國立臺灣大學文學院圖書資訊學系

碩士論文

Department of Library and Information Science
College of Liberal Arts
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Master Thesis

可觸式擴增實境沙盒中學習者控制與科學過程技能之關聯探討

Relation between Learners' Control and Scientific Process Skills in Sandbox-style Tangible Augmented Reality

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中華民國 109 年 1 月

January, 2020

doi:10.6342/NTU202000534

摘要

可觸式擴增實境(Tangible Augmented Reality, TAR)結合可觸式使用者介面(Tangible User Interface, TUI)與擴增實境(Augmented Reality, AR)的特性，讓使用者能夠直接操作數位物件。免除穿戴式裝置的必要，可觸式擴增實境沙盒(sandbox-style TAR)營造更自然的學習環境，學習者得以直覺地操作並取得即時的回饋，在學習如空間問題等抽象概念時，學習者的認知負荷因此得以減緩。至今許多研究皆指出可觸式擴增實境沙盒對地球科學的學習成效，藉由平面地圖與立體模型兩者視覺上的結合，學習者能更容易理解空間問題；然而，鮮少研究闡明操作的效果，故本研究由學習者控制的觀點區分可觸式擴增實境沙盒中不同的操作，探討不同層級之學習者控制與科學過程技能的關聯。基於研究目的，本研究採準實驗設計。

為瞭解受試者解決空間問題與閱讀地形圖的能力，本研究使用 Spatial Ability Test (SAT)與 Topographic Map Assessment (TMA)作為前測，並且將受試者隨機分為 4 組，予以其中一項實驗處理。實驗素材係考量學習者控制之層級設計，用來訓練受試者閱讀等高線地形圖，受試者於實驗中的行為均為實驗者與攝影機觀察及記錄，並經過事後訪談加以佐證。隨後受試者需完成另一份 TMA 作為實驗後測。受試者能力表現之變化由本研究同時根據量化與質化資料所分析，此外其對可觸式擴增實境沙盒之使用者經驗則透過問卷加以調查。

本研究招募 43 位男性及 17 位女性高一學生，共 60 位受試者。就量化資料而言，4 組受試者間在前、後測之 TMA 表現均無顯著差異，且後測表現顯著低於前測；而質化資料顯示了受試者對可觸式擴增實境的高度動機與興趣，並於學習任務中表現不同科學過程技能，受試者在 TMA 分數的變化則可能源自受試者本身

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對地形圖的錯誤理解。根據研究結果，本研究針對地理教師提供若干建議：可觸式擴增實境沙盒建立了良好的學習環境以吸引學習者，而學習者對於不同科學過程技能的使用意味著其在完成學習任務時心力的投注；然而，既有的錯誤觀念或許仍存在，因此，地理教師必須察覺學習者的錯誤觀念，加以提點學習任務背後的重要概念。

關鍵詞：可觸式擴增實境；學習者控制；科學過程技能；空間能力；地球科學學習

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Abstract

With combination of Tangible User Interface (TUI) and Augmented Reality (AR), Tangible Augmented Reality (TAR) enables users to manipulate digital objects physically. Sandbox-style TAR dispenses with use of wearable devices and creates natural learning environments. Learners manipulate intuitively and get real-time feedback. When they learn abstract concepts such as spatial problems, learners' cognitive load is relieved. Many current studies suggest sandbox-style TAR's effects on geoscience learning. Learners make sense of spatial problems more easily with the visual combination of 2D maps and 3D models. Few studies shed light on effects of manipulation, though. The study differentiates the manipulation of sandbox-style TAR from the view of learners' control and explores the relation between control level and scientific process skills. Quasi-experiment is designed based on the research purpose.

To understand subjects' abilities of tackling spatial problems and reading topographic maps, the study uses Spatial Ability Test (SAT) and Topographic Map Assessment (TMA) for pretest before experiment. Subjects are assigned to 4 groups at random to undergo one of the 4 types of experimental treatment in the study. The materials are designed considering levels of learners' control and used to train subjects to read topographic maps. During experiment, subjects' behaviors are recorded by experimenters and cameras. Interviews are also carried out to clarify observation notes. Subjects take another TMA after experiment for posttest. The study analyzes subjects' changes of performance based on both quantitative and qualitative data. Also, the study surveys subjects' experience of using sandbox-style TAR with Questionnaire of User Experience.

The study recruits 60 tenth-graders, 43 males and 17 females. In terms of quantitative data, there's no significant difference between performances of 4 groups of

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the subjects on TMA in pretest as well as posttest. Posttest is significantly lower than pretest. However, qualitative data show subjects' good experience with high motivation and interest in sandbox-style TAR. Different scientific process skills develop in learning tasks. The changes of the subjects' scores on TMA may be caused by their inherent misconceptions about topographic maps. On the basis of the research results, suggestion is made for geography teachers. Sandbox-style TAR creates fine learning environments to attract learners. Learners use different scientific process skills, which means they make mental efforts when completing learning tasks. Misconceptions may exist, though. Thus, geography teachers play the part of identifying learners' misconceptions and reminding them of the key concepts behind learning tasks.

Keywords: Tangible Augmented Reality; Learner Control; Science Process Skills; Spatial Abilities; Geoscience Learning

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