行政院國家科學委員會補助專題研究計畫成果報告

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※河川拼圖：以 PBL 實現多元智慧發展網路學習社群之建構 I　子計畫三※

※　PBL 學習支援模組之建構研究　※

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計畫類別：☐個別型計畫　　☑整合型計畫

計畫編號：NSC 90-2520-S-032-004

執行期間：　90　年　8　月　1　日至　91　年　7　月　31　日

計畫主持人：蔡秉燁

共同主持人：宋雪芳

計畫參與人員：鍾靜蓉、侯念祖、方唯齡、簡甫縉

本成果報告包括以下應繳交之附件：

☐赴國外出差或研習心得報告一份

☐赴大陸地區出差或研習心得報告一份

☐出席國際學術會議心得報告及發表之論文各一份

☐國際合作研究計畫國外研究報告書一份

執行單位：淡江大學教育科技學系

中　華　民　國　九十一　年　七　月　三十一　日

行政院國家科學委員會專題研究計畫成果報告

河川拼圖---以 PBL 實現多元智慧發展網路學習社群之建構(I)---子計畫 III：PBL 學習支援模組之建構研究

A Research on the Electronic Learning Support System

計畫編號：NSC 90-2520-S-032-004

執行期限：90 年 8 月 1 日至 91 年 7 月 31 日

主持人：蔡秉燁　淡江大學教育科技學系

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計畫參與人員：鍾靜蓉、侯念祖、方唯齡、簡甫縉

一、中文摘要

本計劃旨在配合總計劃建置之河川生態主題網站，建立一學習支援系統，並提出其設計方法與開發模式。網路學習支援系統是以學習階層(learning hierarchy)理論及詮釋結構模型(Interpretative Structural Modeling)之階層有向圖(hierarchical digraph)為理論基礎，結合網路技術建立起主題網站內容的知識結構(knowledge structural)以及學習地圖(learning map)，於學習者執行搜尋時提供其先備知識及進階學習建議、相關及進階問題閱讀建議、主題化學習區、學習地圖、知識關聯性分析，幫助學習者在網站大量的資訊中有系統的學習，建立起完整知識體系，而非破碎零亂的知識片斷。

關鍵字：詮釋結構模式、概念圖、網路學習支援系統

Abstract

The purpose of this research was to construct a learning support system for web- based learning community. A process for developing a learning support system will be illustrated with equations. The theoretical framework of a Web-based learning support system is based on the learning hierarchy theory and hierarchical digraph theory as applied to the Interpretive Structure Model (ISM). The tangible product a learning support system perform is a structural model called knowledge structure or learning map which is a hierarchy and multilevel structure. With the knowledge structural the learning support system will be able to provide suggestions for advanced learning, suggested reading on related and advanced questions, structured learning, learning maps, knowledge relation analysis, and help a learner build connections between concepts and ideas from a knowledge structural and learning map, rather than obtaining knowledge in pieces or fragments.

Keywords： Interpretative Structural Modeling、concept mapping、web-based learning support system

二、Introduction

Students engaged in learning new concepts must assimilate new concepts, integrate them into their knowledge structure, and restructure their understanding; this is fundamental to learning. Mandler（1983）stated that meaning does not exist until the structure is achieved. Bruner (1960)

indicated that learning is an active process in which learners construct new ideas or concepts based upon their knowledge structure. The learner selects and transforms concepts or ideas, relying on a cognitive structure to do so.

Ausubel (1969) mentioned that meaningful learning discovery of the meaning of the knowledge by the learner，integrating it into their concept structure connecting new concepts with their previous knowledge structure restructuring their knowledge base，and will be remembered.

Ornstein & Hunkins（1988）indicated that a well organized learning content must be considered when regarding the learning sequence, continuity, articulation, and integration. According to Burner (1960), before any instructional activity, the learner must know the structure of the subject. This explains the subject matter content knowledge and learning content must presented as a structured knowledge system, and then will be correctly integrated with learner’s cognitive structure.

Prerequisite knowledge is fundamental for the assimilation of new knowledge. Meaningful learning only occurred when subjects learned with adequate prerequisite knowledge and built the new concepts into their knowledge structure (Ausubel, 1969). It helped the learner enhance the transformation from concept to concept, and in learning abstract information.

It is not possible to assimilate a new knowledge when the structure is nonexistent. Therefore, any effort to teach must provide a path into the subject for the learner based on that learner's previous knowledge. Thus, where the Web is used to represent great quantity of knowledge and complex knowledge types, it is important to make associations or links between concepts.

One approach that has received considerable application is called interpretive structural modeling (ISM). The tangible product of an ISM exercise is a multilevel structure map (Warfield, 1977). Applying the ISM with web technology, learners will be able to construct knowledge structural and learning paths within a website.

The purpose of this project is to construct a learning support system for a theme web site. With the knowledge structure, the learning support system will be able to provide suggestion for advanced learning, suggested reading on related and advanced questions, structured learning, learning maps, knowledge relation analysis, and will help the learner build connections between concepts and ideas from a knowledge structural and learning map, rather than obtaining knowledge in pieces or fragments.

三、Results and Discussions

Knowledge structural theory and technique

For supporting students' building of a complete knowledge structure while surfing on the web, interpretive structural modeling was applied in this project constructing the knowledge structure of a website. The ISM process transferred the knowledge structure into a structured concept map according to the relationship between two learning subject, and then automatically produces a concept map as a scaffold for assisting students in building their own knowledge structure.

1. The process for forming knowledge structural

Define: Q =web page
S = learning object
$Q_i = f(s_1, s_2, s_3, \ldots s_n)$
s_i，$_i$＝1,2,・・・,n 。

2、Binary Relation：

	s_1	s_2	…	…
s_1	0	0	…	… 1
s_2	1	0	…	… 0
:	:			:
:	:			:
s_n	0	0	…	… 0

3、Organize learning object structural：transfer binary relation to relation matrix
transfer binary relation to mathematic mould will provide with binary matrix called adjacent matrix，represent as symbol A：

【relation matrix】

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \cdots & 1 \\ 1 & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & 0 \end{bmatrix} = [S_{ij}], \quad (i=1,2,\ldots..,n; \quad j=1,2,\ldots..,n) \quad (1)$$

Where , $s_i \overline{R} s_j = 0$ (2)

and $s_i \overline{R} s_j = s_i R s_j = 0$, if $s_i = s_j$ (3)

4、Transfer adjacent matrix to reachable matrix
This step is applying the hierarchical digraph theory（Warfield, 1973a, p.123；蔡秉燁、永井正武、鍾靜蓉,2002b）
【Define】B = A + I
Where A = adjacent matrix
I = unit matrix
【Boolean】
0+0=0 0×0=0
0+1=1 0×1=0
1+0=1 1×0=0
1+1=1 1×1=1

$$\begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} a' & b' \\ c' & d' \\ e' & f' \end{bmatrix} = \begin{bmatrix} a \cdot a' \oplus b \cdot c' \oplus c \cdot e' & a \cdot b' \oplus b \cdot d' \oplus c \cdot f' \\ d \cdot a' \oplus e \cdot c' \oplus f \cdot e' & d \cdot b' \oplus e \cdot d' \oplus f \cdot f' \\ g \cdot a' \oplus h \cdot c' \oplus i \cdot e' & g \cdot b' \oplus h \cdot d' \oplus i \cdot f' \end{bmatrix} \quad (4)$$

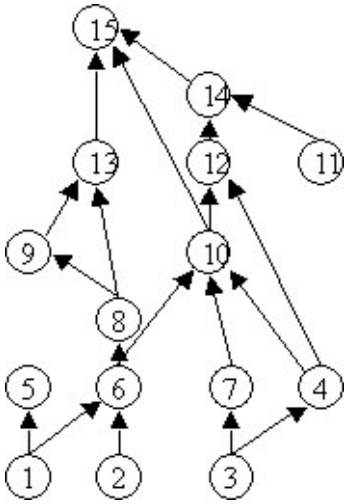
【transfer adjacent matrix to reachable matrix】
$B \neq B^2 \neq \cdots \neq B^{n-1} = B^n$ (5)
reachable matrix T = B^n

5、Transfer reachable matrix to hierarchical matrix
【Define】
si=number of learning object， si＝1,2,…..n。
R（si）reachable matrix

Q（si）
R（si）Q（si）

6、Forming ISM structure map

R（s_i）∩Q（s_i）＝R（s_i）



After completing forming knowledge structural process, the learning support system will be able to provide suggestions for advanced learning, suggested reading on related and advanced questions, structured learning, learning maps, knowledge relation analysis.

四、Conclusion

After completing this project that:

1. Computerized learning structural analysis saves mental capabilities and increases the efficiency of concept mapping.
2. By using the mathematical binary matrix, the ISM map decreases the learner’s cognitive load.
3. The ISM model helps teachers establish a structural knowledge system

Graphic structured text promotes elaborative learning.

五、References

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