具備智慧型媒體特性之網路教學系統：
以空間座標轉換為例

摘要

本研究的目的在建構具備智慧型媒體特性之網路教學系統以增進網路學習的效果，特別是如何輔助學習者理解空間關係，以增進對空間幾何座標轉換的學習成效。電腦運算能力的增進使其成為極具潛力的教育媒體。基於教學及教育媒體的理論，本研究倡議在典型的網路教學中加入「智慧型媒體」的考量與設計以增進學習成效。智慧型媒體包括了兩個面向的考量，我們稱之為「媒體與方法」的考量 (Media and Method concern)。從媒體的角度來考量，電腦多媒體的使用應以能增進學習效果為原則，從「認知媒體」(Cognitive Media)的角度出發來設計網路教學的媒體呈現方式，媒體的目的在於清楚地傳達領域之知識給學習者。而從方法的角度來考量，應考慮如何運用電腦運算的特性以實現其他教育媒體裝置不能實現的教學策略及方法，例如互動式及適性化的教學。接續過去「智慧型教學系統」(Intelligent Tutoring System)及「適性化超媒體」(Adaptive Hypermedia) 的研究，本研究提出一套適性化的機制，將一般適性化系統中課程排序(adaptive course sequencing)的機制明確分離為「學習概念排序」及「教材選擇」兩個部分，達到更佳的抽象化及運用教學策略上的彈性。

本研究以「空間座標轉換」做為領域知識，基於「媒體與方法」的考量，設計了稱為 *CooTutor* (*Coordinate Tutor*)的網路教學系統來輔助空間座標轉換的學習。運用了電腦動畫技術，這個系統使用互動式三維媒體(Interactive

3D Media)清楚有效地傳達領域知識。由於空間座標轉換的學習相信與學習者的空間能力(Spatial Ability)相關，本研究透過實驗來探討互動式三維媒體的使用與空間能力增進之間的關係。另外，我們也研究並評估如何將空間能力及學習風格(learning styles)等學習者個人特質作為適性化依據，以及如何設計相對應的適性化機制。

本研究的主要貢獻包括了 (1) 提出了使用智慧型媒體的概念，以「媒體與方法」的考量來討論網路教學的學習成效，及 (2) 提出一個創新及可行的架構將互動式三維媒體及適性化技術結合、運用於網路學習的學習模式上以輔助空間座標轉換的學習。

A Web-based Tutoring System with Intelligent Media: Spatial Geometric Transformation as an Example

Abstract

The objective of this research is on developing a Web-based educational system with intelligent media to enhance learners' learning effects, especially to facilitate learners' spatial reasoning on learning spatial geometry topics. The increasing computing power allows us to use computers as powerful educational media. Based on theories of pedagogy and educational media, we propose to integrate *intelligent media* into typical Web-based learning paradigm to improve learning. "Intelligent media" in this research refers to two aspects of considerations. They are *media—cognitive media* aspect and *method—intelligent tutoring* aspects. The consideration of cognitive media aims at offering learners the most ease-of-understand presentation of a particular domain. The consideration of intelligent tutoring targets to offer learners personalized learning experience based on individuals' learning needs. To achieve better abstraction and flexibility in the adaptive mechanism, we have chosen to separate the concept sequencing from the underlying task of selecting appropriate learning materials.

By considering the characteristics of spatial geometry concepts, a Web-based learning environment called *CooTutor* (*Coordinate Tutor*) for learning spatial geometric transformation (SGT) is developed. *Interactive 3D media* is integrated into the system for delivering domain concepts effectively. Since the domain,

spatial geometric transformation is evidently related to *spatial ability* (a group of human abilities about the use of space). This research attempts to address the relation between spatial ability and interactive 3D media via experimental evaluations. Moreover, learners' latent traits, including spatial ability and learning styles are considered to be used in adaptive material selection.

The main contribution of this research would be (1) the conceptualization of intelligent media and the M&M concern for effective Web-based learning, and (2) an innovative approach and tenable architecture of employing 3D computer graphics and adaptive technologies in Web-based learning context for SGT learning.