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論文の内容の要旨

The world is now developing so fast that today's knowledge is quickly becoming outdated. This requires us to constantly conduct self-directed learning in order not to be lagged behind. With the fast renovation of internet technologies, it has become really convenient for us to use the internet as an important tool to facilitate our learning. Hence, the field of web-based learning has been drawing attentions from fields of researchers. It has become possible to overcome the restrictions of time and space for people who are learning by themselves.

The most recognizable feature of self-directed learning is that the learners are given full control of their learning activities, which also means that they are completely on their own. It is true that fast development of information technologies especially the ones on World Wide Web have greatly increased the learning situations for self-directed learners nowadays. However, as always, the conveniences new technologies bring to us often come with new difficulties and challenges needed to be addressed in order to take better advantages of Internet technologies. Firstly, it has become difficult for us to locate suitable learning resources that the Internet provides. We easily lose sight of the learning goals and get drowned in the ocean of information. Even we might finally manage to find the resources we want, how to get them organized is not easy either. Moreover, learning skills (also referred as cognitive skills) have been recognized as important especially in self-directed learning. How to learn the things we need from piles of learning information effectively by ourselves is perceived quite demanding. When at school, we can learn from teachers or skilled classmates. But on the Internet, where all are virtual existence, getting our learning skills polished seems really difficult. Thirdly, as the final stage of learning, we extracted and absorbed the knowledge from piles of learning resources. But without appropriate forms of recording it down, the learnt knowledge can be easily faded away. This is probably why we take notes, doing after course exercises at school as a way of constructing knowledge. But when faced with the useful

information scattered here and there in various forms on the Internet, how to build up perceivable knowledge structure proves to be challenging. All of these problems limit learners engaged in web-based self-directed learning from effective control and assessment of their learning activities.

In order to address these issues, the purpose of this research is to further improve the learning situations for web-based self-directed learners in the three major aspects of learning: Resource Finding & Organization, Learning Skill Cultivation and Knowledge Constructing In the context of this research: resource organization means arranging one's learning resources found from the web in a way to facilitate later learning activities such as reviewing or revising. Learning skill cultivation means improving learner's cognitive capabilities (how to learn) in order to attain knowledge or abilities in a more effective way; Knowledge Constructing means creating one's knowledge structure from various types of learning resources. Since mapping theories have been prevalently studied in many research in both the educational and learning setting and have been proved to be effective in knowledge attainment and reflection, I proposed a Multi-layer Map-oriented Model (MLM)-a model to offer multi-dimensional management over concepts/topics with hierarchical relations via superposed layer representations, by introducing the concept of Topic Maps through considering the characteristics of self-directed learning on the web and its challenges. And then designs and develops three learning support systems in an attempt to tackle these issues. Finally, the according cased studies were carried out to evaluate the effectiveness of the developed systems.

Topic Maps are an ISO standard for describing knowledge structures and associating them with information resources. Because of the numerous factors and elements of various kind being involved in the self-directed learning on the web, this model not only offers one-dimensional management over the concepts/topics in the same categories/domain through associations, but also other concepts/topics with hierarchical relations via superposed layer representation (occurrences). I put this model into practical use by basing it to develop three learning support systems: (a). A resource organization system enabling leaners to quickly locate their wanted learning resources and organize the resources to facilitate later learning activities via multi-layer map visualization; (b). A strategy object mashups system enabling learners to build up their own effective learning environment while being made aware of the application of the related learning strategy and tactics; (c). A note-taking systems enabling learners to take non-linear, map-oriented notes for better revision and reflection in VOD (Video on Demand) based learning. These attempts are meant to explore the chances of exploiting this model in the three major aspects of resource finding/organization, learning skill cultivation and knowledge constructing in self-directed learning.

Keywords: web-based learning, self-directed learning, multi-layer map model, topic maps, strategy object mashups

論文審査の結果の要旨

本論文は，情報の findability を実現するための ISO 標準である Topic Maps を基盤として，Web における主体的かつ協調的な学習に見られる課題に対して, 学習プロセスに対応した支援機能を有する多層的なマップ表現モデルに基づく学習支援システムを開発するとともに, その有効性について評価・考察したものである.

まず，Web を対象として，1) 学習者が特定の目的の下で情報収集・構造化を行う学習形態において，情報間の関係づけを行いながら学習を継続することが困難であること，2) 英語学習を行う際に，効果的な学習方法として知られる Listening Strategy/tactics を意識しながら学習を行うことが困難であること，3) ビデオを利用した学習において，複数のビデオ中の内容の関係づけやノートテイキングからの振り返りが困難であること，を課題として取り上げ，それぞれにおいて典型的な学習プロセスのモデル化を行った．さらに，これらの学習プロセスを管理・促進する上で重要であるにも関わらず, 表出化することが困難であるため支援を行うことが難しい，メタ認知的活動に注目し, 学習プロセス上の様々な学習活動を支援するためにマップ表現を多層的に構築することで, 学習時にはそれぞれの活動に集中でき，重畳することで学習プロセス全体を俯瞰することが可能となる，当該分野でも独創性に富む Multi-Layer Map モデルを提案した．このモデルを前述した 3 つの課題に適用することで，1) 学習リソースの管理，個人で学習するためのトピックの関連付け, 同じ目的を持つ学習者のコミュニティで学習するためのトピックの関連付け，2) 学習コンテンツの管理，学習支援機能の関連付け，Strategy/Tactics 構造の提供，3) 講義ビデオの管理，ビデオタイムラインとノートの関連付け，コミュニティにおけるノートの関連付け, と異なる機能を有する学習場をマップ上に構築した学習支援システムをそれぞれ開発した. また，開発した支援機能についてケーススタディを通じて，1) トピック間の関連付けが強化され，学習効果にも良い影響を与えること，2) より多くの学習方法を利用しながら学習を行うことができ，学習成果も向上すること，をそれぞれ示した.

以上，本論文は，Web おける主体的学習の主要な問題である学習に利用可能な情報源と実際に学習した知識の接続性の課題について，多層的なマップ表現に基づく支援機能を開発することによって，様々な観点からの関係性を記述しながら学習できる環境を提供するものであり, 標準技術の効果的応用と主体的学習支援研究の発展の観点から学術的に貢献するところが大きい. よって博士（情報科学）の学位論文として十分価値あるものと認めた.