Synchronizing Technology Courses with Market Needs

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Abstract

Given that technology is changing at an ever accelerating pace, keeping technology courses up-to-date with market needs is becoming increasingly difficult. This paper presents a process for developing college courses that more align to market needs. The iterative process exploits reusable, expandable domain models that are vetted by market experts and that describe the semantics, functions, skills, and knowledge requirements of the target market. These domain models are then used to develop course objectives that better synchronize to the specific domain of interest and better prepare students for what they need to know to be more competitive in the job market.

Keywords: Domain Model, Ontology Model, Course Development, Market Needs, Course Objectives

1. Introduction

Few would argue that the pace of technological change is increasing – and some argue that it is increasing exponentially (Kurzweil, 1999). Given this ever accelerating pace of technological change, keeping our technology courses up-to-date and focused on market needs is becoming increasingly difficult. This is especially true in today's challenging job market.

This paper presents a process for developing the learning objectives of college level courses that better align to market needs, with the objective of improving student competitiveness in the job market. The general process is described along with examples that specifically relate to the development of a university level e-business course. The iterative process involves the development of ontology models and domain models that are vetted by domain experts. These models describe the semantics, functions, skills, and knowledge requirements of the target markets. The domain models, in the form of concept maps, are leveraged to collaborate, develop, and organize course objectives that are better synchronized to market needs in the domain of interest.

Figure 1 outlines the overall process. It exploits ontology and domain models for the technology area that the course is targeting. Each of the four primary tasks in the process, as well as the collaboration with domain experts, is described in this paper.

As shown in **Figure 1**, the process starts at the top with the development of an ontology model that helps the instructor create the search terms necessary to research and collect the appropriate information to create a domain model. The primary purposes of the domain model are to 1) understand the domain, and 2) coordinate that view of the domain with experts for verification and validation purposes. The domain model, with inputs from domain experts, then becomes the primary driver for developing the course objectives, the associated topics to cover, and the organization of the course.

2. Ontology Model and Knowledge Search

The purpose of the first two tasks is to develop an ontology model and then use it to help discover the knowledge necessary to develop the domain model.

An ontology is a formal specification of domain terms along with the relationships between them (Gruber, 1993). The ontology model should capture the unique concepts, relationships, and terms that characterize the domain of interest.

An ontology model can be particularly important for new technology areas because some of the language is often too new to even be in recent hardcopy dictionaries. For example, Twitter was established in 2006 (Twitter, 2017), so in dictionaries before then, to 'tweet' meant only, "…a weak chirping sound, as of a young or small bird". Now, of course, it can also mean, "…a message posted on the Twitter social media service and website." (Tweet, 2017).

The ontology model drives the search to discover the information that defines the domain. Specifically, for course development, we want to discover the functions, skills, and knowledge required by our students to succeed in that domain. The ontological model should contain all the key terms and concepts necessary to research the domain knowledge in order to fully understand, and model the domain in the context of, in this case, students learning and graduating with the necessary knowledge and skills to support market needs.

The ontology model, and its associated semantics, should include not only the specific terms used in the technology area, but also terms or phrases that may be related to them. This includes the appropriate synonyms, hypernyms (superordinate terms), hyponyms (subordinate terms), common misspellings (e.g., the work 'knowledge' versus the incorrectly spelled 'knowlege'), alternate spellings (e.g., 'disc' or 'disk'), acronyms, and other relevant terms necessary to disambiguate the meaning of the terms in their specific search context.

For example, 'search engine optimization' is a relatively new term in the technology realm that means: "…the methods used to boost the ranking or frequency of a website in results returned by a search engine, in an effort to maximize user traffic to the site" (SEO, 2017). For search engine optimization, additional terms and phrases that may be appropriate to discovering knowledge related to this concept include those listed in **Table 1**.

Information sources to mine to capture the necessary student skills and knowledge can include domain specific trade related books and magazines, job search advertisements and websites, and training documentation. Other sources that may be useful, but may also be less up-to-date on the newest technologies and techniques, include academic related textbooks and academic journal articles.

3. Domain Model

The purpose of the domain model is to provide a means to understand and communicate the important domain concepts and how they relate to one another. One approach to modeling domains is to use concept maps, which are diagrams that organize and represent knowledge (Novak & Cañas, 2008). They are relatively simple diagrams that consist of concepts (encapsulated in circles or boxes) that are connected by their relationships (links with words specifying the relationship). The diagrams were first developed in 1972 to support the representation of children's knowledge and conceptual understanding (Novak & Musonda, 1991).

The process advocated in this paper leverages concept maps to model the domain. For our case, the concept map diagrams the information space defined by the domain and by market needs. This includes the skills, functions, and knowledge that students must possess to succeed in the technology area. As an example, **Figure 2** diagrams a portion of a much larger concept map (Otto, 2013) that addresses the field of e-business. This specific portion of the concept map shows how SEO (highlighted in red) relates to that broader field.

A further enlargement of a part of the sample concept map diagram is shown in **Figure 3**. This part of the concept map displays how a concept map connects concepts, via relationship links, to form propositions. For example, in **Figure 3**, one can see how the concept map diagrams the proposition that 'link building' -> enhances -> SEO.
A focus question can be used to appropriately scope a concept map and provide the context for its development and use (Albert & Steiner, 2005). For example, a focus question for our e-business example might be, "What is the key knowledge for students to learn in an introductory e-business course?" Similarly, the scope of the domain model is of key concern. This is because a concept model can quickly get large (and perhaps too large to be of practical use) if there are not disciplined breadth and depth controls on the scope of what is to covered and diagrammed.

To help manage the size and complexity of concept maps, we can create subdomain models. For example, if we isolate the 'Keyword Research' concept in the sample domain, we can further extend the concept map (to create a subdomain model) that provides additional details about that concept (see **Figure 4**).

4. Collaborating with Experts

As a key part of the development of the concept map (in both breadth and depth), the instructor should work closely with domain experts (e.g., recruiters, hiring managers, analysts. etc.) who are currently working in, and have a knowledge of, the field to make sure that it accurately and fully covers the necessary knowledge in the field.

An approach to collaborating with domain experts is to form a working group of six to twelve subject matter experts (SMEs) (ODPSST, 2007). This group collectively develops or updates a concept map that addresses the focus question. The SMEs should be individuals with bona fide expert knowledge about the domain (USOPM, 2007) and collectively represent the breadth, depth, and scope of the area (IREC, 2013).

After developing the initial concept map, the working group administers reliability and validity assessments of the concept map. As part of the process, the working group can also choose to post initial and revised concept maps to the web for crowd-source reviews, comments, and updates to the concept map.

As the concept map is developed, it is important to assess its reliability and validity. According to Albert and Steiner (2008), there are several methods for assessing concept map reliability and validity as summarized in **Table 2**. The specific reliability and validity measurement approach to use can be determined by the working group.

5. Course Objectives

The final part of the process is to collaborate with experts using the concept map to create the course objectives that reflect the needed student knowledge and skills. Thus, following the SEO example (see **Figure 3**), possible SEO-related course objectives could include something like:

- Understand how link building enhances search engine optimization.
- Demonstrate the ability to conduct keyword research to optimize search engine advertising.

As with previous steps in the process, these course objectives (and the specific course topics that support them) should be coordinated with SMEs for accuracy and prioritization as a syllabus is developed. A potential side benefit of working closely with industry experts is that relationships may be developed that can enhance the likelihood that an instructor's students are hired.

Since this is an iterative approach, the process repeats itself as technology changes. The course objectives inform the development of updated ontology and domain models – which in turn lead to updated course objectives.

6. Conclusion

As the rate of technological change continues at its rapid, or even accelerating, pace, course developers and instructors will need to create and update their technology curriculum to keep up. This paper provides an iterative process to support that goal.

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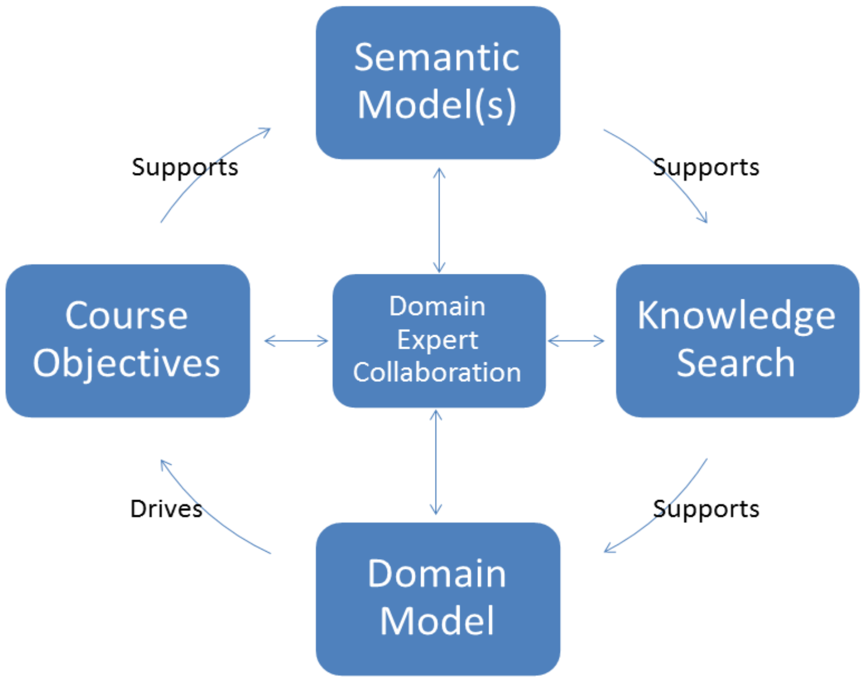

Figure 1. Overall Process

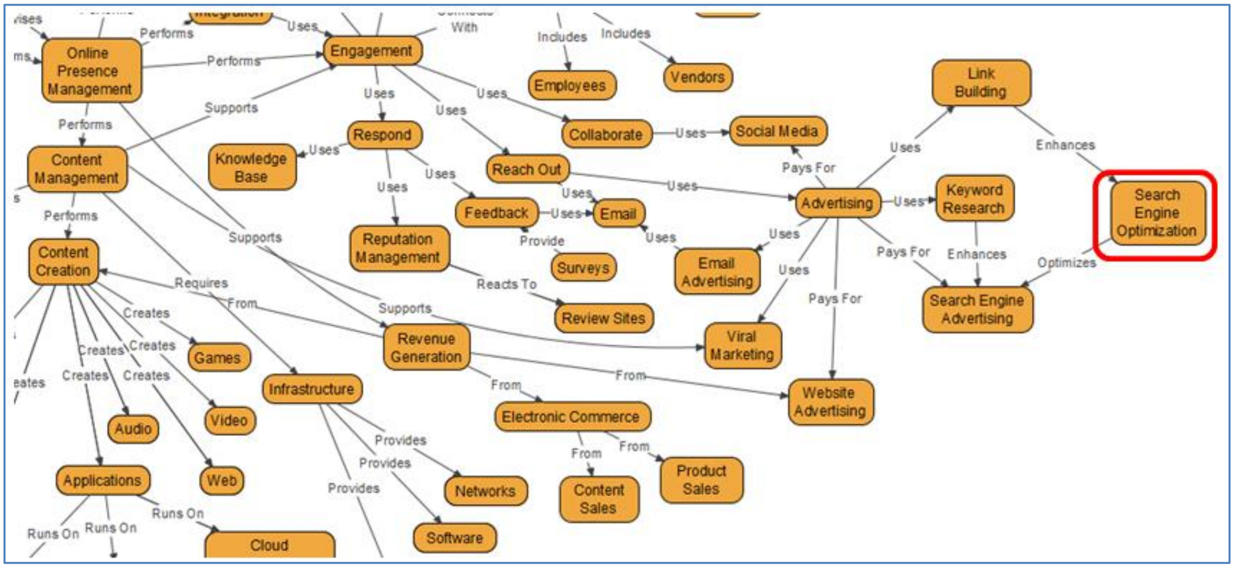

Figure 2. Sample Concept Map Domain Model

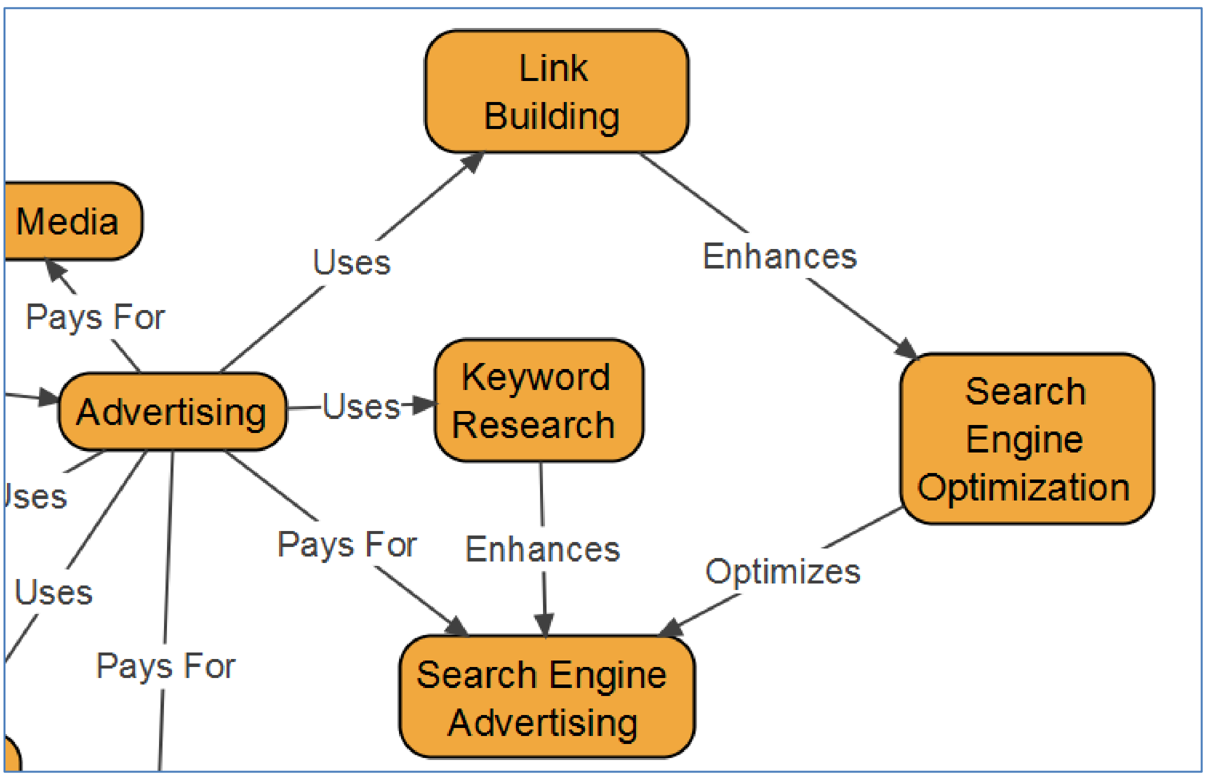

Figure 3. Concept Maps Diagram Propositions

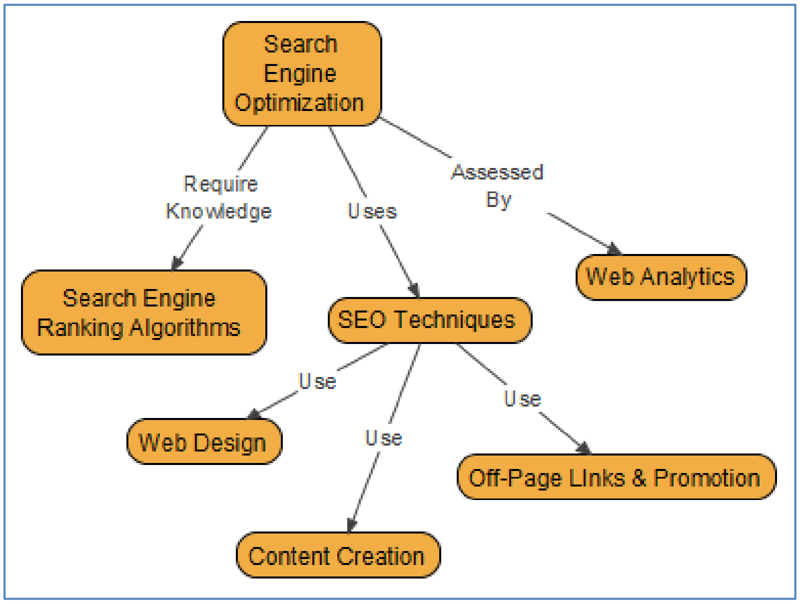

Figure 4. Search Engine Optimization SubDomain Model

Table 1. Related Search Engine Optimization Terms and Phrases

Synonyms	Search (seek, look for, hunt, research, boost, increase) engine (server, crawler, spider) (natural, organic, un-paid, keyword, key term) optimization (ranking, rating, position, priority, results, indexing)
Hypernyms	(web, internet) (advertising, marketing, visibility) (method, technique, approach)
Hyponyms	(Google, Bing, Yahoo) search engines, backlinks
Acronyms	SEO

Table 2. Concept Map Reliability and Validity Assessment Techniques

Concept Map Reliability
• Each SME constructs concept maps for the same domain at different times
• Multiple SMEs independently score a concept map according to a scoring system to determine inter- rater reliability determination
• Multiple SMEs generate concept maps in alternative representations (e.g. a directed graph or a list of propositions) – for parallel-forms reliability determination
Concept Map Validity
• A concept map is compared to several concept maps of the same domain that have been generated from scratch by individuals with different levels of expertise
• Some of the concepts and/or relations in a concept map are left out so that others may fill it out for comparison to the original concept map
• Persons use a numerical scale to rate the degree of relatedness between concept pairs
• Subjects are presented with concept map propositions (concept->linking words->concept) for rating as correct or incorrect