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Simplified Single Source Xml Model: for Student-Centered Educational Content Management

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SIMPLIFIED XML SINGLE SOURCE MODEL:

FOR STUDENT-CENTERED EDUCATIONAL CONTENT MANAGEMENT

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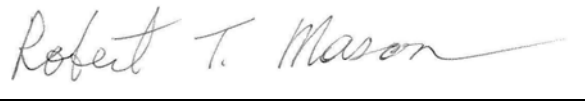
APPROVALS



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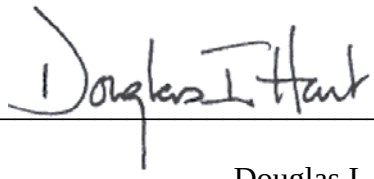

Douglas I. Hart

Abstract

This study investigates XML as a single source, recommending solutions and defining future needs for educators to manage student-centered educational content for diverse user preferences and multi modal delivery. This research proposes a simplified XML single source model for educational course content management and XSL transformation of course material into multi-modal display/output that enables student-centered learning. The reviewed literature exposed four problem areas related to content management in which an XML single source might be a solution. Reviewed and synthesized literature related to XML into a cubed relationship with opposing the sides of the cube (content management/single source, corporate goals/educational goals and reuse/repurpose) compared and contrasted. The result points to the need for a simplified XML model in order to realize the potential of educational goals for student-centered transformations (repurposing content) and to future proof content management that is device independent and provides possible solutions to the problem areas in content management and technology management of course material.

Acknowledgements

I thank God for the moments of inspiration that took a diverse group of literature and tied it together into what became the XML^3 cube, making it possible to organize the information in a meaningful way.

Thank you Connie Holman and Rexine Duley for proofreading my paper and helping to ensure the grammar and syntax are correct and the writing style/tone consistent. I greatly appreciate your time, effort and expertise.

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Chapter 1 – Introduction

The Extensible Markup Language (XML) has shown promise as a tool for developing course content (Wollowski, 2002, p. 1). Walsh (2007) used XML as a single source in his case study, and found that at his institution course materials were in many different formats: PDF, Hypertext Markup Language (HTML), MS Word, etc. He noted that this practice was inefficient as far as data management is concerned and that it leads to an "unnecessary duplication of labour" (p. 392) or duplication of content, which was the problem WestNet dealt with due to their systems of development (Katzman, 2006). *WestNet Learning* (2008) is a large company providing a variety of learning solutions and services such as a hosted Learning Management System (LMS) and 2,500+ ready to purchase online courses. The management of duplicated content took many people, time, and reworking to maintain quality content and keep it consistent (Katzman, 2006).

When an educator authors a course, over time it may need maintenance: Either updating content with new information or having existing information removed. Educators should have a working environment that allows them to manage their content in a single source format without using a manual copy and paste system to perform the transformation. The format should be flexible enough to transform into other formats or views, depending on the educator's delivery mode or the learner's need/preference. WestNet used a manual system for repurposing their content from original print formats into Web publishing and assessment solutions used in their workplace training and development products. First, they created the textbook. When that was finished individuals cut and pasted content to create an instructor guide, next for the online learning environment a third variation was created by copying and then reformatting the content for the Web, finally more processes and additional teams performed work related to assessment.

Even small changes created several manual tasks to update all these versions. It was as one might expect, very time consuming to work this way (Katzman, 2006).

As technologies, such as mobile technologies, change or mature more formats may be needed specific to these new technologies. This will likely have an impact on educators as they keep up with future educational technologies. If the example in the field of technical communication Rockley (2001) writes about is relatable to educators, the impact grows as new delivery methods are innovated. Rockley (2001) lists several daily tasks that have "diverted the profession from its original role" so that technical communicators spend time on technology skills vs. writing skills. These skills include tasks like converting content into an online version, fixing hypertext links, graphics manipulation, and debugging (p. 189). An educator's time could focus more on building education skills related to his/her area of study rather than building technology skills related to new delivery methods, if the single source format he/she worked with was independent of the delivery mode used (Clark, 2002, p. 23; Rockley, 2001, p. 193; Walsh, 2007, p. 401; Wollowski, 2002).

LMS software provides a delivery mode for online education. Unfortunately, LMS design focuses on the management of courses and student tracking (Perry, 2009, p. 29; Watson & Watson, 2007, p. 30) rather than on content management. Additionally, even within this one technology, there is a lack of consistency; LMSs created as standalone systems may make exchanging content difficult (Lehman, 2007, p. 60). This may create a "negative impact on reusability, flexibility and functionality" when learning objects are placed into an LMS (Watson & Watson, 2007 p. 30). Problems may also arise if an instructor relocates his/her course materials from one LMS into another, as may happen to some with the event of Blackboard purchasing ANGEL (Jaschik, 2009). In these cases, content developed for one LMS may need

redevelopment to be compatible with another. If a standard development model is important within a single delivery mode, it makes sense that this is even more important when working with multiple delivery modes currently used in education.

Four Problem Areas

Four problem areas identified in this research, with respect to traditional content management in general are duplication of content, sustaining multiple systems, burden of technology skills and LMS limitations.

duplication of content.

The first problem area is duplication of content. Educators that work with multiple media formats for educational content may have duplicate content in different forms as Walsh (2007) discovered, e.g. a Power Point presentation, a printed handout from a PDF file, an outline of the course content, a Web page, a basic course and an advanced course material. The advanced course may have nearly the same material as the basic course but with additional information. These might be stand-alone documents or content locked into a proprietary content management system (CMS)/LMS. Creating all these variations of similar content may result in duplication of the source content. This duplication is a waste of effort, creating inefficiencies in content management, and requiring updates to more than one copy when updates are needed (Katzman, 2006, p. 55; Rockley 2001, p. 189; Walsh, 2007, p. 392).

sustaining multiple systems.

The second problem is sustaining multiple systems to handle the multiple formats. WestNet had the same issues that Walsh (2007) discovered, in that they generated duplicate content in multiple formats. In addition, they were also maintaining multiple systems designed to generate each version’s format in order to repurpose their content into multiple delivery methods.

First, a book version was developed. Next, they used a manual process of cutting and pasting portions of the content into other materials/versions such as online learning, instruction guides, and assessments. Conversions of one source format to another used different teams, processes and systems based on the format generated. It took time and money to ensure these processes were consistent (Katzman, 2006).

burden of technology skills.

With the introduction of new technologies like the World Wide Web, additional formats or sources of output are a possibility. This could require redevelopment of educational content to take advantage of that new technology, and since older technologies may stay viable this may add additional work over the outputs/formats developers currently create. For example, with the introduction of the Web, documents once made only for print required additional effort to be marked up with HTML tags to transform them into Web pages to take advantage of internet technologies. This third issue relates to the first and second problem areas of duplication of content and sustaining multiple systems. Rockley (2001) describes this third problem as the increased burden of learning new skill sets. These are skills like Web development now required to maintain those multiple sources for print and Web. If one extends Rockley's thoughts against the problems of WestNet's multiple systems, it might also be correct to say there is also a burden of technology skills needed to maintain changing systems used in the conversion process as well.

Rockley (2001) provides an example by chronologically following the changing roles of technical communicators over the span from type to Internet technologies. She explains how technical communicator roles have changed as technology has disrupted their field: First, as the technologies of desktop publishing invaded their daily routine, and next when Internet technologies expanded the Web into the forum for technical communications. Each addition of

technology required new skills, beyond the core skill of writing. Now skills in graphic design, page layout, Web design [and perhaps even Web development] are required. This means that time previously devoted solely to writing is now time spent on building technological skills to create the various formats now required (Rockley, 2001; Rockley & Hackos, 1999).

It seems reasonable that the same skill set change required for technical communicators may also be required of educators. Educators create content in formats for traditional face-to-face courses (print) as well as online courses (Web), and like technical communicators, many of the daily tasks now require them to use new skill sets, which were not a part of their job in the past (Rockley, 2001). For example, educators may now use Web technology skills and other presentation software/technology skills to develop their educational content, depending on the delivery mode(s) used.

Cms/lms limitations.

The fourth problem area focuses on the limitations of CMS/LMS systems as a single source for content management. Katzman (2006) states that the emergence of "'blended training delivery'" (p. 56) is the reason Learning Content Management Systems (LCMS) in the enterprise are not well established. He says this because they are designed to be Web-based training content management systems and that they are not able to handle the additional modes of output, such as a printed document (2006, p. 56). Clark (2007) states that these large systems are rigid and not necessarily designed for reusability outside of their own proprietary software even though they may say they are interoperable.

Lehman (2007) additionally states 'knowledge repositories' such as a CMS are designed as stand-alone systems and are structured differently from one another so that they are not always able to easily exchange content. Likewise, LMS systems may have the same issues as

LCMSs as Katzman (2006) identified; when the LMS design is only capable of handling Web-based content for courses and not for other delivery modes. On top of all this, Perry (2009) notes that LMS systems are administrative tools for students and courses, primarily managing learners and tracking results, rather than managing and reusing content.

Evaluating Possible Solutions

The purpose of this study is to investigate XML as a single source and to recommend solutions and define future needs for educators to manage student-centered educational content for diverse user preferences and multi modal delivery. This might reduce the need for multiple systems, reduce the duplication of content and eliminate some manual processes educators may go through to generate educational content in alternate formats and views of material for online or face-to-face students. It also might relieve some of the burden of technology skills required to develop education content to used with educational technologies and have that single source be independent from a proprietary system and be simple to maintain.

Answers sought after are:

- What "simplified XML" (XML_s) design would allow the development of educational content, such as a course outline, course review, and course lesson view and an assessment object from a single source XML format?
- What schemas/standards are currently in existence that might be simplified?
- What are the common course structures/design/objects that are usually a part of every course (i.e. sections, diagrams & tables)?
- Which elements enable transformability of the XMLs into a course outline, course review, course lesson and course search view and finally, an assessment object for student-centered learning?

- What additional elements might be required to make the XMLs transformable into different media/platforms (i.e. print, mobile)?

relevance.

This model might provide a foundation, a proof-of-concept, for developing a universal design for courseware that delivers accessible and useful information in a student-centered just-in-time environment. Using this XMLs schema and the XSL "language family" of technologies (Quin, 2009) it may be possible to have a single source document structure for educators to efficiently manage his/her content and transform/repurpose it into new or existing media/technologies for presentation to learners without redundant development or manual transformations.

limitations.

This endeavor will construct a XMLs model that provides just a foundation for further research and design by instructional experts. This perspective provides only a technology design approach from a systems design and technology management perspective.

HTML is a language designed specifically "…to be sufficiently simple so as to be easily produced by both people and programs but also to adhere to the SGML standard…" (Berners-Lee, T., Cailliau R., Loutonen, A. Neilsen, H. F., Secret, A., 1994, pp. 78-79), an assumption about the XMLs is that it may be reasonable to extrapolate the success of the HTML language as a subset of a more complex SGML language and the growth and usefulness it has for Web technologies, and apply that to this XMLs schema. This XMLs might be considered a subset of more complex schemas and also designed to be simple and to borrow from Berners-Lee et al. (1994) to be easily produced by educators and programs, yet adhere to XML standards.

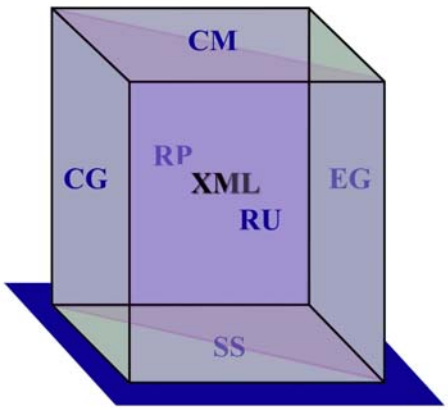
Chapter 2 – Review of Literature and Research

Research on XML as a single source for educational content reveals a three-dimensional model of relationships with subtle differences related to single sourcing, XML and educational content. This three dimensional model is based on the various points of view of the authors cited in this research (See Figure 1).

The purpose of using XML as a single source in educational content might seem obvious to many, but research revealed several different perspectives. Imagining these perspectives as opposing or supporting sides of a cube is helpful to understand their interrelatedness. It also provides a means of synthesizing a wide variety of related discussion on the topic (see Figure 1). At the top of the cube is Content Management (CM). Single Sourcing (SS) is the foundation that supports all the other sides and the top. On the left side is Corporate Goals (CG) for single sourcing & content management at the organization level. On the right side is Educational Goals (EG) for single sourcing & content management at the individual level. In the front is Reuse (RU) of a single source of educational content shared externally with other courses, departments or organizations. Finally, at the back is Repurpose (RP) of a single source of educational content, which is content dynamically repurposed and internally rendered to meet an individual user's current need or preference.

At the center of all of this is XML, because it is possible to use XML (and its metadata) as a single source document format (Clark, 2007, p. 12; McClelland, 2003, p. 107; Wollowski, 2002). Single sourcing goals support the streamlining the development and maintenance of content for centralized content management that facilitates reuse (McClelland, 2003, p. 107; Wollowski, 2007). In addition, single source XML makes dynamic generation of content possible (Albers, 2003, p. 4) that, in turn, might facilitate repurpose as well.

XML[3]



CM – Content Management

SS – Single Sourcing

CG – Corporate Goals

EG – Educational Goals

RU – Reuse (educational content)

RP – Repurpose (educational content)

XML – Extensible Markup Language

Figure 1. XML[3]: A three dimensional visual representation of the perspectives from literature surrounding the use of XML as a single source for educational content.

Other authors also used three-dimensional views to make sense of their XML efforts. Walsh (2007) uses a three-dimensional mezzanine to visualize content design (p. 405). Albers (2003) uses a cube in a cube to map an area of knowledge that dynamic content generation would deliver with different learners having a differently positioned inner cube based on three dimensions of cognitive abilities, knowledge & level of detail. (p. 2). The idea of relating XML concepts in a cube appears to be common even though the content in the cube is different among these papers.

In the discussion that follows there is some overlap in thought since there are relationships between the sides of the XML[3] cube. For example, content management can have corporate goals or educational goals or have the driving force be reuse or repurpose of content. The literature review is broken into three sets of two with the related sides of the cube either contrasted or compared, and then individually discussed. At the end is a short discussion on using a simplified XML model to manage content for student-centered education, which the literature review appears to support.

Content Management/Single Source

Where content management is the goal, Single Sourcing is a solution written about by many authors in this research. However, it is not without some drawbacks. Clark (2002; 2007) writes both on the topic of content management and single sourcing. His focus is on the negative impacts of both when content is micromanaged to a very 'granular' level of tagging or structured too rigidly (2007, p. 12), but he does also acknowledge the advantages of reusing content (2007, pg. 11). Clark (2002) also expresses concern that single sourcing has the potential to limit the roles of writers since they may no longer need to be involved with the design or layout of the final presentation (p. 23).

content management.

Content Management is where everything starts and why it is at the top of Figure 1. Clark (2007) defines content management as the processes that "evaluate, organize and publish organizational materials" (p. 9). There are two distinct perspectives on content management that fit into the XML^3 structure used in this paper. The first perspective is a corporate view of the kind written about by Barritt, Lewis, & Wieseler (1999), Rockley (2001), Clark (2002), Clark (2007), Walsh (2007), Watson and Watson (2007), and Perry (2009). The other is the individual view, the kind written about by Snyder (2004) and Wollowski (2002). The corporate view comes from a large entity such as a corporate business or an educational institution creating and managing large volumes of content or developing Reusable Learning Objects (RLOs) to benefit from having repeated content maintained in such a way that it can be reused externally across departments or courses. The second perspective is an individual view where individuals (educators, for example) develop original content or develop course material by consuming RLOs, with the focus on student-centered learning and repurposing of content. This paper will

focus on the individual view of maintaining an educator's content to eliminate duplicate sources made for a particular delivery mode or learner's need/preference.

Content stored into multiple document formats for presentation such as PDF, HTML, etc. lead to inefficiencies in content management (Walsh, 2007, p. 392). This is because the manual processes behind the updating and reuse and repurpose of content are costly and time-consuming (Clark, 2002, p. 20; Katzman, 2006, p. 56-56; Walsh, 2007, p. 392; Wollowski, 2002, p. 3). To deal with multiple presentation format issues, separating content from presentation is beneficial so developers do not need to be concerned with handling each presentation format (Clark, 2002, p. 23; Katzman, 2006, p. 56; Rockley, 2001, p. 192; Walsh, 2007, p. 398; Wollowski, 2002, p. 1). Rockley (2001) describes a related inefficiency to content management, which is a burden of skill that new technologies impose on manual content management processes. New technologies may require a developer to learn new skills and make additional versions of the content for presentation in that technology (p. 189). Content management systems (CMS) approach these problems [of inefficiency] using metadata markup that enables the reuse and repurpose of content into different presentations or media (Clark, 2007, p.10)

Metadata standards (what XML schemas provide) help to manage content like documents, images and multimedia in a repository by describing the resource to facilitate its reuse (McClelland, 2003, p. 107). Additionally, LCMSs used as an editor can update a single piece of content that affects every reference to the content (Perry, 2009). Using content management systems like an LCMS eases content reusability (Prakash, Saini, & Kutti, 2009).

However, there needs to be better collaboration between LMS systems (Watson & Watson, 2007, p. 31). Standards like the Sharable Content Object Reference Model (SCORM®) and Learning Object Metadata (LOM) still have problems related to the exchange of educational

content (Prakash et al., 2009, p. 1), and because of this, education/training organizations should develop a “standard means of content manipulation and dissemination” (Prakash et al., 2009, p. 3). This hints at the need for a standard XML schema focused specifically on reuse/repurpose. Watson & Watson (2007) further support this by writing that open-source technologies might be a promising solution for content management that provides non-proprietary exchange/reuse of content in a “global community” (p. 31).

single source.

Rockley (2001) defines single sourcing as “writing information once and using it many times.” It is important to note here that this reuse is by reference or called from a database, not by copy and paste (p. 189). Single sourcing facilitates updating multiple versions or instances faster by automatically updating content wherever it is used. The content can be edited in one place (Katzman, 2006, p. 55; Perry, 2009, p. 30; Rockley, 2001; Walsh, 2007, p. 406; Wollowski, 2002, p. 1), streamlining content development processes (Katzman, 2006, p. 55). Single sourcing also keeps the focus on the task of “‘writing itself’” (Clark, 2002, p. 23).

Rockley (2001) describes four (4) levels of single sourcing. If applying XML as the single source, Level 1 might be the tagging of the single source that allows the selection of content, either included or excluded, in a transformation of the source to another format. Level 2 focuses on customizing static content for an end user’s needs. An example for educational content can be seen in Walsh’s (2007) model for single source publishing: There is both a higher learning (HL) user and a standard level (SL) user, and the single source customizes an output to the end user’s needs. Figure 2 depicts the model of Walsh’s (2007) single source publishing effort. It is also an adaptation from another published schematic titled “’centralized content aggregation’ (Merceica, 2001, (p.81)” (p. 399). Level 3 of Rockley’s (2001) four levels focuses

on the dynamic "'on-the-fly'" (p. 191) creation of customized content, where a user's profile or user selection controls the delivery of information. Some examples for educational content might be the ability to switch from a learning view to a review view. Finally, Clark (2002) describes Rockley's Level 4 as "just-in-time" content (p. 21) based on a system that has learned the user's habits and progress.

The focus for this paper is on Level 3 dynamic transformation with the intent of expanding on the Walsh model. Level 3 provides some dynamic sophistication in serving student-centered educational content without the need for more costly artificial intelligence (AI) systems. Walsh's model used the XML single source he developed and transformed it into two online versions: one with advanced material in addition to the standard information and the other with just the standard information. Likewise several variations in print output were developed. Benefits were realized with effort savings on maintenance and updates it also promoted consistency in development, and "'future proofing'" (2007 p. 403) of content to handle technology changes and organizational changes. Walsh stated using XML made the content searchable and customizable and provided an architecture for knowledge management (2007, p. 406). However, Walsh has not include in his model on how a single source XML document might be developed for course content, the kind of content written of by McGreal (1997).

Single sourcing using XML makes it possible to generate content dynamically, but a more detailed analysis and a means to transform the analysis into a "usable format for dynamic information generation" is needed (Albers, 2003, p. 4-5). This analysis could provide the basis for the design of an single source XML model that considers the student's need for dynamic content generation and for the transformations for reuse and repurpose of educational content.

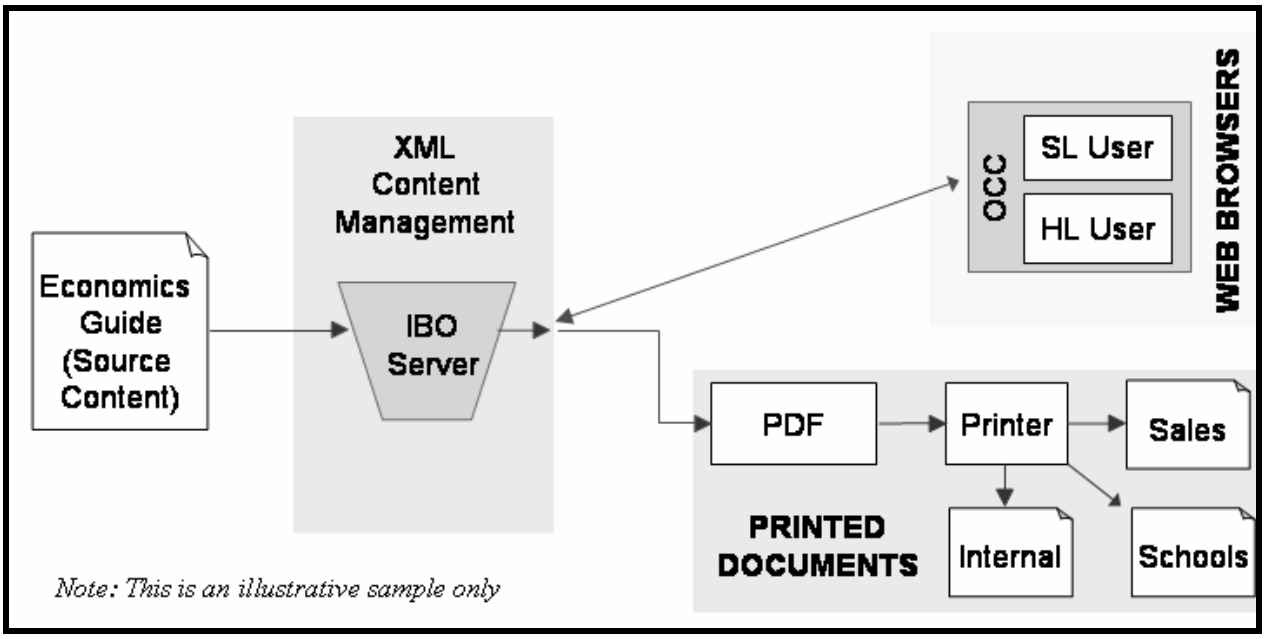


Figure 2. Walsh's example of single source publishing. Reprinted from "Using Extensible Markup Language (XML) for the Single Source Delivery of Educational Resources by Print and Online: A Case Study" by L. Walsh, 2007, *AACE Journal*, 15(4), p. 400. Copyright 2007 by the Association for the Advancement of Computing in Education (AACE). [http://www.aace.org]

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Corporate Goals/Educational Goals

The benefits behind content management and single sourcing are very similar: streamlining processes, reuse, repurpose customization, dynamic delivery of content, time savings, cost savings, and burden of skill relief (when separation of content from presentation is achieved). However, this research reveals two primary goals for implementing a single-source content management system for educational materials; corporate goals (CG) and educational goals (EG).

Corporate goals for the purpose of this paper are goals for large volume handling of content: such as a college or university managing both the content and delivery of hundreds of courses efficiently. Educational goals for the purpose of this paper are goals that benefit the individuals who develop and manage their content, or benefit the end user by delivering learner centered content.

corporate goals.

Much of the discussion about the need of single source documentation, based on the references used in this research, focuses on technical communicators writing for a corporation and maintaining corporate level documentation (Clark, 2002; Katzman, 2006; Rockley, 2001; Rockley & Hackos, 1999). These authors's point of view when writing of course content management seemed to be coming from an organizational level and how content is "synchronized" (Clark, 2007, p. 10) to an organization's standard. Other authors wrote about single sourcing as a large-scale solution for a corporate training and development business or for courses used globally (Katzman, 2006; Walsh, 2007). With single sourcing, updates made to a source object update every reference, saving time when there is a lot of reuse. In Perry's (2009) experience, reusing content saved time and effort in updating shared course content (p. 30).

It is possible that the expectation is that the corporate solution for content management will also serve as the individual solution for content developers, like educators, who deliver course content within an enterprise level LMS or CMS system. However, Walsh (2007) felt it was important to have a system that "'captured' content early in the authoring and formatting stage" (p. 392). That "capturing" in education might be at the educator level for those educators who develop or assemble their own course materials for instruction. Ironically Walsh (2007)

does not feel XML is appropriate for small projects (p. 407), which a single course's content developed by an individual might be considered to be.

Clark (2007) seems to share a similar opinion for technical communicators when he writes that it is necessary to reuse a CMS's RLOs in order to make the effort worthwhile. (p. 11). RLOs, covered in more detail in the next section, are small objects or chunks of knowledge shared and reused to build new courses (Lehman, 2007, p. 57). Reusing RLOs provides a means of rapidly building course materials, thus reducing the costs of developing courseware for an organization (Katzman, 2006, p. 56). In addition, maintenance is easier and updates are consistent when referencing XML RLO objects or "common files" as Wollowski (2002) did with a file that contained departmental information used in several course information pages (p. 3)

These are all examples of corporate goals for saving on course development costs and organizational level management of a large volume of content and reuse across departments and organizations.

educational goals.

Educational Goals may also be Corporate Goals, especially when an institution is a learner-centered institution. Distinctions between the two goals are in the different levels of management for content, which result in different types of benefits. With educational goals there are benefits for individuals creating content or individuals consuming the content versus the corporate goals where the benefits to an institution managing/delivering large volumes of content might be in economies of scale (which may explain Walsh's (2007) and Clark's (2007) expression that the most is gained when large-scale reuse is achieved).

The use of XML makes content creation easier for individuals by the fact that there is a separation between content development (writing) tasks and formatting display (presentation)

tasks (Clark, 2002, p. 23; Katzman, 2006, pp. 55-56; Rockley, 2001, p. 192; Walsh, 2007, p. 401; Wollowski, 2002, pp. 1-2). Several authors held this view, repeating the same sentiments that authors no longer needed to deal with formatting for presentation with the benefit of time and effort savings. When existing RLOs are used, it also enables developers to create new materials quickly, thereby saving time (Katzman, 2007, p. 56).

However, there is a trade-off in effort. XML schemas, perhaps like those designed for RLOs and Reusable Information Objects (RIOs), will require a more detailed analysis up front (Albers, 2003, pp. 1, 4). In addition, using XML as the single source will have an initial learning curve until content developers become more familiar with the new system of processes and workflows required to handle XML markup for reuse and repurpose (Walsh, 2007 p. 401). As an example: Walsh (2007) speaks of the creation of an ontology or 'common vocabulary' and how this is a challenge for "educational institutions seeking to exploit XML (Saini, 2003)" (p. 406). New workflows may have to operate within a defined ontology, which may require a little more analysis up front.

Using XML for content management eliminates manual redundancy in development when reusing or repurposing content elsewhere in other material, since each derived use references the same initial source XML rather than a manual copy and paste into another print document or electronic format. It also saves time that spent manually creating alternate formats/versions (Katzman, 2007, p. 56; Rockley, 2001, p. 192).

Snyder (2004) states that XML makes a perfect intermediate format to hold content for transferring information between different systems (p. 241). This transformability is another benefit of using XML as a single source for educational goals: it provides the ability to transform an XML source into alternate formats or views of the content based on an individual user's

request (Walsh, 2007, p. 399). Albers (2003) writes about multidimensional structures of content that allow the dynamic presentation of information built specifically to the learner's current need. He also writes that a well-designed system will help a student understand and analyze information (pp. 2-4). Albers (2008) also writes about Human Information Interaction (HII) that is concerned with how people interact and interpret information (p. 117) and proposes a "user-problem-centered-design" (p. 119). A thoughtful XML design for enabling transformation might provide a means of implementing HII concepts for a student-centered design/transformation of information, giving greater benefit and a customized educational experience for the student. Perhaps it could even provide content based on a learner's cognitive level as both Albers (2003) and Barritt et al. (1999) suggest, or provide interactive assessment objects like in Snyder's (2004) example where he used XML in an assessment system. In this design, he incorporated an option for the user to select "show me how" (pp. 245-246). These also seem to exemplify an HII implementation.

Some of these educational goals make the individual content developer's role easier, while other goals make the student's consumption of information easier. For the purpose of this paper, please consider these both as educational goals (EG).

Reuse/Repurpose

Two distinct perspectives of content reuse came out of this research as it relates to educational content. First, there are papers that discuss the use of RLOs for the purpose of a content source published and reused externally, i.e. shared content to other courses or institutions (Barritt et al., 1999; Lehman, 2007). Secondly, there are papers written that describe the need for student-centered content where content is transformed or repurposed based on a student's current

need or preference internally or ”intra-contextually” (Lehman, 2007, p. 58). For the purpose of this paper, this is how the terms reuse (external) and repurpose (internal) are used.

reuse (external).

Lehman (2007) includes a definition of a learning object (LO) in her paper that is “most widely accepted […is from] Wiley (2000); ‘any digital resource that can be reused to support learning’ (p. 7).” A RLO is a LO that can be reused “in different learning contexts and for various objectives” (Prakash et al., 2009, p. 2). Metadata (which XML provides) is essential to make search and retrieval of RLOs easier (Lehman, 2007, p. 58). These “small reusable educational chunks” (Lehman, 2007, p. 57) are created to be published in a Learning Object Repository (LOR) so they can be found and reused. This is an external reuse of content and these objects designed for use in the originator’s course and shared with others across departments and to other organizations.

Barritt et al. (1999) further describes a more granular design of what they call a RIO (see Figure 3). Several RIOs combined form a RLO (see Figure 4).

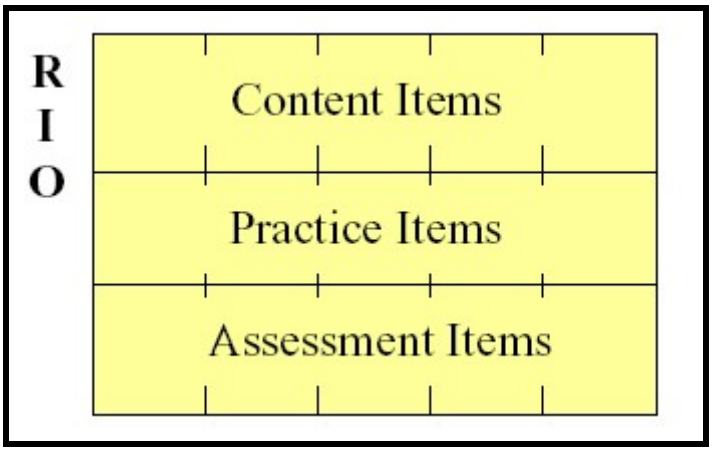

Figure 3. Barritt et al. design for a reusable information object, which contains the assessment items. Reprinted from “Cisco systems reusable information object strategy: definition, creation overview, and guidelines. (Version 3.0 June 25, 1999)” by Cisco Systems,

Inc. p. 6. Copyright 1999 by Systems, Inc., Courtesy of Cisco Systems, Inc. Unauthorized use not permitted. Reprinted with permission. Retrieved January 8, 2011 from http://www.cisco.com/warp/public/779/ibs/solutions/learning/whitepapers/el_cisco_rio.pdf.

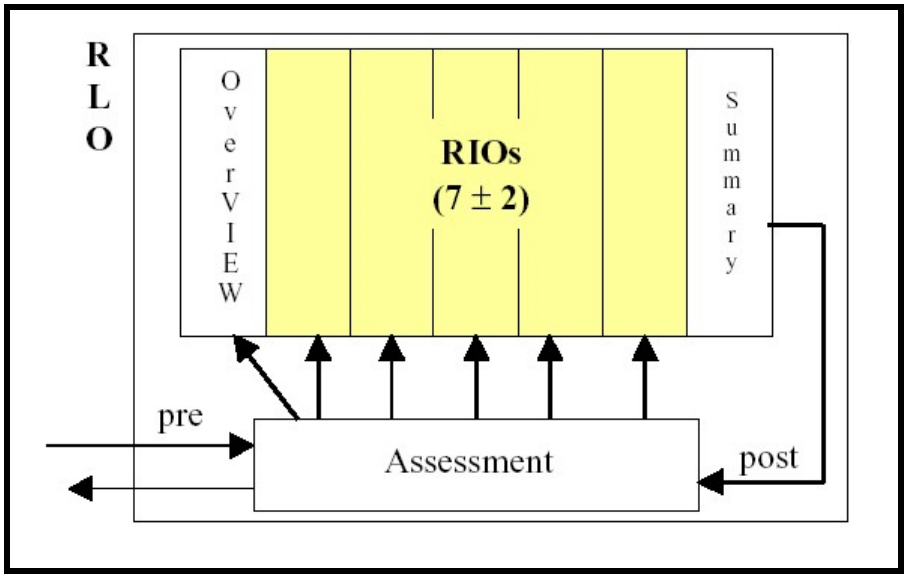

Figure 4. Barritt et al. design for a reusable learning object, which contains multiple RIOs and multiple assessment items referenced by the assessment object. Reprinted from "Cisco systems reusable information object strategy: definition, creation overview, and guidelines. (Version 3.0 June 25, 1999)" by Cisco Systems, Inc., p. 6. Copyright 1999 by Systems, Inc., Courtesy of Cisco Systems, Inc. Unauthorized use not permitted. Reprinted with permission. Retrieved January 8, 2011 from http://www.cisco.com/warp/public/779/ibs/solutions/learning/whitepapers/el_cisco_rio.pdf.

The goals behind the use of RLOs are: (a) To develop course content quickly (Katzman, 2006, p. 56), (b) to provide a cost savings in content creation (Clark, 2007, p. 11; Katzman, 2006, p. 56), (c) to enable automation in reusing content (Clark, 2007, p. 9), and (d) for customized delivery of content based on the end user's goal or needs (Albers, 2003, p. 4).

Benefits arise when reusing many “chunks” of content in more than one document (Clark, 2007, p. 11). In addition, content is developed and maintained more easily for the same reasons discussed earlier under the Corporate Goals section.

There are some difficulties in developing content for automated reuse or for customization. Making reusable content requires an “audience analysis” to identify end user’s needs in order to deliver the type of information they require (Rockley & Hackos, 1999). Clark’s (2002, p. 22; 2007, p. 9) concern is that the development of content for single sourcing with automated reuse would generate a “broiler plating” style of content design at the cost of a well-groomed finished product. This is especially important to Clark (2007) when reusing across other genres (p. 9); for example, when a content module appears in both marketing materials and training guides. Clark (2007) also notes that “sloppy” reuse of content in “dissimilar genres” without critical analysis, will lead to poor communication (p. 11). Similarly Prakash, et al. (2009) write that Subject Matter Experts (SMEs) may find it difficult to convert existing content into the “small granules of Knowledge [sic]” (p. 2) to be reused as RLOs.

Albers (2003) writes that single-sourcing technologies promote the creation of text elements that can be reused (p. 1). With XML it is possible to store metadata about an item or LO’s elements in the XML, which helps content management (Walsh, 2007 p. 400). The metadata in RLOs are necessary to make it possible to search and retrieve them out of the repositories in which they are stored in (Lehman, 2007, p. 58). These repositories are databases that organize these LOs, and Lehman (2007) describes three types of LOR/databases: “general, discipline specific and commercial” (p. 62).

Developing learning object metadata is important because it helps the process of cataloging, searching and reuse of the LOs (McClelland, 2003, p. 107), but creating complex

hierarchical relationships poses a learning curve that limits content creators (p. 109). However, if appropriate tagging is used, it "enables assembly, interoperability, reusability, durability, and scalability" (Lehman, 2007, p. 59); these statements may imply that there needs to be a simpler XML schema with appropriate tagging.

repurpose (internal).

XSL style sheets can aid the transformation/repurpose of XML so that it is possible to present the same original source into different formats/outputs (Katzman, 2006, p. 55; Snyder, 2004, p. 241; Wollowski, 2002, p. 6). With a single source in XML, the tagged content can conditionally display based on a user's selection of preference. This gives a personalized delivery of content that dynamically responds to a user's request (Walsh, 2007, p. 399). It also makes it possible to arrange or rearrange content, making it more searchable (p. 399).

XML as a single source for repurposing content has many benefits. Properly tagged content can enable "accessibility…, adaptability… and scalability" (Lehman, 2007, p. 59). Another benefit from transformations/repurposing of the content is that it makes "multi-channel" display possible (Walsh, 2007). Examples of these channels might be interactive television, PDAs, mobile devices, speech-based applications, and Braille (p. 399). Additionally, transformation/repurpose of content can be made to conditionally display information conformed to a reader's knowledge level, desired detail level, or cognitive ability (Albers, 2003, p. 2), benefiting the individual learner.

Albers' (2003, 2008) research is learner-centered, whereas other research was corporately focused or content-developer focused. Albers (2003) writes that having a system that allows users to "'restructure the information' O'Mally [14]…(p. 396)", view it from different view points, in a presentation that suits their current goals, helps users mentally understand and

analyze information (p. 4). This might be a double benefit to educators in that both the educator and the student gain by easing the learning process.

Walsh (2007) found that an XML single source was able to provide formats to serve the needs of both the content developers and end users (p. 389). Walsh did not specify how he accomplished that; however, content developers might benefit from the content management perspective and single-sourcing perspective as well as many of the educational goals discussed earlier in this paper. Students may benefit when they receive customized content that communicates useful information according to their needs, when they need it (Albers, 2008, p. 122). Albers (2008) also makes a distinction between designing text and communicating information with the emphasis on "communicating useful information" (p. 122).

Rockley's (2001) single sourcing Level three (3) and four (4) includes dynamic delivery of content. In Level 3, user selection is one way to generate the dynamic customization. Albers' (2003) multi-dimensional analysis goes a step further by considering how a user's needs change over time (p. 2). An example of this might be a student reading educational content to learn the material in depth, then later needing to go over the same information, but only desiring a summary of the material to refresh one's memory or to study for an assessment test; or later needing material that is more advanced.

Walsh (2007) also recognized the importance of marking-up content early in the authoring process. This helps unify the process to create content for multiple display formats (p. 392). Writing content for extraction into other objects and repurposing content requires understanding the multiple uses content may have (Rockley, 2001, p. 191). If the author knows how end users will interact with the information, and can apply Albers' (2003) multidimensional analysis to get the student just what they need using XML's repurposing ability to dynamically

deliver content, then there might be additional opportunity to create added value for the student's education. However, educators are still determining how to apply XML technologies for course delivery that has a learning object approach and is dynamic and responsive to end users (Walsh, 2007, p. 390)

Clark (2007) believes that strict standardization needs to be in place for the level of granularity of mark-up for enterprise reuse because of the many contexts into which content might go (p. 12). However if the content were only repurposed within a single course instead of across an enterprise and possibly even cross "genre" (p. 12) the standards may not need to be as strict and may have room for flexibility. In the Barritt et al. (1999) design for a RIO, the parts are not too complex. Therefore while planning the content for enterprise reuse, cross genre, might be difficult, planning content for repurpose within a single course may not be.

Separating content from presentation is a solution for content management issues when multiple display formats are required (as was discussed in the content management section of this paper). Likewise, a separation of schema (a different schema design) for educational content designed for reuse, as opposed to content designed for repurposing, might simplify the development process for educational materials meant for repurposing. Some course content authors may only need to consider the different uses his/her end users may have for the content rather than being concerned with the different uses externally, perhaps into different genres. This paper focuses on the design of an XML schema for internal repurpose of educational content.

XML_s Solution

Educators who maintain educational content should have a simplified XML schema to use. This would allow them to create a single source XML file for their content so they can take

advantage of the flexibility, reusability and transformation that XML offers. It would also give them the ability to repurpose their educational content to a diverse audience and to a growing number of technology devices without having to add the burden of learning how to generate content for every new technology.

While a SCORM standard XML single source alone may eliminate corporate organizational issues in the first three problem areas discussed in the introduction (duplication of content, sustaining multiple systems, burden of technology skills), a simplified XML schema design may be required to address the fourth problem of LMS limitations for content interoperability and exchangeability. A simplified XML schema might enable individual content developers to separate their content from a proprietary system's complex schema, and enable content repurposing for student-centered learning.

Development of educational content for RLOs for enterprise reuse, global reuse, or cross genre reuse, may require a more in-depth analysis ending in a more complex XML design to enable the cataloging, retrieval, and reuse from an LOR into various presentation formats/systems. However, a small-scale simplified XML schema, designed only to meet the needs for internal repurposing or transformation content within a single course and to a smaller group of end-users, may not require such a high level of complexity. This could make the use of XML as a single source a less complex solution for managing student-centered educational content.

Chapter 3 – Methodology

This is a constructive ontology for the development and design of an XMLs model. Definitions are constructed for XML elements and attributes needed to enable the transformation of a single source XMLs course document into three alternate student-centered views of course content: (a) an outline view, (b) a course review view and (c) a search view. Included are structures for common course content design that take into consideration transformations required for an assessment object, future technologies and different media/modes such as print or mobile.

There can be more than one correct answer for this proof-of-concept design in the XMLs. However, for the long-range goals, if this seems to be a right direction to take, it might be best to strive for a single industry-approved standard for functional consistency, portability and compatibility for external systems such as SCORM that might package or transform/exchange data with the XMLs schema. The effort here is to build a foundation for future refinement, which leaves room for more than one possible design for the initial XMLs foundation.

Research Design

The chosen methodology is design science/design research because a model is constructed using (a) proscriptive research using existing schemas and terminology, (b) the functionalities/advantages of existing XML technologies, and (c) the needs already discussed in other literature. The XMLs schema constructed will be refined/simplified and evaluated for suitability against the measurements detailed in the data analysis and evaluation section later in this paper.

Materials

The materials required to perform the research are a computer with Internet capability, a text editor or XML editor freely downloadable (NetBeans IDE 7.0.1 is useful) and an .xsd validator the World Wide Web Consortium (W3C) offers one online ("W3c xml ltg," 2007), along with existing XML schemas published on the Internet related to or useful in education. Also needed are a sampling of books to include: an APA manual, MLA Manual, highly structured educational textbooks, books related to the subject of course design/development and technical references for designing XML schemas (books or online).

Procedures for Data Collection and Analysis

step 1 – collect related schemas.

First, I built a selected list of well-known schemas for consideration and then ranked them according to a preference matrix. These are schemas mentioned in the literature review or other education schemas found on the Internet. The following criteria determined the admissibility of the data: first, the literature review mentions the standard schema or the discovered schema contained elements and attributes that hold/describe features that might be included in course content design. Second, the schema's elements used easy to understand labels rather than ambiguous or cryptic naming, or finally, the schema contained elements/attributes that appear to allow for future growth or added functionality. The last criterion is a subjective measurement but allows for the inclusion of discovered elements not specifically meeting the first two criteria, but which seem innovative or useful to mark-up educational content.

The ranking for the schemas used a preference matrix having weights on six attributes (see Table 1). After the ranking, the final selection contains schemas that have licenses that make it possible to distribute this newly constructed schema under a Creative Commons 3.0 (CC 3.0)

license (see Table 1). The existence of a copyright or vendor-specific license was cause for elimination. The reason for this two-step selection process is because there were few schemas to start with, and based on the copyright elimination, so few left in the end. It seems prudent to list those schemas that are otherwise highly ranked so the reader knows why they were not included in the final selection.

step 2 – list possible elements/attributes.

Second, I refined step two in the absence of a schema to simplify, instead of reusing an existing design and selecting elements from there I listed possible element and attribute names that might meet the basic needs for a standard course structure or .xsd design. These are possible elements names and attributes names that came from terminology found in the literature review, internet research and books/journals on education & course design, assessment test types/design as well book publishing formatting and layout terminology. In the list, related element names are associated with a parenthetical group reference. These helped define the parent/child type relationships for elements in the final XMLs model. Next, I removed redundant element names and reduced unnecessary or complex element names from the list. These are elements not necessary for the needed transformations or may not be required elements in course content. Not all the elements from this list are in the final design.

step 3 – list transformation elements/attributes.

Third, I listed the possible element and attributes items from step 2 which can be used to develop the course outline view, course review view, and an assessment object from an XML single source course document. Created new element/attribute names without using ambiguous or cryptic names as needed to enable this functionality. The elements needed for the

transformations will be the elements containing the displayed content for each particular view the transformed XML creates.

step 4 – choose multi-modal elements/attributes.

Then I listed the possible element and attributes from step 2 and created new element/attribute names that might aid the XMLs transformability into different media / platforms (e.g. print, mobile). This is not an exhaustive or proven list but a sampling of rudimentary needs for a proof of concept.

step 5 – organize the elements/attributes.

In the final step I shortened the list by selecting elements/attributes that focus on course content and course metadata without adding too much LOM or Dublin Core Metadata Initiative (DCMI) type metadata, since this model is not concerned directly with external reuse or indexing in a LOR. Categorization of the elements fell into four categories of element types: metadata, objects, structured text, and dynamic structures. This exercise of categorization aided further organization and planning for the XMLs design. Course and educator metadata type elements were at the top, and then followed by student informational text (e.g. course policies, grading plan, etc.), with the actual course content parent element with its child-elements below that.

Next, the initial rough draft design was evaluated and it was determined that a syllabus parent element was redundant and could be a dynamically generated object/document by pulling together elements such as the course title, policy and grading plan elements; so it was removed. Additionally, there was a repeating design that was nearly the same for institution, campus, department, instructor etc., which was normalized to be one reusable structure with the parent element named <communication_contact> with institution, campus and department, course

defined as possible attribute types. In a final evaluation, I removed the institution, campus and department structures completely, since it is better to maintain information, repeated over several courses, externally from the course, in its own single source document, and maintained at the institution, campus, and department levels respectively. This can become content that is referenced/included during a transformation and rather than content manually duplicated in every course's single source. Additionally, a <text> element in the first draft was considered unnecessary and removed from the <content_division> element

The elements used for incoming communication or outgoing communication information were included in the <communication_contact> parent element and organized there. Elements that consider the use of alternate technologies are also included. These are elements for a reference to a Really Simple Syndication (RSS) news feed, Global Positioning System (GPS) coordinates for directions, and even a reference to a Quick Response code (QR code) graphic for a cell phone to scan. The QR code might be used in a print transformation, allowing a student to scan the code from a face-to-face handout or marketing ad and be redirected automatically to an online resource (video/Web page) related to the institution, campus, department or course.

The length of the element names is not an issue even when taking into consideration that some transformations of the content would be to mobile devices with narrow bandwidth. This is because a transformation XSL can rename any XMLs element (during a transformation) to a shorter name used in a mobile schema or mobile optimized XHTML. It may be perfectly fine to have the single source use long element (tag) names for clarity in the single source for non-technical content developers, should they want a more readable/understandable source code to view.

The next step was to verify that the XMLs design model included the elements necessary for student-centered views including the course outline, course review, course lesson and course search view and also an assessment object, as well as transformations to multi-modal delivery media. The XSL transformation for a course outline view will use the content division headings and can dynamically number them based on whatever the desired numbering scheme is. The XSL transformation for a course review will use the content division headings along with the division's summary or a bulleted list of topic sentences. The XSL transformation for a search view will simply select all course content. There are several different types of assessment objects defined (e.g. true/false, multiple choice, part/whole and matching/stem) an XSL transformation can be used to capture the element/attribute data in a database type structure and then used as input into a Flash interactive self-assessment object or into an LMS databank for a test. Other modes of transformation possible using the models elements might be to a Power Point slide presentation dynamically generated using a combination of headings, topic sentences and summaries, or to a print document using whatever combination of content is desired (e.g. a syllabus handout or course outline).

It was determined that the elements existed to make the transformation for the student centered views, assessments and interaction with other platforms like print (syllabus), lecture (Power Point) and mobile (QR codes); this is not an exhaustive list just a proof of concept.

The final step included a mock-up .xml file (with dummy course content) using the newly defined XMLs elements (see Appendix A). The mock-up validated as a well formed XML document using the W3C validation service ("W3c xml ltg," 2007) and the NetBeans IDE check XML function, and errors handled until it passed the as a valid XML document. Additionally,

Appendix B provides the reader with a skeleton structure of the design to see the elements without content (for clarity).

Evaluation Methods

static analysis.

I reviewed the XMLs schema to reduce the complexity of the design without losing the required functionality. During this analysis I removed, normalized and reorganized elements and attributes to simplify the structure, and then reevaluated the XMLs again. For example, when generating the outline view, the headings and subheadings of text will need to be numbered with Roman numerals I., II., III… there might be attributes in an element that were designed to signify which elements will be in the outline view. However, that can also be logically determined by the fact the element types used in an outline will be a heading or subheading, meaning that an element with a redundant attribute can be simplified by eliminating the attribute (in this case the outline number attribute). The numbering system can be determined at the point of transformation and does not require manual mark-up while writing the content. In other cases, it might be several similar elements such as a ‘figure’ element, a ‘table’ element or a ‘photograph’ element; if each contains similar elements such as ‘title’, ‘author’, ‘date,’ etc., which can be simplified when combining the elements into a single element, with an attribute to state what type of object (e.g. figure, table, photograph) is within.

The final selection of elements and attributes uses subjectivity. The choices made focused on demonstrating one of many possible solutions that might provide a model for a XMLs single source for student-centered educational content management and answers the questions posed in this thesis.

structural testing.

To determine the structure is valid XML, I ran the XMLs schema through an online XML validator using the W3C validation service (“W3c xml ltg,” 2007) and offline using the NetBeans IDE check XML function. These programs helped to verify the XML was a valid and well-formed XML document). I iteratively corrected the design/structure as needed then retested and revalidated until it finally passed the validator without error.

Chapter 4 – Results/Discussion

Step 1 – Results

The selection process ended with a ranked list of 12 XML schema definitions mentioned in literature or found via the Internet and contained content that would relate to educational content (see Table 1). These 12 schemas comprise two basic types: metadata schemas and mark-up languages. However, none of these qualifies as a design that to be simplified to produce a schema with the desired student-centered transformations. See Table 1 for the list of schemas, copyright information and final selection status.

Four schemas mentioned often in literature include DCMI, IMS Global, LOM and SCORM. Two additional metadata schemas related to education, and containing elements that related to educational content are GEM and the Department of Education meta-data information model (DOE MIM).

Table 1

Preference matrix of desired characteristics/weight, weight score for ranking, and final selection status.

C1/10	C2/20	C3/30	C4/40	C5/50	C6/60	Total	Name	Type	Selected	Copyright
✓	✓		✓			70	Dublin Core Metadata Initiative (DCMI) / DC-Education (DC-Ed)	Metadata	Y	CC 3.0
	✓				✓	80	IMS Global	Metadata	N	Licensed
	✓		✓		✓	120	IEEE P1484.12.3 Learning Object Metadata (LOM)	Metadata	Y	CC 2.0
	✓			✓	✓	130	Gateway to Educational Materials (GEM) controlled vocabulary	Metadata	N	n/a
			✓		✓	100	Department of Education meta-data information model	Metadata	Y	None
	✓		✓	✓	✓	170	Advanced Distributed Learning (ADL) Sharable Content Object Reference Model (SCORM)	Metadata	Y	By Permission
✓	✓		✓	✓		130	DocBook version 5.0	Mark-up	N	n/a
✓	✓			✓		80	OpenDocument version 1.1	Mark-up	N	n/a
✓	✓			✓		80	Darwin Information Typing Architecture (DITA) version 1.2	Mark-up	N	n/a
			✓	✓	✓	150	eLesson Markup Language (eLML)	Mark-up	N	Apache 2.0
✓		✓		✓		90	Mathematical Markup Language (MathML) version 3.0	Mark-up	N	n/a
✓	✓	✓	✓			80	Really Simple Syndication (RSS) version 2.0	Mark-up	N	n/a

Note. C1=used outside of education, C2=written about in literature, C3=contains elements for future growth (these are elements not necessary for marking up educational content but allow for added functionality), C4=contains easy to understand element/attribute names, C5=used to mark-up educational content, C6=designed for education. For the purpose of this paper, DCMI's DC-Ed schema is included with DCMI core elements.

Three XML schema mark-up language definitions contained elements useful for content structure and formatting at word, paragraph and chapter levels and also contain other book-like formatting features that might be familiar to educators who use a word processor to develop their content. These three schemas are DocBook, OpenDocument, and DITA. One XML schema, eLML, also has an editor to go with it. It is called the Firedocs eLML Editor (beta), which is a plug-in for Mozilla Firefox ("Tools for elml," 2010). Two other mark-up languages found might be desirable to import/include into a course; they are MathML and RSS. MathML is a W3C recommendation by the math working group (“MathML,” 2011) and RSS is a standardized format for Web feeds such as blogs, news headlines and podcasts (“RSS,” 2011). These two are included because they contain structures for added functionality and point to the need for the ability to import other language objects.

step 1 – discussion.

The selection process did not turn out as expected. No one schema found can be simplified and published under a Creative Commons 3.0 license and meet the needs for single sourcing educational content for student centered content management. Some of these schemas, expected to be mark-up languages for content, were not. Many of the schemas mentioned often in the literature did not contain the expected level of complexity at the course content level, even though the documentation on the definitions ran into the hundreds and thousands of pages.

Of the three schemas that met the requirements (SCORM, LOM and DCMI) the SCORM standard was a surprise. It was very complex but after some review, it appeared that the standard does not delve deeper into course content than for the purpose of packaging sections and modules. It contained structures to move course material between LMS systems and maintain the student tracking (scores, completion %'s) and course sequencing and navigation. The DCMI is

for metadata at a more abstract level and not designed specifically for educational content. On the other hand, the LOM is a metadata model for education but it describes content for cataloging RLOs, where the primary purpose is for reuse from a CG point of view.

The IMS Global schema seemed complex. One of the points of this work is XML readability to a non-technical user group; however, IMS Global's elimination is because of licensing issues.

The DCMI DC-Ed community provides information to help one appreciate the sheer volume of data out on the Internet related to XML schema definitions for education and the level of work it takes to define just two elements in a schema. In this case the two elements are Instructional Method and Type. Not only is the DC-Ed looking at the same schemas included in this paper; they are reviewing many others, which they list in their "Candidate Vocabularies for Instructional Method and Type" ("Vocabularies," 2007). Their list includes 15 vocabularies for Instructional Method and 10 vocabularies for Type. They have a team of people working together to define just two elements. The work on the XMLs will not be at this same level of professional scrutiny; it is beyond the scope of this paper.

Another surprise was finding eLML, earlier research did not reveal this schema. eLML is a new mark-up language designed for course development and is freely available to download and use. It also has a Firedocs eLML Editor tool for educators to develop and transform (externally) course content into many other formats such as WebCT Vista, GITTA and PDF. However, what are lacking are the designs for repurpose of content for student-centered transformations. The fact that the tool is designed for just one schema, however, does point out the need to have a tool that is independent of a non-standard single schema design in order to be useful for future technologies, or even as current schemas change or standards for this level of

granularity are established and accepted. While the eLML license allows remixing of their schema, it contains vendor specific Apache 2.0 license that must be included in any variation developed from the eLML language. The Apache 2.0 seems to be more restrictive than a CC 3.0 license this schema contains. The reason for a CC 3.0 license is so that those with extensive educational experience can improve upon the concept for repurposing and refine it, or so that LMS vendors can incorporate additional student-centered functionality when importing this schema design.

Likewise, one might say the same of this project's XMLs model. It should be independent of a single LMS system. An article in eCampus News highlighted the requirement for making course content compliant to a particular schema, in this case SCORM, in order to receive some of the Trade Adjustment Assistance Community College and Career Training Grant Program (TAACCCT) two billion dollar federal grant funding. It also stated that opponents to this requirement felt that sometimes other schemas, like IMS, might be more correct to use given different situations. This article quoted Michael Feldstein as stating that a single standard is too limiting ("Open education group," 2011). However, a transformable standard repurposed/transformed into other standards may not be limiting at all. In the future, there may be even more schemas institutions may need to provide content in order to receive course development grant funding in education. Educators/institutions should not have to change their single source tools/technology for each grant awarded.

The original expectation for this research was to simplify an existing schema(s) like SCORM so that the resulting schema would contain elements that already passed a higher level of scrutiny and assessment like the DCMI performs, but SCORM did not have the granularity of design for course content desired for re-purposing content within a course.

It is beyond the scope of this paper to define new elements at this level of scrutiny and beyond the scope of this paper to review all schemas that fit the selection criteria. Instead, a XMLs model that is freely available to modify and redistribute will be drafted here and include elements for student-centered repurposing, with the expectation that it will be modified and improved. Additionally, the eCampus News article mentioned earlier (discovered after the literature review), pointed to the need for independence from external schemas, since different schema types might may be better in certain situations ("Open education group," 2011).

Step 2 – Results

The results/findings from Step 1 affected Step 2, since there are no existing freely modifiable schema mark-up languages for course content with which to choose or modify elements. The intent in this step was to list the elements and attributes meeting the basic needs for standard course structures or design from the schemas in Step 1. Instead, only the last option was available, which resulted in a raw list of 353 names (see Appendix C) drawn from the literature review and other published books and articles.

step 2 – discussion.

During this process, another piece of recent literature written by Khlaisang (2010) surfaced that reiterates the problem that there is a need for a standard for courseware design. Khlaisang (2010) stated, "…though there are various formats of website and courseware design, there is no common ground or proposed models that institutions that plans [sic] to initiate e-learning program can follow."

The expectation for this point in the project was to have a mostly-finished definition of elements and attributes from existing schemas and have only a few elements/attributes to create. Instead there is a long a list of names for possible elements and attributes, which will need to be

categorized, organized and streamlined. In this case, it was better to save the bulk of organizing the names for element/attribute associations until Step 5, which is now the step that defines most of the XMLs design. However, during this process, it was evident that certain elements belonged together such as parts of a syllabus; parenthetical references indicate these groups in the list.

It was very surprising to find that while there are many papers written related to XML, single sourcing, and user-centered design, and a lot of work done at the level of SCORM, there appears to be very little standardization of course material developed by an instructor outside of a major LMS system. The reason for the lack of use of XML for single source content development and repurpose appears not to be an over-complexity of existing schemas but perhaps a lack of a standard schema definition and tools. This may also explain why very little seems to be done in the RP (repurpose) side of the cube. Although the late discovery of the eLML language (“elml,” 2011) might be an indicator this is changing [and changing quickly see the conclusion in this paper], eLML is not considered in this paper because of the Apache 2.0 license.

Step 3 – Results

Using the list of possible element names in Step 2, elements were highlighted that fit with one of the three student-centered transformations related to the repurpose side of the cube, which resulted in the creation of Appendix D.

step 3 – discussion.

Again, the expectation for this XMLs model definition [especially with the unexpected results of Step 1] is for a simple draft XMLs design, not for a final recommendation with the same level of research and work as the DCMI, LOM or SCORM schema definitions. If other researchers feel this is a viable direction to take for educational course content development,

additional research will likely be required to define a more robust definition suitable for an industry standard that Prakash et. al (2009) feels should be developed.

Step 4 – Results

Using the list of possible element names in the raw list from Appendix C, no elements were highlighted that fit with specific multi-modal needs because that part of the research focused on content elements/attributes. In this step, device names or delivery modes for the display of course related content became new attribute names to flag content for multi-modal delivery (see Appendix E).

step 4 – discussion.

This ended up being a very short list of names that could become attribute names used to indicate a type of output (e.g. .mp3 or eBook). The expectation here is not an exhaustive list but a starting point of common terminology and enough information to show the concept of the ability to convert content via an XSLT transformation to alternative devices/software that Walsh (2007) mentions (braille, speech based, mobile). However, in some cases, it may be possible to infer logically an element's suitability for a particular kind of output or output device during a transformation. So specifying these as attributes may be redundant; for example, a reference to video content would imply it is not suitable for print media, so no additional attributes may be required to filter out this content in a print transformation.

Step 5 – Results

Step 5 resulted in the creation of two valid XML versions of the proposed model, one with dummy course content (see Appendix A) and another with just the structure of the elements with no content (see Appendix B). The XMLs contains elements for common course structure,

content transformability for internal repurpose (student-centered views and assessment) and transformability for multi-modal delivery (print, Web, or other device).

step 5 – discussion.

As has happened in earlier steps, this step did not go as planned and late research findings (noted at the end of this discussion) indicated that there yet is another avenue to take in the search for the future development of a single source XMLs .xsd schema. The original thought, at the beginning of this research, was to simplify an existing schema, which did not exist, leaving the need for entirely new development. However, time does not allow for the level of work required to develop a working .xsd to a desired standard. Since expert educators will need to improve anything developed during this research, the focus is for this paper resides on the XMLs .xml mock-up as a starting point for discussion before creating the formal .xsd schema.

In addition, the future may require the elimination of some XMLs elements in Appendix A and B. For example, it became apparent that in the XMLs model there are text objects included; an example would be any one of the elements that would be used to dynamically create a syllabus. In the future a syllabus might have its own standard XML schema definition, and be maintained separately. However, syllabus information can still be included during a transformation by referencing the separate source; meaning that elements in this model (e.g. grading plan) could be removed in the future and placed in a separate XML document to eliminate redundant maintenance of duplicated content.

Other ideas came to mind as I evaluated the structures and design in this model. One is that an annotated bibliography can be a living document for a researcher/instructor so that as new quotes are used his/her personal annotated bibliography expands. Related to this is the idea that an instructor would likely use the same body of knowledge he/she is an expert at in more than

one type of course he/she develops. In this scenario, the annotated bibliography citation id connects the two parts to pull the full reference during a transformation. If the single source were a thesis the reference list could be dynamically generated using just the parenthetical citation (with reference id) from the text to pull the associated reference (APA style) from the annotated bibliography into a print output of the paper rather than be duplicated content in both the annotated bibliography and the thesis reference list.

More online transformations are possible than just those originally considered in the design of this model. For example, a student-centered transformation to select all the quotes from a source and order them by order of appearance or by order of author is possible. This transformed list can contain a link back to the position in the course where the quote is used. This provides a student a means of navigating course material when he/she wants to get back to a particular point in the learning material but is not sure which unit contained the desired material. Likewise, ordered list transformations are possible with figures, tables, etc.

Another idea relates to dates. Most dates might generally display in the MM/DD/YYYY format. However, for student use, an assignment due date could display with using the day of the week in the format (e.g. due Monday, Tuesday, etc.). Due dates might be calculated from the start date of a course and programmatically included in the calendar dynamically in a XMLs-smart LMS system. For example the first day of class could be calculated from a start date as Monday and have the appropriate assignment displayed in the LMS calendar dynamically. However, in some cases, it may be better to manage data, related only to a specific instance of a course, directly in the LMS system rather than in the single source that is used for all instances (if they teach more than one of the same class).

The late research found, that may influence the future .xsd design, is the discovery of the specifications for the modularization of the XHTML language (“Xhtml™ 1.1,” 2010*)*. The design in the modularization of the XHTML language by the W3C allows developers to redefine elements and attributes to either remove or add new child elements and attributes specific to an end user’s need. This means that the XHTML language, which was not a schema on the list to simplify, may now be redefined and expanded to include the elements necessary for the XMLs single source model. This redefinition could result in an .xsd schema, which can then be used to validate an XMLs single source like Appendix A, with the added benefit that educators can use either XHTML or XMLs elements (tags) in their single source. In addition, the modularization allows the integration of other XML languages such as MathML, which would allow a math instructor to maintain their math formula content in a single source as well. The W3C website provides an online example of a XHTML 1.1/MathML 2.0 redefinition “mathml-model-1.xsd” (“Index of /markup/schema/examples,” 2008).

Chapter 5 – Conclusion

The problem is not what it initially appeared to be: First, rather than needing to simply overly complex existing educational schemas like SCORM, existing schemas like eLML or XHTML should have complexity added to enable a single source for educational content that provides student –centered transformations. Second, rather than working in a saturated area, it appears that there is an area of research with less focus, which is single sourcing of educational content for the purpose to aid individual course developer's content management and to aid student-centered repurposing/transformation of content. Rather than making an incremental step in the development of the XMLs model from a finished schema a draft model for a proposed design is made that is not as refined as existing schema designs that have evolved from years of research or development by teams of people. This leaves work to establish an accepted industry standard that enables the research goals for an XML single source model for student-centered educational content management.

Whether or not this is typical of most thesis research, nothing went as originally planned. The path to a conclusion was like a roller-coaster ride. This thesis concludes with a proposed model, designed to meet the need for student-centered instruction (repurposing and transformation), and single source for course content management. While the XMLs model's design is for simplicity, viewing and working with the source code does not seem to be as easy as viewing and working with a word processing document or other what-you-see-is-what-you-get (WYSIWYG) editor.

Further, during this research, it came to my attention that the bulk of the research seemed to focus on the development of LOs and the rapid or dynamic development of course materials created from multiple subject matter experts or assembled from using multiple RLOs possibly

found in an LOR. There was less focus on a single instructor/individual building a course, which may indicate that current educational technology/trends are moving away from instructor-developed courses, or this is an overlooked area for further research. However, whether a course is dynamically generated or individually developed the result is still a single course, and students may have individual needs for accessing/navigating the course. At this point, a standard course content mark-up such as the XMLs might be useful as an aid for dynamic student-centered transformations to a student's preference or current needs (i.e. search, study, review, or self-assess). When the system the student is using to access the course is aware of the XMLs standard, and the RLO content is valid XMLs, it may be possible to transform/repurpose collected RLO content as well; allowing diversely assembled content to behave more like a coherent whole.

The literature review indicates a disparity between research addressing the "repurpose for educational goals single source" (RP/EG/SS) area of the cube and the "reuse for corporate goals content management" (RU/CG/CM) (see Figure 1) indicating the area of RP/EG/SS may need more research.

Future development needs include the development of a formal .xsd definition that will allow XML validators to validate the XMLs content as valid XMLs (vs. valid XML); one option for developing the .xsd might be to extend the XHTML 1.1 language rather than build an entirely new language from scratch. This is beneficial because as the W3C updates their XHTML modules no additional updates may be required in the XMLs other than updating the reference to the new module.

In addition, there is a need for development tools to be created that can accept any .xsd schema and provide a WYSIWYG graphical user interface (GUI). This would allow content

developers to (a) build/manage XMLs content without the need for viewing or XMLs source code, or (b) have the developer tied to one proprietary XMLs editor, and (c) so future improvements/modifications to the XMLs does not require retooling. Until then it might be best not to expand the model to the point of being too complex for non-technical course content developers.

Most importantly there is a need for default XSL transformations. These programming type documents are what will take the single source structure and convert it into a HTML, PDF or Power Point document; so that end users unfamiliar with XSL technologies can still implement basic transformations. A technical person can develop a single XSL transformation to create a Power Point document from a XMLs single source; once that is done any XMLs course can use the same XSL to create Power Point documents at the push of a button. XSL technologies might also transform content into SCORM, or IMS compliant output, should that be required to meet TAACCCT or other grant funding opportunities (although it might take additional research to identify what additional XMLs elements/attributes are needed). In the future, it will also be useful to have a default cascading style sheets developed so that the online transformed documents can be more visually appealing or be more easily modified to meet a particular style preferred by an institution.

For institutions desiring to conform to the Americans with Disabilities Act (ADA) Section 508, it might also be possible to develop a single XSL to transform XMLs content into documents conforming to section 508, or possibly even warn users when needed elements are missing (although this may also take additional research to implement elements/attributes to aid 508 compliance). Likewise, if a student wants an eBook version of a course XSL can do that too. If XSL transformations made for XMLs content are freely available to use by all, everyone will

have the ability to make that transformation. Who knows what the future holds, and what the next popular instructional technology or standard will be for XMLs XSL transformation?

The eLML editor/language discovered late in the research in May 2011 is in a final (and first) stable state as of July 12, 2011 noting new functionality with added XSL transformation abilities (“elml,” 2011). The eLML editor has vendor specific license that eliminated it for use in this research and as of May did not have student-centered transformations or use XHTML modules.

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401cb51dede6%40sessionmgr11&vid=1&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=aph&AN=4403707

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Appendix A

```
<?xml version="1.0" encoding="iso-8859-1"?>
<Course>
  <communication_contact>
    <office_hours>
      <weekday>Monday</weekday>
      <from_hour>10:00:00</from_hour>
      <to_hour>12:00:00</to_hour>
    </office_hours>
    <office_hours>
      <weekday>Monday</weekday>
      <from_hour>01:00:00</from_hour>
      <to_hour>03:00:00</to_hour>
    </office_hours>
    <office_hours>
      <weekday>Wednesday</weekday>
      <from_hour>01:00:00</from_hour>
      <to_hour>03:00:00</to_hour>
    </office_hours>
    <office_hours>
      <weekday>Friday</weekday>
      <from_hour>01:00:00</from_hour>
      <to_hour>03:00:00</to_hour>
    </office_hours>
    <location>
      <address>
        <address1>123 College Street</address1>
        <address2>Room 123</address2>
        <city>My City</city>
        <state>FL</state>
        <postal>12345</postal>
      </address>
      <map>http:\\www.myCollege.edu\College\Campus\Campus1_Map.svg</map>
      <building>Lanuage Arts</building>
      <room_number>123</room_number>
      <physical_directions>Main Street 2 blocks east of Central Avenue</physical_directions>
      <GPS_position>39.788852,-105.031021</GPS_position> <!-- Regis University GPS: from
Google Maps http://www.google.com -->
      <course_url>http:\\lms.myCollege.edu\login\</course_url>
      <online_directions>From the home page: select menu &amp;gt; myCourses</online_directions>
    </location>
    <phone>
      <phone_number>111-222-3333</phone_number>
      <phone_hours>
```

```
      <weekday>Monday</weekday>
      <from_hour>10:00:00</from_hour>
      <to_hour>12:00:00</to_hour>
    </phone_hours>
  </phone>
  <email>instructor.name@myCollege.edu</email>
  <rss>http:\\mediaserver.MyCollege.edu\rss\instructor\course1News\</rss>
  <blog>http:\\mediaserver.MyCollege.edu\blogs\instructor\blog\</blog>

<podcast>http:\\mediaserver.MyCollege.edu\mp3\department\subject\classID\lecture1\</podcast
>
  <video>http:\\mediaserver.MyCollege.edu\video\instructor\introduction.mov</video>

<qr_code>http:\\mediaserver.MyCollege.edu\graphics\qrCodes\subject\catalog\courseID.jpg</qr
_code>

<FAQ_frequently_asked_questions>http:\\info.MyCollege.edu\instructor\courseID\faq.html</F
AQ_frequently_asked_questions>
 </communication_contact>
 <abstract_description>This is a simple sample abstract and/or course description
</abstract_description>
 <course_overview>Course overview text</course_overview>
 <required_referenced_materials>
  <reference_type>reference</reference_type> <!-- options: reference | required_materials -->
  <reference>
   <reference_id>Walsh_2007</reference_id>
   <authors>
    <name>
     <first_name>Lucas</first_name>
     <middle_name />
     <last_name>Walsh</last_name>
    </name>
   </authors>
   <editors>
    <name>
     <first_name />
     <middle_name />
     <last_name />
    </name>
   </editors>
   <edition />
   <pub_day>---15</pub_day> <!-- dashes are required to enter partial information in a gDay,
gMonth, gYear types and have the content validate -->
   <pub_month>--06</pub_month>
   <pub_year>2007</pub_year>
```

```
    <reference_title>Using Extensible Markup Language (XML) for the Single Source Delivery of Educational Resources by Print and Online: A Case Study
    </reference_title>
    <publication_title>AACE Journal</publication_title>
    <presented_at>Proceedings of the 26th annual ACM international conference on Design of communication</presented_at>
    <volumn_number>15</volumn_number>
    <issue_number>4</issue_number>
    <page_pageRange>389-411</page_pageRange>
    <city>Chesapeake</city>
    <state>VA</state>
    <country>USA</country>
    <publisher>AACE</publisher>
    <url>http://www.editlib.org/p/22927</url>
    <doi>10.1145/1456536.1456560</doi>
   </reference>
  </required_referenced_materials>
  <course_policies>Policies to follow for this course....</course_policies>
  <grading_plan>grading plan stuff here....</grading_plan>
  <how_to_learn>Suggested learning route. First read the course outline view then full course material, taking the assessments at the end of each unit.</how_to_learn>
  <how_to_study>Read the course outline view then the summary view then take the assessment and re-read the full content for areas that where your understanding is not complete.</how_to_study>
  <student_expectations>The student is expected to participate in class discussions....</student_expectations>
  <evaluation>The criteria for evaluating...</evaluation>
  <disclaimer>The schedule, policies, etc... are subject to change ... </disclaimer>


  <course_content>
   <content_division division_level="unit">
    <!-- options might include: phase|unit|block|module|sub_course|lesson|task|learning_objective|performance_objective|enabling_objective|teaching_point and in this order allow for several different learning taxonomies to be implemented using this schema design.-->

    <!-- NOTE: if modular XHTML 1.1 is extended/redefined to develop this XMLs' schema then familiar elements already existing in XHTML like the <h1..h6> heading tags, <p> paragraph, <acronmyn> emphasis tag etc. will be available to the developer and can be redefined to include new attributes such as 'paragaph_style' used as an example below -->
    <heading>Introduction</heading> <!-- the combination of unit > heading or module > heading etc. can define the display characteristics of the heading (size, bold, italic, centered, etc. based on the XSL transformation or CSS style sheet -->
    <p paragraph_style="example">
```

```
<!-- paragraph styles:
undefined|comparson|contrast|causeNeffect|analogy|process|definition|deductive_reasoning|inductive_reasoning|chronological_order|climatic_order|example|classification|analogy|checklist -->
<topic_sentence>This is an example of content structure for the course.</topic_sentence>
Content is wrapped in
<term definition="Extensible Markup Language: a language similar to HTML but more strict in structure and more robust">XML</term> tags allowable by the
<term explanation="a simplified XML schema designed to mark-up educational course content for a single source content management document">XMLs schema</term>.
<!-- can also have a <false true=""></false> -->
<true false="This draft schema is a fully completed design">This draft schema has many design restrictions that still need to be worked out.</true> It is not a polished document such as would be created by
<acronym title="World Wide Web Consortium">W3C</acronym>,
<acronym title="Dublin Core Metadata Initiative">DCMI</acronym>, or
<acronym title="Advanced Distributed Learning">ADL</acronym>.
<answer question="What is the point of this XMLs schema?">The point of this schema is to provide a rough idea for what a simplified XML single source model for student centered educational content management might look like.</answer>
</p>
<content_division division_level="module">
<heading>Four Problem areas:</heading>
<p paragraph_style="climatic_order"> There are seveal problem areas to be addressed. Four problem areas identified with respect to traditional content management in general are
<part whole="Traditional content management problem areas.">duplication of content</part>,
<part whole="Traditional content management problem areas.">sustaining multiple systems</part>,
<part whole="Traditional content management problem areas.">burden of technology skills</part> and finally
<part whole="Traditional content management problem areas.">LMS limitiations</part>.
</p>
<content_division division_level="lesson">
<heading>duplication of content</heading>
<p paragraph_style="undefined">
<topic_sentence>The first problem area is duplication of content.</topic_sentence>
Educators that work with multiple media formats for educational content may have duplicate content in different forms as
<citation reference_id="Walsh_2007">Walsh (2007)</citation> discovered, i.e. a Power Point presentation, a printed handout from a
<acronym title="Postscript Downloadable Format">PDF</acronym> file, an outline of the course content, a Web page, a basic course and an advanced course material.
</p>
<!-- summary can be optional -->
<summary>this lesson summary</summary>
</content_division>
```

```
<content_division division_level="lesson">
  <heading>sustaining multiple systems</heading>
  <p paragraph_style="undefined">
    <topic_sentence>The second problem is sustaining multiple systems to handle the multiple formats as WestNet had to do
      (
      <citation reference_id="Katzman_2006">Katzman, 2006</citation>).
    </topic_sentence>
    Conversions of one source format to another used different teams, processes and systems based on the format generated. It took time and money to ensure these processes were consistent
    (
    <citation reference_id="Katzman_2006">Katzman, 2006)</citation>).
  </p>
  <multiple_choice>
    <question>Why is sustaining multiple systems a problem?</question>
    <correct_answer>B</correct_answer>
    <A>There are not enough skilled people to manage multiple systems.</A>
    <B>It takes time and money to ensure these processes are consistent.</B>
    <C>Because they are always complex and difficult to work with.</C>
    <D>It's not fun.</D>
    <E>All of the above.</E>
    <F>None of the above.</F>
  </multiple_choice>
  <summary>this lesson summary</summary>
</content_division>
<content_division division_level="lesson">
  <heading>burden of technology skills</heading>
  <p paragraph_style="undefined">
    <topic_sentence>The third problem is the increased burden of learning new skill sets.</topic_sentence> These are skills like
    <!-- with the matching_stem either the stem or the response can be tagged & the other half entered into either the stem or response attribute
    in the example below the response is tagged and the stem provided in the stem attribute -->
    <matching_stem stem="Two skills added to the burden of technical writers due to new technologies" response="">desktop publishing and Web development</matching_stem> now required to maintain multiple sources of content for their final output such as print and Web. Time previously devoted solely to writing, is now used building technological skills to create the various formats now required
    (
    <citation reference_id="Rockley_2001">Rockley, 2001</citation>;
    <citation reference_id="Rockley_Hackos_1999">Rockley &amp;amp; Hackos, 1999</citation>).
  </p>
  <summary>this lesson summary</summary>
</content_division>
```

```
    <content_division division_level="lesson">
      <heading>CMS/LMS limitations</heading>
      <p paragraph_style="undefined">
        <topic_sentence>CMS/LMS systems are designed to be Web based training content
management systems and that they are not able to handle the additional modes of output, such as
a document (
          <citation reference_id="Katzman_2006">Katzman, 2006</citation>, p. 56).
        </topic_sentence>
                    Clark (
        <citation reference_id="Clark_2007">2007</citation>) states that these large systems
        <incomplete_statement_best_answer incomplete_statement="The main problem with
CMS/LMS systems are that they...">are rigid and not necessarily designed for reusability outside
of their own proprietary software</incomplete_statement_best_answer> even though they may
say they are interoperable. They are primarily managing learners and tracking results rather than
managing content and reusing content.
      </p>
      <summary>this lesson summary</summary>
    </content_division>
    <summary>this module summary</summary>
  </content_division>
    <summary>unit 1 summary</summary>
 </content_division>
 <content_division division_level="unit" title="Evaluating Possible Solutions">
  <p paragraph_style="undefined">
    <topic_sentence>CMS/LMS systems are designed to be Web based training content
management systems and that they are not able to handle the additional modes of output, such as
a document (
      <citation reference_id="Katzman_2006">Katzman, 2006</citation>, p. 56).
    </topic_sentence> The purpose of this study is to investigate XML as a single source and
    <!-- can also have a <problem solution=""></problem> -->
    <solution problem="Content is duplicated and maintained in many different formats making
updates difficult and time consuming">find solutions or define future needs for educators to
manage student centered educational content for diverse user preferences and multi modal
delivery</solution>. To reduce the need for multiple systems, duplication of content and manual
process educators may go through to generate educational content in alternate formats and views
of material for online or face-to-face students by developing
    <solution problem="There are too many systems to maintain when content is often
converted into different format manually.">an XML single source that can be transformed into
alternate formats</solution>. To relieve some of the burden of technology skills required to
develop education content to used with educational technologies and have a single source that is
independent from a proprietary system and simply maintained.
  </p>
  <content_division division_level="module">
    <!-- ... -->
    <content_division division_level="lession">
      <!-- ... -->
```

```
        <content_division division_level="learning objective">
          <!-- ... -->
         <content_division division_level="teaching_point">
          <!-- ... --> etc.
         </content_division>
        </content_division>
       </content_division>
       <summary>this module summary</summary>
     </content_division>
     <summary>unit 2 summary</summary>
   </content_division>
  </course_content>
</Course>
```

Appendix B

```
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      <weekday></weekday>
      <from_hour></from_hour>
      <to_hour></to_hour>
    </office_hours>
    <location>
      <address>
        <address1></address1>
        <address2></address2>
        <city></city>
        <state></state>
        <postal></postal>
      </address>
      <map></map>
      <building></building>
      <room_number></room_number>
      <physical_directions></physical_directions>
      <GPS_position></GPS_position>
      <course_url></course_url>
      <online_directions></online_directions>
    </location>
    <phone>
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      <phone_hours>
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        <from_hour></from_hour>
        <to_hour></to_hour>
      </phone_hours>
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    <email></email>
    <rss></rss>
    <blog></blog>
    <podcast></podcast>
    <video></video>
    <qr_code></qr_code>
    <FAQ_frequently_asked_questions></FAQ_frequently_asked_questions>
  </communication_contact>
  <abstract_description></abstract_description>
  <course_overview></course_overview>
  <required_referenced_materials>
```

```
  <reference_type></reference_type>
  <reference>
   <reference_id></reference_id>
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     <middle_name />
     <last_name></last_name>
    </name>
   </authors>
   <editors>
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     <middle_name />
     <last_name />
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   <pub_month></pub_month>
   <pub_year></pub_year>
   <reference_title></reference_title>
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   <volumn_number></volumn_number>
   <issue_number></issue_number>
   <page_pageRange></page_pageRange>
   <city></city>
   <state></state>
   <country></country>
   <publisher></publisher>
   <url></url>
   <doi></doi>
  </reference>
 </required_referenced_materials>
 <course_policies></course_policies>
 <grading_plan></grading_plan>
 <how_to_learn></how_to_learn>
 <how_to_study></how_to_study>
 <student_expectations></student_expectations>
 <evaluation></evaluation>
 <disclaimer></disclaimer>

 <course_content>
  <content_division division_level="unit" title="">
```

```
    <!-- NOTE: if modular XHTML 1.1 is extended/redefined to develop this XMLs' schema
then familiar elements already existing in XHTML like the <h1..h6> heading tags, <p>
paragraph, <acronmyn> emphasis tag etc.
will be available to the developer and can be redefined to include new attributes such as
'paragaph_style' used as an example below -->
    <heading></heading>
    <p paragraph_style="example">
      <!-- paragraph styles:
undefined|comparson|contrast|causeNeffect|analogy|process|definition|deductive_reasoning|induc
tive_reasoning|chronological_order|climatic_order|example|classification|analogy|checklist
-->
     <topic_sentence></topic_sentence>
     <term definition=""></term>
     <term explanation=""></term>
     <false true=""></false>
     <acronym title=""></acronym>,
     <answer question=""></answer>
     <part whole=""></part>
     <citation reference_id=""></citation>
     <matching_stem stem="" response=""></matching_stem>
     <incomplete_statement_best_answer incomplete_statement="" best_answer="">
     </incomplete_statement_best_answer>
    </p>
    <multiple_choice>
     <question></question>
     <correct_answer></correct_answer>
     <A></A>
     <B></B>
     <C></C>
     <D></D>
     <E></E>
     <F></F>
    </multiple_choice>
    <summary></summary>
    <content_division division_level="module">
     <content_division division_level="lession">
      <content_division division_level="learning objective">
       <content_division division_level="teaching_point">
        <!-- ... --> etc.
       </content_division>
      </content_division>
     </content_division>
    </content_division>
   </content_division>
  </course_content>
</Course>
```

Appendix C

Preface
Acknowledgements
Sections
Chapters
Syllabus
Header (syllabus)
Course description (syllabus)
Course focus (syllabus)
Textbook (syllabus)
References (syllabus)
Content Goals (syllabus)
Student Contributions (syllabus)
Evaluation (syllabus)
Schedule (syllabus)
Performance (syllabus)
Measurable Outcomes
Immeasurable Outcomes
General Objectives
Specific Objectives
National Goals for Education
Knowledge Objectives (KO)
Comprehension–Translation (KO)
Comprehension–Interpretation (KO)
Application (KO)
Analysis (KO)
Synthesis (KO)
Manuals
Workbooks
Pamphlets
Study Guides
Reference Books
Standard Textbooks
Magazines
Newspapers
Modules
Pictures
Graphics
Transparencies
Film Strip
Posters
Audio Tapes
Records
Films
Film Loops
Slide Series
Video Tapes
Microcomputers
Internet
Puzzles
Models
Specimen
Puppets
Figures
Learning Kits
Experiments
Trainers
Simulators
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Directions for Use
Technical Content
Bibliography
End of Chapter (EOC)
Summary (EOC)
In Brief (EOC)
Key Terms (EOC)
Check Point (EOC)
Teaching Today
Educational Issues (EOC)
Integration Corner (EOC)
Software Corner (EOC)
In the Lab (EOC)
Learn it Online (EOC)
Course Number
Title
Credit Hours
Classroom #
Building
Address
Map (campus)
Days/Hours
URL
Prerequisites
Permissions
Requirement course satisfies
Lab Information
Personal Information (PI)
Name (PI)
Title (PI)
How to Address You (PI)
Office location (PI)
Phone (PI)
Email (PI)
Office Hours (PI)
When to Call (PI)
Bio Info (PI) (BI)
Degrees (PI) (BI)
Universities (PI) (BI)
Experience (PI) (BI)
Research Areas (PI) (BI)
Course Description
Popular Topics Not Covered
Student Objectives
Required Materials
Course Requirements
Grading Standards
Rubric
Course Policies
Advanced Organizer
Comparative Organizer
Expository Organizer
Learner Time Required
Cognitive Dsgn Blueprint (CDB)
Teaching Goal (CDB)
Learning Objective (CDB)
Learning Experience (CDB)
Evaluation Plan (CDB)

Feedback (FBK)
Discussion questions (FBK)
Assignments
Course Policies (CP)
Late Papers (CP)
Missed Tests (CP)
Honesty (CP)
Grading Plan
Bloom Levels (BL)
1 Remember (BL)
2 Understand (BL)
3 Apply (BL)
4 Analyze (BL)
5 Evaluate (BL)
6 Create (BL)
A factual knowledge (BL)
B conceptual knowledge (BL)
C procedural knowledge (BL)
D Meta-cognitive knowledge (BL)
Introduction (text or video)
Course Overview (CO)
Roadmap (CO)
Structure (CO)
How to Learn
Courseware
Tools
Technology Requirements (TR)
Computer Equipment (TR)
Software (TR)
Configuration (TR)
Vital Information (VI)
Teacher Email (VI)
Tutor Email (VI)
Phone (VI)
Fax (VI)
Online Hours (VI)
Roles (VI)
Responsibilities (VI)
Student Expectations (VI)
How they are graded (VI)
Assignment due dates (VI)
Weekly announcements
Sample tests
Biography
Curriculum vitae
Photos
Glossary
Index
Full-text search
FAQ
Copyright ©
Year ©
Name ©
Underline
Numbers (N)
Arabic (N)
Roman (N)
Procedural (N)
Paragraphs (P)
Topic/Main Sentence (P)
Comparison (P)
Contrast (P)
Cause (P)
Effect (P)
Analogy (P)
Process (P)
Definition (P)
Deductive Reasoning (P)
Inductive Reasoning (P)
Time/Chronological order (P)
Climatic Order (P)
Example (P)
Classification (P)
Analogy (P)
Checklist (P)
Article (A)
Empirical (A)
Literature Review (A)
Theoretical Article (A)
Methodological Article (A)
Case Studies (A)
Brief Reports (A)
Comments (A)
Replies on previously published articles (A)
Book Reviews (A)
Obituary (A)
Letters to the editor (A)
Monographs (A)
Manuscript
Structure/Content (M)
Title (M)
Author's Name (M)
Institutional Affiliation (M)
Author Note (M)
Abstract (M)
Introduction (M)
Method (M)
Results (M)
Discussion (M)
Multiple Experiments (M)
Meta-Analysis (M)
References (M)
Footnotes (M)
Appendixes (M)
Supplemental Materials (M)
Italics
Abbreviations
Formulas
Tables (T)
Titles (T)
Headings (T)
Body (T)
Table Notes (T)
Figures (F)
Graphs (F)
Chart (F)
Map (F)
Drawing (F)
Photograph (F)
Legends (F)
Captions (F)
Quote
Citation
Acronym
Reference List (RL)
Author (RL)
Edition Info (RL)
Publication Date (RL)
Title (RL)
Volume Number (italicized) (RL)
Issue Number (RL)

Page(s) (RL)
City (RL)
State (RL)
Country (RL)
URL (RL)
DOI (RL)
Audio Visual (AV)
Music (AV)
Podcast (AV)
Video (AV)
Animation (AV)
Key Term
Questions for Review
Questions for Discussion
Internet Exercises
Team Assignments
Real-World Case
How to Use
Annotation
Explanatory Note
Alternate Translation
Subject Headings
Special Abbreviations
How to Study
Outline
Index of Annotations
Concordance
Outlines
Power Point Slides
Instructions
Handouts
Contact Information
Presentation Object
Practice Object
Simulation Object
Conceptual Model
Information Object
Contextual Representation
Learning Objects (LO)
Mini-Tutorial (LO)
Mini Case Study (LO)
Mini Simulation (LO)
Overview (LO)
Summary (LO)
Descriptions (LO)
Definitions (LO)
Demonstrations (LO)
Models (LO)
Worked Examples (LO)
Case Studies (LO)
Stories (LO)
Papers (LO)
Articles (LO)
Decision Aids (LO)
Problems (LO)
Games (LO)
Simulations (LO)
Drill Exercises (LO)
Practice Exercise (LO)
Review exercises (LO)
Test assessments (LO)
Course
Modules
Lesson
Learning Step
Block
Phase
Subcourse
Task
Performance Objective
Enabling Objective
Teaching Point
Learning Objective (CDB)
Unit
Captions
True/False
Matching (MTC)
Stem (MTC)
Response (MTC)
Multiple Choices (MC)
Stem (question/statement) (MC)
Distractors (MC)
Term/Definition (MTC)
Phrase/Phrase (MTC)
Parts/Larger Unit (MTC)
Problems/Solutions (MTC)
Question/Answer (MC)
Incomplete Statement/Best Answer (MC)
Fill in the Blank/Terms (MC)
Multi-Modal Display
Options (MM)
Phone (MM)
Tablet (MM)
PC (MM)
eBook (MM)
MP3 (MM)
RSS (MM)

Appendix D

General Objectives
Specific Objectives
End of Chapter (EOC)
Summary (EOC)
In Brief (EOC)
Key Terms (EOC)
Check Point (EOC)
Course Description
Student Objectives
Required Materials
Rubric
Teaching Goal (CDB)
Learning Objective (CDB)
Discussion questions (FBK)
Course Overview (CO)
Roadmap (CO)
Structure (CO)
How to Learn
Student Expectations (VI)
Sample tests
Biography
Topic/Main Sentence (P)
Definition (P)
Footnotes (M)
Key Term
Questions for Review
Questions for Discussion
Explanatory Note
How to Study
Introduction
Overview (LO)
Summary (LO)
Descriptions (LO)
Definitions (LO)
Drill Exercises (LO)
Practice Exercise (LO)
Review exercises (LO)
Test assessments (LO)
Course
Modules
Lesson
Learning Step
Block
Phase
Subcourse
Task
Performance Objective
Enabling Objective
Teaching Point
Learning Objective (CDB)
Unit
True/False
Matching (MTC)
Stem (MTC)
Response (MTC)
Multiple Choices (MC)
Stem (question/statement) (MC)
Distractors (MC)
Term/Definition (MTC)
Phrase/Phrase (MTC)
Parts/Larger Unit (MTC)
Problems/Solutions (MTC)
Question/Answer (MC)
Incomplete Statement/Best Answer (MC)
Fill in the Blank/Terms (MC)
Multi-Modal Display
Options (MM)
Phone (MM)
Tablet (MM)
PC (MM)
eBook (MM)
MP3 (MM)
RSS (MM)

Appendix E

Multi-Modal Display Options (MM)
Phone (MM)
Tablet (MM)
PC (MM)
eBook (MM)
MP3 (MM)
RSS (MM)
Braille (MM)
Speech (MM)

Glossary

content management system (cms)

The term LMS, and CMS will, for the purpose of this paper, refer to the same type of software such as Blackboard, ANGEL and Moodle type systems. LMS is the common term used, however CMS is the more correct term according to (Watson, & Watson, 2007). Course Management System will likewise refer to the same type of system as Content Management System.

learning content management systems (lcms)

LCMS is different from the term LMS in that LCMS technology works with the learning content directly making LCMSs a “first step in developing training initiatives” (Perry, 2009, p.29). Another way to look at this might be to view the LMS as the presentation system and the LCMS as the content system.

schema

The term ‘schema’ generically refers to two types of XML definitions XSD and Document Type Definition (DTD).

scorm

SCORM is an XML schema developed by Advanced Distributed Learning (ADL). This schema is the result of an initiative and collaboration of government, industry and academia sponsored by the Office of the Under Secretary of Defense for Personnel and Readiness (OUSD P&R) to provide access to custom education/training in a cost effective manner “anywhere, anytime.” (“Advanced Distributed Learning,” 2010d).

single source

A ‘single source document’ for the purpose of this paper refers to a single location of content edited in one place and having all the outputs that use/reference this source updated without additional editing.

xml, xsd, xsl

XML developed by the W3C, an international organization that develops standards that promote the growth of the Web (“W3c,” 2010), is used for structuring data allowing it to be shared between computers and people (“Xml essentials,” 2010). The structure is defined by an XML Schema Definition (XSD that provides a means to define the correct structure, order and attributes of an XML document so that an XML document can be validated against it to determine if it is properly formatted (“Introduction to xml schema,” 2010; Gao, Sperberg-McQueen, & Thompson, 2010). A DTD performs a similar function as XSD in that it describes the valid structure of an XML document, but XSD is XML-based and more powerful than a DTD (“Introduction to xml schema,” 2010; “Why use xml schemas?” 2010). In addition to the XML document (written according to the XSD schema), there is another ‘family’ of recommendations developed by the W3C named The Extensible Stylesheet Language Family (XSL). This family of recommendations provides the languages useful for transforming and presenting XML.