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■ 期中進度報告

融入成長心向的數位創造力遊戲導向學習對提升城鄉地區學童創造力心向與創造力的效果

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Integrating growth mindset into digital creativity game-based learning: Its effects on urban and remote area pupils' creativity mindset and creativity

執行期限：107 年 8 月 1 日至 108 年 7 月 31 日

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摘要

本研究以數位遊戲導向學習為媒介，並以近年來受到矚目的成長心向觀點結合創造力訓練課程，以促進學童(尤其是較為弱勢的離島偏遠地區)孩子之創造力成長心向與創造力。本研究為兩年期研究，第一年的主要目的在建構創造力心向量表，並以修正後之數位化創造力遊戲導向學習系統(DGLC)，了解 DGLC 對提升創造力表現的城鄉差異。此外，本研究探討創造力心向和創造力之關係。創造力心向量表的預試參與者為台北市與澎湖縣六所國小的三至六年級學童共 351 人，驗證性因素分析的參與者為三至六年級學童共 281 人，參與 DGLC 訓練課程的參與者為三至六年級學童共 261 人。使用工具包括創造力心向量表、DGLC 和創造力測驗。研究發現如下：DGLC 可以有效提高國小中高年級學童的創造力，城市中年級學生比鄉村中年級學生提升更多創造力，且城市中年級學生從一開始就在創造力測驗中表現較好。另一方面，城市高年級學生比鄉村高年級學生提升更多創造力，但他們在創造力前測表現並無差異。這些研究結果顯示，城市中高年級學生在 DGLC 的學習效果優於鄉村中高年級學生。城市學童有較佳的學習效果可能是因為他們在遊戲中有更強的學習動機和更有效的自我調節策略。此外，研究者也至澎湖進行創造力教學工作坊，深化教師對創造力的認知與教學技巧。

Keywords: 成長心向、創造力、創造力心向、遊戲導向學習、城鄉差距、學童

Integrating growth mindset into digital creativity game-based learning: Its effects on urban and remote area pupils' creativity mindset and creativity

Abstract

This study attempted to integrate growth mindset into a creativity game-based learning system to improve pupils' (especially those are in rural areas) creativity and growth mindset. The first year aimed at investigating the urban-rural gap of creativity mindset and creativity among pupils. Participants for the pretest of Inventory of Mindset (IMC) were 351 third to six graders' sampled from Taipei City and Penghu County, those for confirmatory factor analysis were 281, and those for DGLC training were 261 pupils. The employed instruments included IMC, DGLC, and Creativity Test. The mian findings were as follows: The IMC, with four factors, had good reliability and validity. Moroever, the urban middle graders improved more creativity than the rural middle graders, and the urban middle graders performed better in the creativity test at the beginning. One the other hand, the urban upper graders improved more creativity than the rural upper graders, but they did not perform differently in the pretest creativity test. These findings revealed that the urban middle graders and upper graders benefited more from the DGLC than the rural middle graders, but he upper graders did not have better creativitiy before taking the DGLC. The better learning effect of urban pupils may be because that the urban pupils have stronger motivation and better self-regulation strategies during the game-based learning.

Keywords: growth mindset, creativity, creativity mindset, game-based learning, urban-rural gap, pupils

融入成長心向的數位創造力遊戲導向學習對提升城鄉地區學童創造力心向與創造力的效果

培育創造力是各先進國家列為重 21 世紀重要的教育目標(Plucker, Kaufman, & Beghetto, 2015)。英國創意文化與教育中心執行長彼得・寇拉強調：英國正在進行一場創造力教育的學習革命，因為未來的工作，有六成還沒有「被發明」；孩子需要具備的是「自己創造工作、創造前途」的能力(何琦瑜，2011)。二十一世紀也是強調知識經濟的時代，知識競爭力乃邁入新經濟時代取得競爭優勢的關鍵，不論是個人、企業、學校乃至整體社會，對於創新與創造力應如何培養與應用皆有著莫大的關注。最近，英國《金融時報》更預言，本世紀末，我們熟悉的職業，七〇%會被自動化技術取代，因為 AI 將取代人類許多工作(天下雜誌，2016)。AI 時代中，創意將成為人類存在的重要價值。可見，創造力是未來人才的關鍵能力，在強調知識經濟、資訊科技、人工智慧以及高感性、高體會的二十一世紀，創造力的重要性不言而喻。

有鑑於數位學習有助於提升偏鄉孩童的學習機會與競爭力，教育部自 2015 年起推動「偏鄉教育創新發展方案」，分成：「實驗教育－教育創新」、「數位融入－虛實共學」、「資源媒合－社群互聯」及「看見改變－典範分享」四大構面(吳俊憲、羅詩意，2017)。雖然政府投注了許多資金和硬體設備到偏鄉地區，希冀藉由數位學習提升偏鄉學童的學習成效與未來競爭力，但卻很少強調透過數位學習強化偏鄉孩童創造力。未來是一個極度需求創造力的時代，因此，透過數位學習提升創造力，是偏鄉孩子開啟未來希望之鑰。近年來，已有公益團體發起此類活動並在偏鄉地區實施成功的案例。然而，這些公益團體大多在台灣本島偏鄉地區推動相關活動，極少公益團體到澎湖離島偏遠地區進行類似活動。過去研究發現，城市學童的創造力優於鄉下地區學童的創造力(葉玉珠，2003)。教育機會和激發教育潛能對偏遠地區孩子未來發展與競爭力極為重要，本研究因此嘗試結合研究資源，藉由數位遊戲導向學習比較都市(台北市)與偏遠地區(澎湖)孩子們的創造力，並嘗試提升偏遠地區教師對於創造力的認知，共同致力提升偏遠地區學童的創造力與競爭力。

遊戲導向學習的主要特徵為藉由一些有趣的活動設計，引導學習者進行主動與沉浸式的學習，進而達成教育目標(Freitas & Oliver, 2006; Kinzie & Joseph, 2008)。近年來許多研究發現遊戲導向學習能有效促進學習動機與學習成效(Dickey, 2011; Hung, Hwang, Lee, & Su, 2012; Sung & Hwang, 2013)。此外， Dweck (2006, 2012)基於其對成就與成功的研究，提出心向(Mindset)的概念。她認為心向有兩種：固定心向(fixed mindset)和成長心向(growth mindset)。持成長心智的人相信大部分的個人基本特質是可以透過不斷努力而改善的，這樣的觀點創造了達致偉大成就所需的學習熱情與復原力。Gerstein (2016)也認為要有高創造力，必須具備創造力心向；創造力心向意指支持創意產生的展望、態度和信念。當抱持成長心向時，個體可以自由與深入思考個體存在的目的與價值，比較會開放心胸，把握機會，也比較能享受創造過程的喜悅與產生創新的思維(Gerstein, 2016)。這樣的心向不僅影響創造力表現，也影響未來職涯發展與生命的自我價值。因此，本研究擬以近年來備受推崇的數位遊戲導向學習為媒介，並以近年來受到矚目的成長心向觀點結合創造力訓練課程，以促學童(尤其是較為弱勢的離島偏遠地區)孩子之創造力成長心向(creativity growth-mindset)與創造力。

本研究為期兩年，第一年的目的為：

1. 建構創造力心向量表與創造力遊戲導向學習實驗教學課程。
2. 瞭解數位創造力遊戲導向學習對激發學童創造力的城鄉差異
3. 瞭解數位學童創造力心向的城鄉差異。
4. 透過數位遊戲導向學習，瞭解學童創造力心向對創造力學習的效果。
5. 在偏遠地區進行創造力教學工作坊，深化教師對創造力的認知與教學技巧，並邀集有熱情的老師一起參與創造力遊戲導向學習內容的建構以及創造力遊戲導向學習的實驗教學。

研究一：發展創造力心向量表

一、 研究目的

本研究的目的在發展適用於評量小學生之創造力心向量表。

二、研究方法

(一) 研究參與者

創造力心向量表的第一階段預試參與者以立意取樣抽取台北市與澎湖縣六所國小的三至六年級學童共351人，其中男生為183人（52.1%）、女生為168人（47.9%）。三四年級人數為195人(55.6%)、五六年級人數為155人(44.2%)。第二階段進行驗證性因素分析的參與者為三至六年級學童共281人，其中男生為150人（53.4%）、女生為131人（46.6%）；三四年級人數為155人(55.2%)、五六年級人數為126人(44.8%)。

(二) 研究工具

本研究的研究工具為創造力心向量表。本研究小組參考相關文獻，並透過多次的討論，發展出量表題目。此量表為李克特式六點量表，以 1～6 分分別代表「非常不同意」、「很不同意」、「不同意」、「同意」、「很同意」、「非常同意」。創造力心向量表用於測量學習者對於創造力的心向是成長-內控型(Growth-internal locus of control)、成長-外控型(Growth-external locus of control)、固定-內控型(Fixed-internal locus of control)、固定-外控型(Fixed-external locus of control)。初步編製的創造力心向量表包含 16 題，每個向度各四題。

(三)研究過程

本研究資料的收集乃透過任教老師的協助，於電腦教室進行問卷填答。時間約為15分鐘。

(四)資料分析方法

本研究分為兩個階段：第一階段為預試，目的在進行各量表初步的題目刪選、信度與建構效度分析。第二階段以驗證性因素分析再次確認所發展量表的建構效度。最後根據最後版本進行效度和信度分析。本研究以SPSS套裝軟體進行Cronbach's α內部一致性分析及相關分析析，以AMOS軟體進行驗證性因素分析。

三、研究結果

(一)信度分析

創造力心向量表中，其校正題目—總分的相關係數在.592~.771(見表 1)。兩個因素的相關為.699，$p < .001$。總量表的 Cronbach's α 係數為.886，成長-內控、成長-外控兩個分量表的 α 係數分別為.825 與.838。創造力固定心向量表中，其校正題目—總分的相關係數在.728~.866(見表 2)。兩個因素的相關為.801，$p < .001$。總量表的 Cronbach's α 係數為.936，固定-內控、固定-外控兩個分量表的 α 係數分別為.866 與.878。

(二)驗證性因素分析

本研究以 281 位國小學童為參與者，並以最概似估計法（maximum likelihood, ML）進行參數估計來檢驗量表的因素效度。本研究在創造力心向量表測量模式的設定上，分為成長型心向和固定型心向，形成兩個一階二因素（「Growth-Internal」、「Growth-External」與「Fixed-Internal」「Fixed-External」）各自有其對應的測量題目，各自形成兩個一階的潛在因素，經適配度考驗後，模式分析的結果見圖 1。

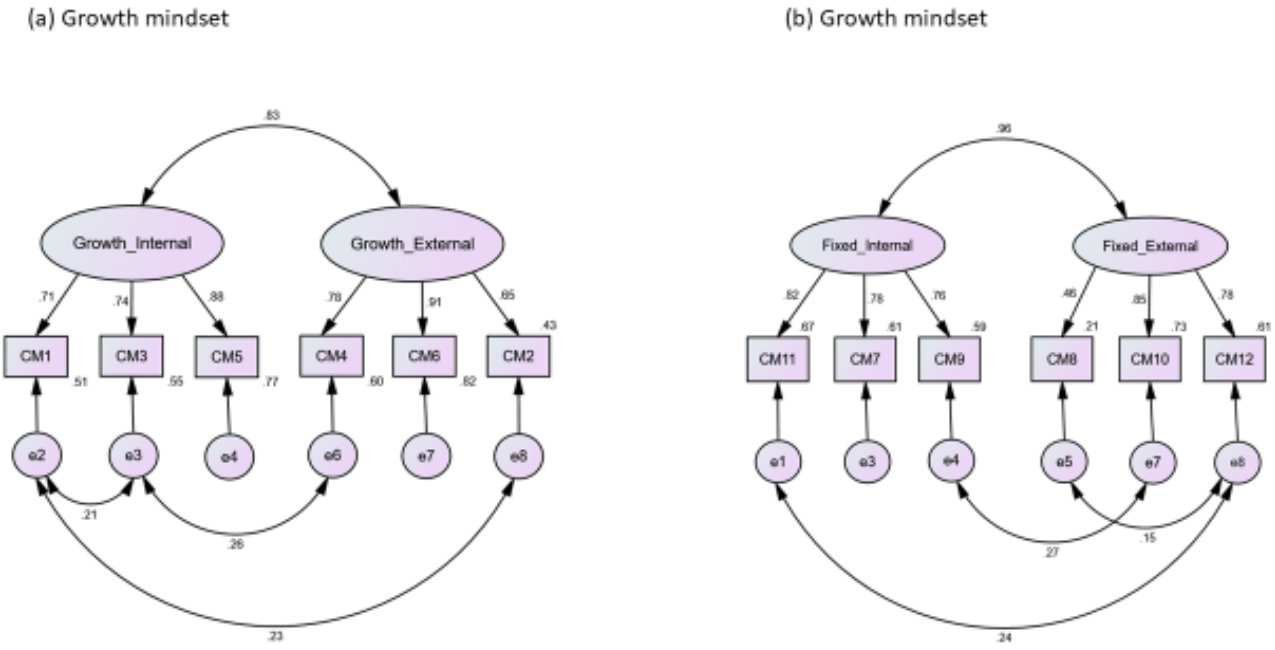

圖 1：創造力心向驗證性因素分析模式

1. 模式適配度考驗

本研究創造力心向分析模式與觀察資料適配的卡方考驗發現，在創造力固定心向驗證性因素分析模式中，$\chi^2(N = 281, df = 15) = 59.873\ (p < .05)$， GFI = .992、AGFI = .965、RMR = .039、RMSEA = .039。在相對適配指標方面，NFI = .992、RFI = .976、IFI = .998、CFI = .998。在精簡適配度方面，PNFI = .331、PCFI = .333。創造力成長心向驗證性因素分析模式，$\chi^2(N = 281, df = 15) = 60.064\ (p < .05)$， GFI = .988、AGFI = .948、RMR = .185、RMSEA = .065。在相對適配指標方面，NFI = .988、RFI = .964、IFI = .993、CFI = .993。在精簡適配度方面，PNFI = .329、PCFI = .331。因此，本研究所建構的創造力

心向量表模式在整體適配度、比較適配度和精簡適配度都有良好的適配度。

2. 組合信度與平均變異解釋量

本就以組合信度（composite reliability, ρ_c）和平均變異解釋量（average variance extracted, ρ_v）來檢視固定心向量表的信度與聚斂效度(convergent validity)，發現兩個一階的組合信度依序為.831、.752，平均變異解釋量依序為.621、.517。另外，以 ρ_c 和 ρ_v 來檢視量表的信度與聚斂效度，發現兩個一階的組合信度依序為.823、.826，平均變異解釋量依序為.609、.618，表示這二個潛在變項被某個變項或理論建構解釋的量，高於被測量誤差所解釋到的變異量，顯示本量表的內部品質良好。

3. 性別差異考驗

使用創造力四個因素的分數為依變項，性別為自變項，進行 MANOVA 分析發現(見表 4)，不同性別的參與者在整體創造力心向表現沒有顯著差異，Wilks' Λ= .976, p = .083, η_p^2 = .024。ANOVA 分析結果亦顯示：不同性別的參與者在四個分量表的表現均無顯著差異。本量表得分的平均數與標準誤見圖 2。

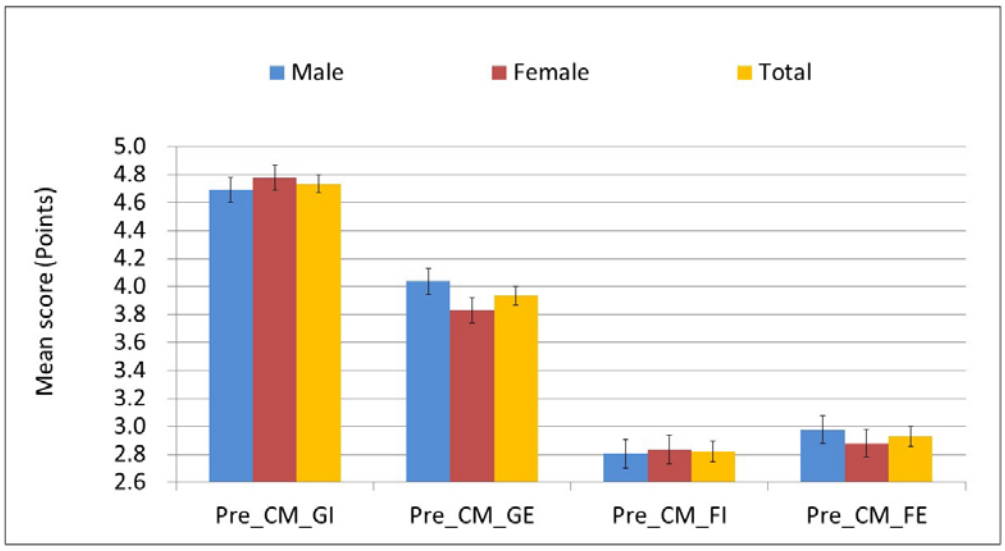

圖2：創造力心向量表不同性別參與者得分的平均數與標準誤

表1：創造力心向的性別差異分析(MANOVA)

	ANCOVA				
Source	*MS*	*F* (1, 33)	*P*	η^2_p	Post hoc test
Growth-Internal	.689	.503	.478	.001	*n.s.*
Growth-External	3.629	2.434	.120	.007	*n.s.*
Fixed-Internal	.094	.051	.821	.000	*n.s.*
Fixed-External	.818	.489	.485	.001	*n.s.*

研究二：創造力數位遊戲導向學習對促進創造力心向與創造力之城鄉差異分析 (Study 2: The influence of living areas on improvement of creativitiy and creativity mindset through game-based creativity learning)

1. Aims and hypotheses of this study

This study aimed at using Digital Game-based Learning for Creativity (DGLC) to investigate whether the learning system would effectively improve pupils' growth mindset of creativity as well as their creativity performance. Meanwhile, the differences between urban and suburban pupils' performance were analyzed.

2. Method

2.1. Participants

Based on purposive sampling, 261 3rd and 4th graders (middle graders) and 194 5th and 6th graders (upper graders) selected from six elementary schools participated in this study. The participants were composed of 241 boys (53.0%) and 214 girls (47.0%). While 211 of them were urban pupils (46.4%), 244 were rural pupils (53.6%). Written informed consent was obtained from all participants' parents and each participant was rewarded with a gift valued at 10 USD.

2.2. Instruments

2.2.1. The Digital Game-based Learning for Creativity (DGLC)

The DGLC-A developed for the middle graders (Yeh, Chang, & Chen, 2019) and the DGLC-B developed for the upper graders at elementary school (Yeh, 2018) were employed to investigate the participants' learning effect. Although the games in the two learning systems were connected by different stories (Searching for the clown's color balls vs. Searching for lost treasures), both learning systems consist of nine games for enhamcing dispositions and skills of creativity; each game ranges from 10 minutes to 15 minutes.

2.2.2. Creativity Test

The Product-based Figural Creativity Test (PB-FCT) (Yeh, et al, 2013) was employed to measure the participants' creativity. The PB-FCT included three subtests in which participants were requested to draw product based the given figures of C, ⊓, or ⤫. Two indices were measured in the PB-FCT: originality and valuableness. The creativity score of each designed produt was the score of originality (0-4 points) × valuableness (0-3 points), and the total score of creativity was the sum of each score of the drawn products.

2.2.3. Inventory of Creatiivty Mindset

Inventory of Creatiivty Mindset (ICM) was employed to measure the participants' creativity mindset. With 12 items, the ICM included four factors: growth-internal, growth-external, fixed-internal, and fixed-external. The Cronbach's α is .886.

2.2.Experimental design and procedures

All participants completed the experiment in the computer laboratory at their school during their flexible learning time or the computer classs. The DGLC incorpated many teaching strategies to enhance learning effects, such as proving scaffolding to learn challenged creativity skills, offering chances for self-

determination, giving constructive feedback for answers, immediate feedback regarding obtained scores, proving verbal encouragement for performance, and peer evaluation for creative design. The participants completed their learning in five classes throughout one week.

3. Results

3.1. Learning effects

Eight reflection questions were employed to understand the participants' feelings toward the game. The *M*s and *SD*s are shown in Table 1. The results showed that the participants' feelings toward the learning were positive.

3.2. Analysis of Instructional effects

3.2.1. Effects of area on improvemnet of creativity

Using Test (posttest vs. posttest score of creativity) as the dependent variables and using Area (rural vs. urban) as the independent variable, we conducted repeated measure analysis of variance (Repeated measure ANOVA) to examin the effects of Area on imporvemnt of creativity. For middle graders, significant differences were found on Test, $F(1, 229) = 63.153$, $p < .001$, $\eta^2_p = .216$, on Test × Area, $F(1, 229) = 6.161$, $p = .014$, $\eta^2_p = .026$, and on Area, $F(1, 229) = 25.729$, $p < .001$, $\eta^2_p = .101$ (see Table 1). Analysis of simple main effect effect revealed that the pupils in both the urban and the rural areas improved their creativity performance, $F(1, 106) = 43.669$, $p < .001$, $\eta^2_p = .292$ and $F(1, 123) = 18.695$, $p < .001$, $\eta^2_p = .132$. Moreover, the urban pupils outperformed the rural pupils in the pretest, $F(1, 254) = 12.982$, $p < .001$, $\eta^2_p = .49$ and in the posttest, $F(1, 230) = 27.793$, $p < .001$, $\eta^2_p = .108$, respectively.

For upper graders, significant differences were found on Test, $F(1, 229) = 31.744$, $p < .001$, $\eta^2_p = .149$ and on Test × Area, $F(1, 229) = 67.533$, $p = .007$, $\eta^2_p = .026$. However, no significan Area effect was found. Analysis of simple main effect effect revealed that the pupils in both the urban and the rural areas improved their creativity performance, $F(1, 185) = 19.679$, $p < .001$, $\eta^2_p = .49$. Analysis of simple main effect effect revealed that the pupils in both the urban and the rural areas improved their creativity performance, $F(1, 65) = 22.828$, $p < .001$, $\eta^2_p = .260$ and $F(1, 116) = 6.529$, $p = .012$, $\eta^2_p = .053$. Moreover, the urban pupils outperformed the rural pupils in the posttest, $F(1, 185) = .053$, $p = .818$, $\eta^2_p = .000$. However, the urban pupils did not outperforme the rural pupils in the pretest, $F(1, 182) = 4.218$, $p = .041$, $\eta^2_p = .023$, respectively.

Additionally, we used game score obtained in the DGLC as the independent variable and used Area (urban vs. rural) as the independent variables to conduct ANOVA. The results suggest that the urban middle graders obtained higher game scores than the rural graders, $F(1, 252) = 7.147$, $p = .008$, $\eta^2_p = .028$, wheras urban upper graders didn't obtaine higher game scores than the rural graders.

3.2.2. Effects of Area on mindset

Using the pretest score of the four types of midset (growth-internal, growth-external, fixed-internal, and fixed-external) as the dependent variables and using Area (rural vs. urban) as the independent variable, we conducted MANOVA to examin the effects of Area on mindset. For the middle graders as well as for the upper graders, no significant Area effects were found, suggesting the rural and the urban pupils did not differ

in all types of mindset (see Figure 3).

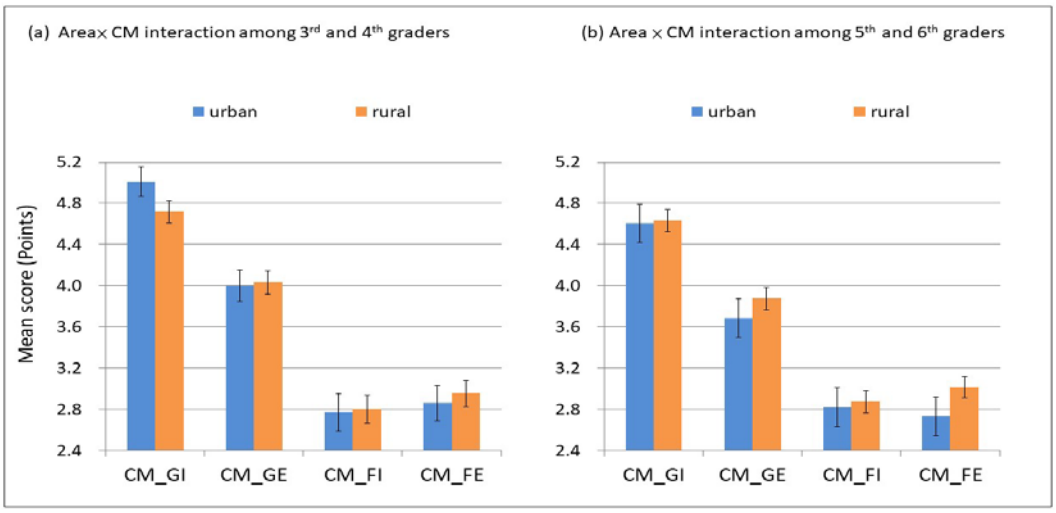

Figure3. Effects of Area on mindset

3.2.3. Effects of mindset on creativity

The ICM included four factors: growth-internal, growth-external, fixed-internal, and fixed-external. Using pretest of creativity as the dependent variables and using the ICM group (High, Medium, and Low group) as the independent variable, we conducted four repeated measure analysis of variance (Repeated measure ANOVA) to examine the effect of pretest mindest on pretest of creativity. In each of the analyses, the independent variable was devided into the Low, the Medium, and the High group. The results revealed that the middle graders with lower level of fixed-internal, and fixed-external mindsest had a better performance of creativity.

3. 討論與結論

本研究發展了創造力心向（ICM）量表，並進一步採用數位遊戲導向創造力學習系統（DGLC）和 ICM 調查透過 DGLC 提升創造力和創造力心向的城鄉差異。之前學者所提出的創造力心向量表僅包含成長和固定思維兩個因素（Dweck，2006，2012），本研究所發展的 ICM 包含另一個維度—控制信念。更具體地說，ICM 包括兩個維度—發展觀（增長 vs. 固定）和控制信念(內控 vs. 外控)，形成四個因素，即成長-內控、成長-外控、固定-內控和固定-外控。本研究的實證結果顯示，ICM 具有良好的信度和效度。

研究結果也發現，包含創造力意向和技巧的 DGLC 可以有效地提高國小中年級和高年級學生的創造力。然而，城鄉學生的訓練效果不同，尤其是中年級學生。有趣的是，城市中年級學生比鄉村中年級學生提高更多創造力，且城市中年級學生從一開始就在創造力測試中表現較好。另一方面，城市高年級學生比鄉村高年級學生提高更多創造力，但他們在創造力前測表現並無不同。這些研究結果顯示，城市中高年級學生在 DGLC 的學習效果優於鄉村中高年級學生，但城鄉高年級學生在進行 DGLC 實驗課程前並未有顯著差異。城市學童有較佳的學習效果可能是因為他們在遊戲中有更強的學習動機和更有效的自我調節策略。此外，城鄉學童在創造力心向各個面向並無顯著差異，但中年級學童持較低程度的固定-內控和固定-外控心向者有較佳表現。

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