could then be applied to each students work and correlations that demonstrate fulfillment of objectives identified. When this process is achieved the ability to assess learning outcomes will be automated in the same fashion as content alignment, shedding complete transparency upon the academy.

REFERENCES

Accreditation Council for Business Schools & Programs (2011). ACBSP Standards and Criteria for Demonstrating Excellence in Baccalaureate/Graduate Degree Schools and Programs. Retrieved from www.acbsp.org/download.php?sid=29

Allen, I.E. & Seaman, J. (2011). *Going the Distance: Online Education in the United States 2011*, Babson Survey Research Group. Retrieved from http://sloanconsortium.org/publications/survey/going_distance_2011

American Public University System (2012). Mission, Vision, and Core Values. Retrieved from http://www.apus.edu/about-us/mission.htm.

American Public University System (2012). School of Business. Retrieved from http://www.apu.apus.edu/academic/programs/school/apubus/business

Anthony, S. D., Johnson, M. W., Sinfield, J. V., & Altman, E. J. (2008*). Innovator's Guide to Growth - Putting Disruptive Innovation to Work*. Harvard Business School Press.

Arbaugh, J. B., Cleveland-Innes, M., Diaz, S. R., Garrison, D. R., Ice, P., Richardson, & Swan, K. P. 2008. Developing a community of inquiry instrument: Testing a measure of the Community of Inquiry framework using a multi-institutional sample. *The Internet and Higher Education, 11*(3-4): 133-136.

Christensen, C. M., Baumann, H., Ruggles, R., & Sadtler, T. M. (2006). "Disruptive Innovation for Social Change" *Harvard Business Review*, December 2006.

Combs, K. L., Gibson, S. K., Hays, J. M., Saly, J., & Wendt, J. T. (2008). Enhancing curriculum and delivery: linking assessment to learning objectives. *Assessment & Evaluation in Higher Education, 33*(1).

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education, 7(2*), 95-105.

Gartner, Inc. (2012). Four Forces Combine to Transform the IT Landscape. Retrieved from http://www.gartner.com/DisplayDocument?id=1871420&ref=g_noreg

IEEE Learning Technology Standards Committee (2002). Learning object metadata. Retrieved from http://www.ieeeltsc.org:8080/Plone

Johnson, L., Levine, A., Smith, R. (2009). The 2009 Horizon Report. Austin, Texas: The New Media Consortium.

Kay, R., & Knaack, L. (2007). Evaluating the learning in learning objects. *Open Learning: The Journal of Open and Distance Learning, 22*(1).

Krauss, F., & Ally, M. (2005). A study of the design and evaluation of a learning object and implications for content development, *Interdisciplinary Journal of Knowledge and Learning Objects, 1*:1-22. Retrieved from http://ijklo.org/Volume1/v1p001-022Krauss.pdf

Landis, J. R., Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics 33:*159-174.

Lejeune, C. & Vas, A. (2009). Organizational culture and effectiveness in business schools: A test of the accreditation impact, *Journal of Management Development, Vol. 28* (8), 728–741.

Marzano, R. J. (2001). Designing a new taxonomy of educational objectives. Thousand Oaks: Corwin Press.

McKeachie, W. (1986). Teaching and learning in the college classroom: A review of the research literature. Ann Arbor, MI: University of Michigan.

Merrill, M. D. (1994). Instructional design theory. Englewood Cliffs: Educational Technology Publications.

Mohammed, P., & Mohan, P. (2007). Contextualizing learning objects using ontologies. *Computational Intelligence, 23*(3), 339-355. Retrieved from http://www.blackwell-synergy.com/doi/abs/10.1111/j.1467-8640.2007.00309.x

Mohan, P. & Greer, J. (2003). Using learning object technology to tackle the education challenges of the Caribbean. International Conference on Information Technology: Research and Education, 2003. Proceedings. ITRE2003, 11-13: 484 – 488. Retrieved from http://ieeexplore.ieee.org/Xplore/login.jsp?url=/iel5/8953/28360/01270665.pdf?arnumber=1270665

Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement, 42*(5).

Neal, R. M. (2000). Markov chain sampling methods for Dirichlet process mixture models. *Journal of Computational and Graphical Statistics, 9*:285.

Nesbit, J. C., Belfer, K., & Vargo, J. (2002). A convergent participation model for evaluation of learning objects, *Canadian Journal of Learning and Technology, 28* (3):105–120.

Ramamoorthi, R. V. & Srikanth, K. R. (2007). Dirichlet processes. In Encyclopedia of Statistical Sciences. New York: John Wiley and Sons.

Staley, J., Gibson, A., Ice, P. (February, 2010). "Impacts on Student Satisfaction through Curricular Design: Factors of the Community of Inquiry Framework and Instructional Design

Practices" New Orleans, LA: Southwest Educational Research Association, 32nd Annual Conference.

Yu, K., Yu, S., Volker Tresp, V. (2005). Dirichlet enhanced latent semantic analysis. In Workshop on Artificial Intelligence and Statistics AISTAT 2005.

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