Integration of a Concept Map Generator and a Knowledge-Portal-Based E-learning System

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Abstract

Knowledge management (KM) is the research field aimed to create, organize, and store explicit knowledge for easy access and manipulation, whereas e-learning is concerned with delivering a suite of knowledge contents to a group of learners via the Internet. Since e-learning techniques have grown quickly nowadays to complement the conventional learning system, integration of KM and e-learning has been a tendency to improve the creation, organization, and delivery of a learner-oriented knowledge management system. Particularly, knowledge portal systems are usually efficient vehicles to realize this integration for we can create new content types on the portal sites to serve e-learning purpose. Nevertheless, a knowledge portal site allows the members to create and share their knowledge objects; implying that the website containing group knowledge grows itself unlimitedly and unexpectedly. To display the sitemap of a knowledge portal and observe the concept map of group knowledge, we have developed a visualization tool referred to as the Site-And-Concept (SAC) map generator. In this paper, we apply this map generator on a knowledge-portal-based e-learning system. Users can convert the generated concept maps into SCORM-compliant course packages with sequencing and navigation supports. They can further edit the learning content and share it to peer learners, and thus establish a collaborative learning environment.

Keywords:
Knowledge management, e-learning, knowledge portal, concept map, SCORM, collaborative learning

1 Introduction

Integration of knowledge management (KM) and e-learning has been an attractive research topic for the many dependencies and interrelations between these two fields [10, 11]. Learners over the computer networks usually benefit from KM, whereas the research within KM also considers learning as an import part of knowledge sharing processes. Therefore, the integration is of high potential to complete knowledge creation and delivery cycle. In the beginning of the research into integration, the KM systems are used as online materials supplementary to regular face-to-face teaching [4, 8]. The group activity provided by KM systems was immediately found highly effective for the traditional classroom teaching [1], and thus the research towards integration of KM and e-learning receives increasing attention ever since.

Nowadays, most popular integrated models tend to coordinate techniques following different perspectives of KM and e-learning [11, 12]. KM is mainly related to an “organization” perspective and can be seen as the process of integrating information and making it explicit, organized, accessible, and portable [10]. On the other hand, e-learning derives a “regeneration” perspective. The perspective of e-learning can be further considered involving short-term performance and long-term development [5]. For the short-term performance, the user learns the target materials just in time and in context; whereas in the case of long-term development, the learner can feedback the knowledge base by producing new knowledge objects or supporting behavior and tendency analysis.

Knowledge portal systems are usually considered as efficient vehicles to incorporate knowledge management with e-learning functions. A knowledge portal is a kind of website aimed to create, organize, and store explicit knowl-
edge for easy access, sharing and manipulation. Research of education [3, 14] has developed several manners to convert knowledge objects into learning assets and to facilitate packaging of content aggregation. These methods are convenient to implement and have proved practical; however, there still exist performance issues that deserve further research. For example, we may suffer the cognitive disconnection problem [5] if we create e-learning content types on a portal system immediately. The e-learning function may have limited performance because the isolated learning content cannot cooperate with the underlying knowledge ontology smoothly. In this paper, we present our previous developed Site-And-Concept (SAC) map generator, which automatically constructs concept map linking knowledge objects and thus helps users visualize the formation of group knowledge. Then, we use this map generator as a mediate tool to produce SCORM-compliant course packages with supports of sequencing and navigation. As for the practice platform of this work, we choose a locally developed knowledge portal, called Open Computational Problem Solving (OpenCPS, http://www.opencps.org) Knowledge Portal.

2 Map Generator to Visualize the Formation of Group Knowledge

In comparison with conventional websites, knowledge portals have three features: (1) The contents are contributed by all the portal members, not just by the web design community. Accordingly, the contents of a knowledge portal can be regarded as group knowledge, which aggregates all the intelligent assets from the userbase; (2) Apart from an axiom ontology given by the portal designer, no detailed sitemaps or blueprints are prepared to outline the contents in advance, i.e., the contents of the website grow in an unplanned and unpredictable manner; (3) The developed knowledge objects are associated with conceptual elements defined within the ontology of the knowledge portal. Consequently, we can construct the sitemap of the portal site by adopting the notion of a concept map. In consideration of the above three aspects, we developed a visualization tool in our previous work [6, 13] for constructing a Site-And-Concept map to improve the quality of a knowledge portal.

Figure 1 shows the experimental results conducted on our OpenCPS website. The typical operations of the SAC map generator can be categorized into three classes, i.e., the basic, learner-mode, and expert-mode operations. To simplify the demonstration, the knowledge objects only include the problem objects inside the OpenCPS portal. The relations are labeled as “reduced-to”, “equivalent”, “variant” and so on.

1. Basic operation: The basic search operation is to use keywords to search the target objects. For example, users may type “map labeling” as the keyword and thus draw a SAC map as shown in Fig. 1 except parts (b) and (c). They can also right-click the relation links to look up and edit the property of the relationship of interests.

2. Learner-mode operation: For an aggressive learner, to show the knowledge objects associated with given keywords is not enough. For example, the 3-SAT and 2-SAT problems cannot be found when we search for keyword “map labeling”, but these two problems are important for a student to get a thorough understanding

Figure 1. Showcases of the Site-And-Concept map. (a) Right-click k-NN function; (b) Aggressive learners can display k nearest neighbors of a target object; (c) Expert users may be interested in verifying the completeness of group knowledge.
of how difficult map labeling problems are, because they can be polynomially reduced to the "Fixed square label placement on the plane" problem. The right-click k-NN function helps display k nearest neighbors of a target object, as Fig 1(b) shows.

3. **Expert-mode operation:** Expert users are usually interested in verifying the completeness of other members’ knowledge. The SAC map generator is suitable for the experts to make contributions. If they are very certain that one problem object is related to another and this relation cannot be found by the k-NN function, they can use the keyword search again. The search result will imply that they either create such a new problem or add a relation link between these problems. For example, an expert user firmly believes that the "Max cardinality fixed square label placement on the plane" problem is a variant of the "Max independent set on rectangle intersection graph" problem, and a follow-up search also reveals that the latter problem object is an isolated node as shown in Fig 1(c). Accordingly, this expert user could generate such a relation in OpenCPS and label the relation link, and thus make the knowledge structure more complete.

The SAC map generator allows the members to examine the current knowledge formation by visualization. Thereby, the group knowledge of this knowledge portal can thus serve as an aggregation of content for learning purposes and get enhanced from users’ feedback. As a comparison,
3 Knowledge-Portal-Based E-learning System with Concept Map Support

Figure 3 shows the architecture for integrating the concept map generator into a knowledge-portal-based e-learning system. In this work, we follow the SCORM (Sharable Content Object Reference Model) standard to convert a generated concept map to a course package including the sharable content objects (SCOs) and the properties for sequencing and navigation. To suggest users an appropriate learning sequence, we take account of near-optimal solution algorithms to the ATSP (Asymmetric Traveling salesman problems) such as the shortest-edge-first algorithm accompanying with the 2-opt advancement.

In our design, the concept maps are generated automatically by assessing the knowledge relationships based on the probability of “shared referenced papers”. Assuming that two knowledge objects (i.e., portal pages, nodes of the maps) $M$ and $N$ have $Q(M)$ and $Q(N)$ referenced papers in the citation database respectively and the number of shared referenced papers is $Q(M,N) = Q(N,M)$, we define the cross-reference probabilities $p(M,N) = Q(M,N) / Q(N)$ and $p(N,M) = Q(N,M) / Q(M)$. The map generator thereby indicates a link between the two objects if $max(p(N,M), p(M,N)) \geq T_p$, where $T_p$ is a threshold for mining this association rule. Notably, the default arrow direction on the concept map is from $N$ to $M$ if $p(M,N) > p(N,M)$ and vice versa. The probability is now also concerned to count the edge weight, i.e., cost = $1 - max(p(N,M), p(M,N))$, for use in this work. Accordingly, we approximate the solution for the ATSP corresponding to the given concept map, and then figure out some learning sequences of the learning package.

On converting a concept map to a course package, OpenCPS switches to an edit form, as shown in Fig 4(a), for the user to input the SCO names, select the SCORM version, and modify the suggested learning sequence if necessary. For each SCO, the user can also click “learning object metadata (lom)” tab next to the “edit” tab on the same page to input the metadata. Figure 4(b) shows that the subpage within the “lom” tab has deeper tabs binding to “general”, “lifecycle”, “technical”, “rights”, and “educational” categories, for which the user can fill out all the associated metadata. This work adopts the SCORM standard, because SCORM clearly defines the format of content object metadata and content aggregation manifest files, and can therefore facilitate us in creating new content types with relevant data columns. Content types following the SCORM standard also inherit its benefits, i.e., they can be accessible, adaptable, affordable, durable, interoperable, and reusable.

4 Conclusion

For integration of knowledge management and e-learning, Ley et al. [5] addressed that a typical workplace must link a work space, a learning space, and a knowledge space. In this case, the first problem that developers may encounter is the “cognitive disconnection”, namely, “each of the spaces has an inherent structure which mirrors to some extent mental model of the people who are using it” and it might be hard to connect available KM model to learning activities. In this paper, we develop a mechanism that generates a local concept map and then converts the knowledge.
nodes and relation links of interests into sharable content objects (SCOs) with supports of sequencing and navigation properties.

Users can generate their concept maps of group knowledge and then manipulate the objects thereof instead of working directly on the substantial objects which belong to the knowledge portal. This implementation evades the problem of cognitive disconnection by using the mediate concept maps, and can seamlessly support learning activities with the ability to organize information and knowledge resources on the website. Additionally, users are allowed to transmit their packages to teaching assistants and all peer learners. This mechanism can therefore also realize the aspect of learning by teaching [2, 7, 9].

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References


