教育部教學實踐研究計畫成果報告(封面)

多媒體影像應用於教學:以影像評估食物份量為例
Teaching with digital image: application of the image-based dietary assessment

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(計畫名稱/Title of the Project) 多媒體影像應用於教學:以影像評估食物份量為例
(配合課程名稱/Course Name) 營養學實驗

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中文摘要

本研究目的旨在探討數位媒體運用在營養評估教育訓練的即時補救教學模式，藉由建置「以食物圖像呈現的飲食評估平台」讓選修「營養學實驗」的學生平時可以在課後訓練食物份量，並在期末考時比較學生評估實體食物及影像食物的 (1)食材認識正確率 (2)食物份量正確率 (3) 總熱量正確率，並以問卷探討學生以「食物圖像評估份量」的困難及問題點,做為未來教學設計的考量。主要研究對象為 84 位選修台北醫學大學營養學實驗的大二學生。第一學期表現: 學生在實體食物評估與圖像評估的食材辨識及份量評估準確度並無統計差異。重複練習提升學生的影像判讀技術並提高整體食材辨識(第一學期: 67%,小考:77%,第二學期: 84%).及份量評估(第一學期:23%,小考:28%,第二學期:32%)準確度。第一學期表現最差的學生(n=14),經由網路的補救教學平台後, 也有提升其第二學期份量評估準確度 (評估誤差值: 第一學期:47%,小考:24%,第二學期:25%)。

中文關鍵詞(5 個內): 數位科技,食物圖像飲食評估,營養教育訓練,食物份量評估,營養系學生

Abstract

Although a growing number of studies have shown that image-based dietary assessment (IBDA) is a reliable dietary assessment tool, there is still no dietetic course integrating IBDA in the Taiwanese University so far. The broad aims of this study were: 1) to train nutritional students to understand technique involved in IBDA, 2) to assess the ability of students to perform real-food and image-based dietary assessment, 3) to understand problems or challenge associated with performing IBDA, and 4) develop teaching strategies for IBDA. A total of eighty-four students who enrolled in nutritional practical course were the primary responders. An online IBDA platform was created as an off-campus remedial teaching tool to reinforce the conceptualization of food portion sizes. Students' receptiveness and response to the IBDA, and their performance in food identification and quantification were compared between the IBDA and real food visual estimations (RFVEs). In the first-semester test, no differences were found between the IBDA and RFVE in terms of food identification (67% vs. 71%) or quantification (±10% of estimated calories: 23% vs. 24%). Repeated IBDA training significantly improved food identification (67%, 77%, 84% for first, pre-test and second semester, respectively) and quantification (23%, 28%, 32% for first, pre-test and second semester, respectively). Training also greatly improved performers of those who were the poorest performers on the first semester (estimated errors: first semester:47%, pre-test: 24%, second semester: 25%).

Key words: Digital technology, image-based dietary assessment, dietetic students,

food portion size

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一. 報告內文(Content)

1. 研究動機與目的(Research Motive and Purpose)

In recent years, an increasing attention has been paid to the needs of students to develop interdisciplinary learning and study (跨領域學習). With the advanced in digital technology, web-based healthcare system has been widely used to monitor individual's nutrient intake, which is relative low cost, suitable for large sample size and may reduce health care costs [1]. Image-based dietary assessment (IBDA) integrated with smartphone-web based system has emerged as potential tool for assessing food portion size and nutrient intake. However, there are no universities integrate IBDA skills to the dietetics training in Taiwan so far. **Hence, this project attempts to integrate IBDA to the nutrition practical course (大二營養學實驗).**

2. 文獻探討(Literature Review)

Recent development in digital technology has motivated scientists to create innovative tools to assess individual's dietary intake using devices such as electronic sensors, smartphone, wearable sensors and web-based platform [2]. The data or food image collected from each device is then sent to the internet cloud or web-based platform, where it is stored or analyzed by dieticians or nutritionists. However, it requires at least ≥5 years of experience in practice in order to accurately quantitate food portion size and from food image [3].

As early as the 1980 to 90's [4, 5], scientist started to use food photographs to assist dietary assessment such as 24 hours (hr) dietary recall or food records. For example, Hankin and Wilkens [4, 6] has employed food photographs to assist dietary assessment among different ethnic groups and Nelson and colleagues [5] estimated food portion size and nutrient content based on food photographs.

Broadly speaking, food images taken by smartphone or wearable devices can be used to "assists" traditional dietary assessment methods or as the main tool to assess dietary intake, which is known as "image-based dietary assessment (IBDA)" [7]. Gemming et al [8] conducted a systemic review examming 13 publications related to "image-based" or "image-assisted" dietary assessment and concluded that (1) when used alone, IBDA is a valid tool to estimate energy intake; (2) when used alone with traditional dietary assessment methods (e.g. food record or 24hrs dietary recall), food image increases the accuracy of food intake assessment as it detects underreported foods and identify misreporting errors not captured by standard dietary assessment methods. However, authors [8] also conclude that image analysis maybe prone to underestimation or overestimation if users forget to take photo or do not take photos before and after foods are consumed or do not capture image of satisfactory quality. Studies showed good accuracy of IBDA in identifying food items (~80%) but very low accuracy in quantifying food portion size and nutrient contents (38%) among dietetic students [3]. However, students may improve IBDA skills through practicing cooking at home or practical course at school.

3. 研究問題(Research Question)

Although a growing number of studies have shown that IBDA is a reliable dietary assessment tool [9-11], there is still no dietetic course integrating IBDA in the Taiwanese University so far. Hence, question remains on the ability of students to perform IBDA? Challenge associated with identify and quantify foods from images? How to implement IBDA

to the course at the university level.

4. 研究設計與方法(Research Methodology)

A convenience sample of students who were enrolled in a nutritional practicum (NP) course in the School of Nutrition and Health Sciences, Taipei Medical University (TMU) (Taipei, Taiwan), between September 2018 and July 2019. Participants were second-year undergraduate students, aged ≥19 years. In total, 81 students completed both the first- and second-semester studies; three students only completed the first semester study (n=84 for first semester). All students completed the online pretest. The study protocol was approved by the Institutional Review Board of TMU (N201904035).

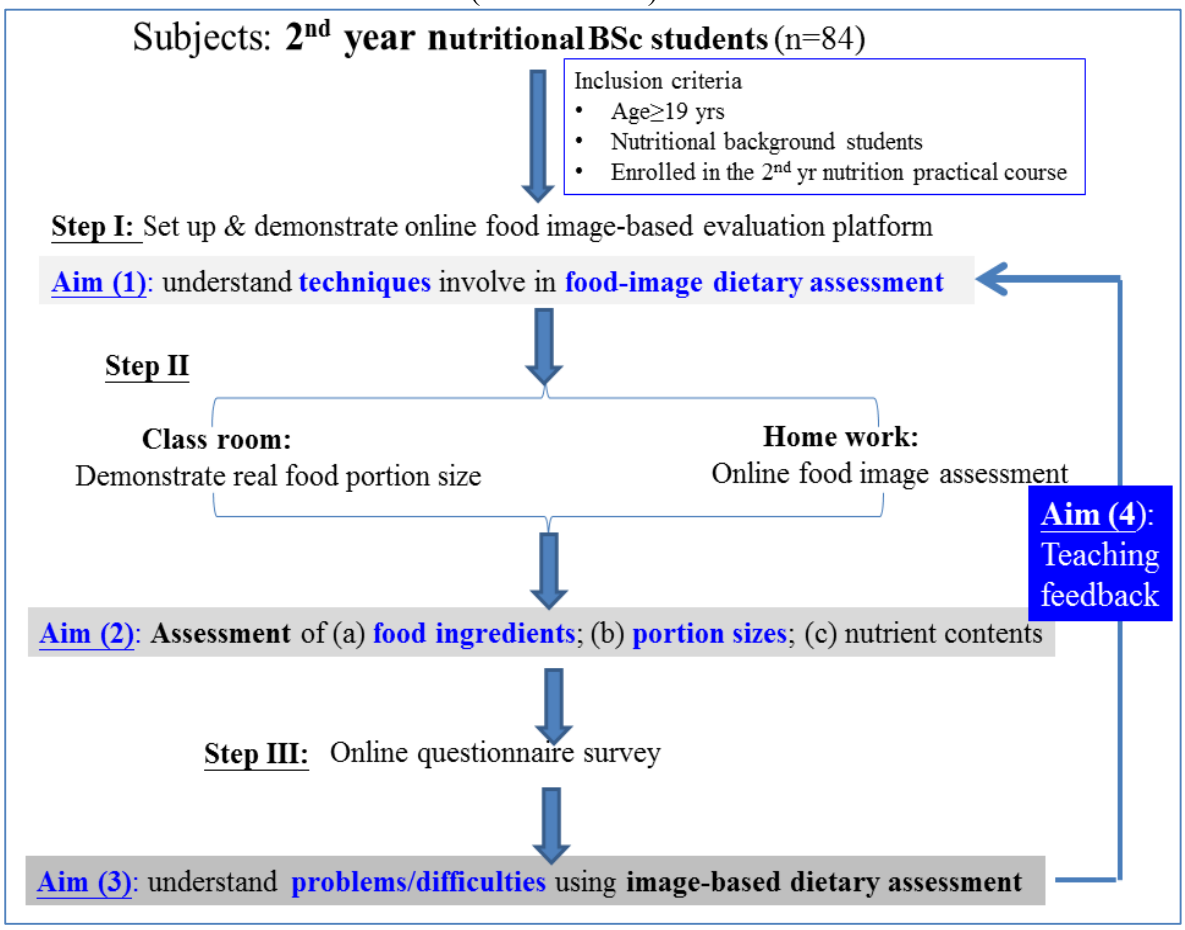


Figure 1 schematic flow chart of study recruitment.

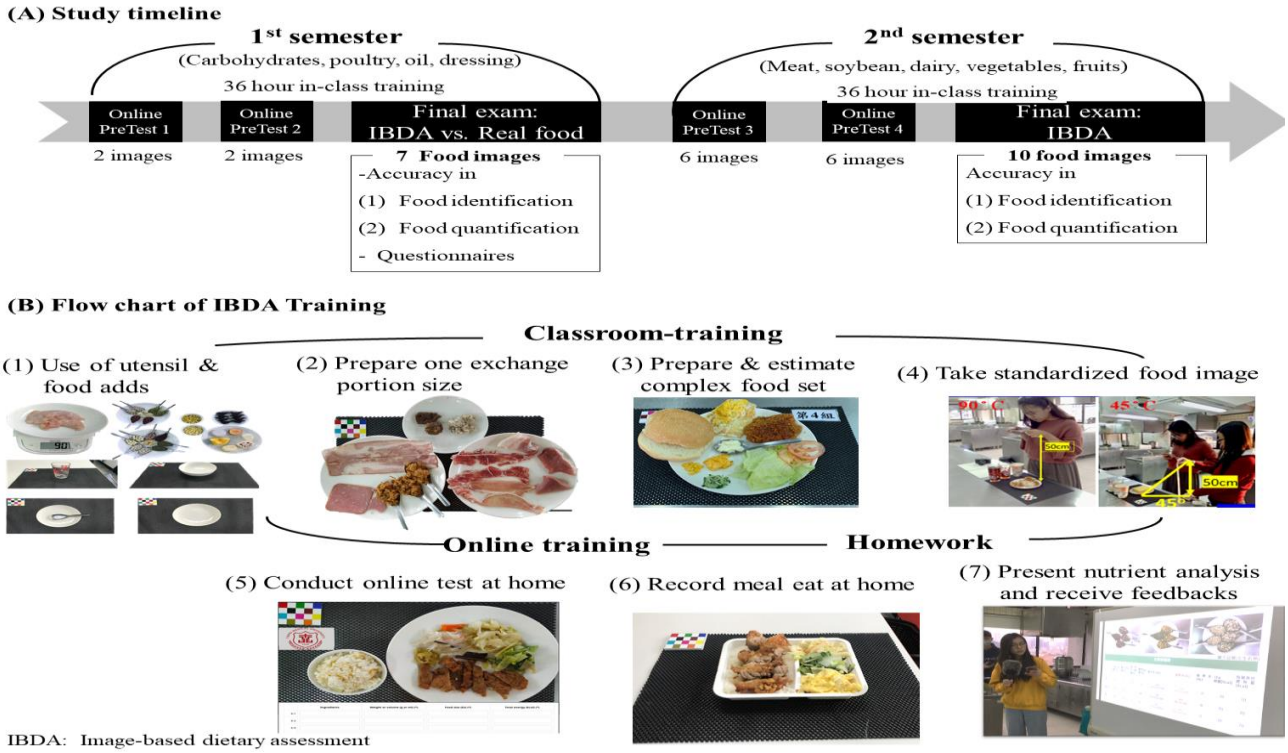


Figure 2 shows study timeline (A) and flowchart (B) of the IBDA training protocol

Accuracy of identifying food items: Participants's response were categorized into "accurate(正確)", "inaccurate(不正確)" and "omitted (遺漏；省略)" .

- **% accurate food items**= 100* (total accurate number of food items identified by Participants /total actual number of food items)
- **% inaccurate food items**= 100* (total inaccurate number of food items reported by participants／total actual number of food items)
- **% omitted food items**= 100* (total number of omitted food items by Participants /total actual number of food items)

Accuracy of quantifying food portion size:

- **% accuracy**= 100* (reported food weight by participants −actual food weight／actual food weight)

Accurate estimation is defined as provided answer fall within ±10% difference from actual food weight. Estimation with more than 10% is regarded as overestimation, whilst, estimation with less than 10% is regarded as underestimation.

Analyses were conducted using IBM SPSS 21 and GraphPad Prism 5. The Kolmogorov-Smirnov test was used to test whether data were normally distributed. Normally distributed data are presented as the mean and 95% confidence interval (CI) and median and interquartile range (IQR) [quartile 1 (Q1); Q3] for non-parametric data. Categorical data are presented as the number [percentage (%)], and continuous data are presented as the mean ± standard deviation (SD). A general linear model and Chi-squared were used to analyze the *p*-trend between variables for continuous data and categorical data, respectively. Spearman's coefficient was used to obtain correlations between students' calorie estimates for each food item with two methods real food visual estimation (RFVE) vs. IBDA). Cohen kappa was used to evaluate the interrater agreement between RFVE and IBDA. The One-way ANOVA and linear trend test were used to evaluate differences among group. *p*-values ≤ 0.05 were considered significant.

5. 教學暨研究成果(Teaching and Research Outcomes)

First semester results

✓ **Accuracy of food identification and quantification between the IBDA and RFVE**

On the food tested for food identification, 64% of participants were able to correctly identify food ingredients based on food images and 71% for the RFVE. No differences were observed in portion size estimations (within ±10% difference of total calories) between the IBDA (23%) and RFVE (24%) (Table 1).

✓ **Student's receptiveness and response to IBDA integration**

Table 2 summarizes students' receptiveness and response to IBDA training. As to the food tested for food identification, 70% of students thought that the IBDA was more difficult to perform than the RFVE (2%). A similar rate for food quantification was seen (68% for the IBDA and 30% for the RFVE). Factors that affected student's IBDA performance included the following: foods being mixed (65%) or food ingredients being hidden inside (36%), lacking the ability to estimate food portion sizes (52%), the angle at which the food image was taken (44%), food presentation (26%), and food images looking different from real food (21%). On a scale of 0 to 10, moderate to strong agreement (7.0~8.5 points) was found as to the usefulness of integrating the IBDA into training or as an important dietary assessment method (Table 2).

Table 1 Accuracy in food identification and portion size quantification in image-based dietary assessments (IBDAs) and real food visual estimations (RFVEs) evaluated in the first semster of the nutrition practicum course (*n*=84)

Food item	IBDA					RFVE					Spearman correlation	
	Identified correctly [a] (%)	Quantified correctly ±10% (%) [b]	Overestimated (%) [c]	Underestimated (%) [d]	Omitted (%) [e]	Identified correctly (%)	Quantified correctly ±10% (%)	Overestimated (%)	Underestimated (%)	Omitted (%)	*r*	*p* value
Sweet corn	100%	15%	19%	67%	0%	100%	21%	26%	52%	0%	0.638	<0.0001
Sweet potato	87%	8%	6%	86%	0%	93%	7%	8%	85%	0%	0.592	<0.0001
Noodles	91%	26%	30%	44%	0%	91%	21%	45%	34%	0%	0.679	<0.0001
Dorayaki	98%	12%	60%	26%	0%	88%	18%	43%	39%	0%	0.393	0.0004
Toast	97%	52%	28%	18%	2%	93%	38%	47%	14%	7%	0.755	<0.0001

Eggs	94%	76%	15%	8%	0%	100%	93%	5%	2%	0%	0.624	<0.0001
Chicken	95%	1%	93%	2%	0%	90%	2%	73%	15%	10%	0.519	<0.0001
Butter	71%	10%	52%	21%	17%	88%	7%	65%	27%	0%	0.628	<0.0001
Red beans	91%	17%	48%	32%	4%	96%	18%	56%	23%	4%	0.572	<0.0001
Mayonnaise	7%	4%	2.4%	2.4%	92%	10%	5%	1%	1%	93%	NA	
Batter coating	4%	1%	1.2%	2.4%	95%	1%	0%	0%	1%	99%	NA	
Vegetables	76%	8%	59%	13%	19%	100%	5%	79%	16%	0%	0.632	<0.0001
Sugar	51%	6%	18%	29%	48%	54%	5%	22%	32%	41%	0.706	<0.0001
Sauce	2%	0%	12%	6%	82%	44%	1%	38%	18%	43%	NA	
Oil	46%	15%	23%	10%	**52%**	26%	8%	4%	17%	71%	**0.404**	0.004
Coix seed beverage	69%	2%	50%	15%	32%	69%	5%	70%	20%	5%	**0.331**	0.0073
Overall	**67%**	**23%**	**28%**	**50%**		**71%**	**24%**	**36%**	**25%**			

[a] Percentage of students correctly identifying food items. [b] Percentage of students quantifying food calories within ±10% of ground truth calories.

[c] Overestimate: >10% of the ground truth total kcal; [d] Underestimate: <-10% of the ground truth total kcal; [e] Omitted: students who failed to recognize and quantify food items from images.

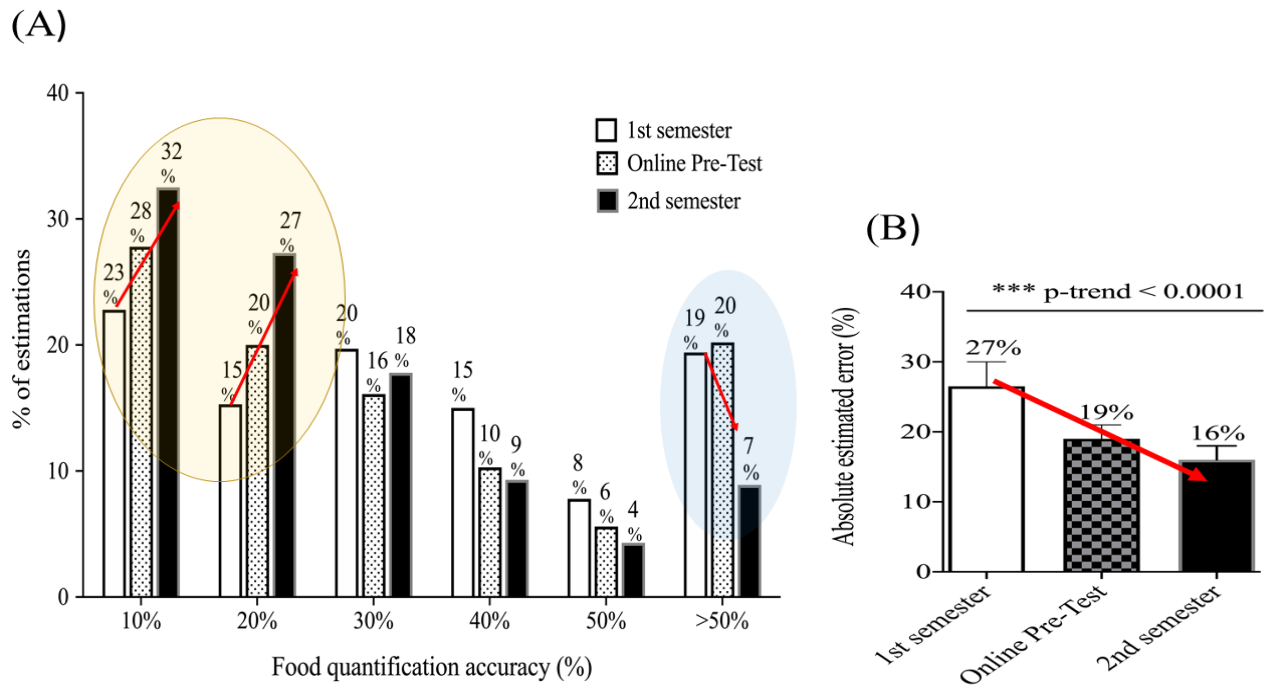
Table 2 Students' receptiveness and response to the image-based dietary assessment (IBDA) (*n*=84)

Which method was more difficult to identify food items
- Real food visual estimation (RFVE)
- IBDA
- Both
Which method was more difficult to quantify food items
- RFVE
- IBDA
- Both
What challenges did you experience when trying to identify food items in the images?
- The way the food was placed made it difficult to evaluate.
- Food pictures were too different from real foods.
- The food was mixed together making it difficult to recognize.
What was the most challenges aspects of estimating the quantity of the food items in the images?
- The angle at which the picture was taken made it difficult to judge the size of the food.
- It was impossible to estimate the portion size of hidden food items.
- A student's ability to estimate the portion size was not related to the food image itself.
Student's responses to the integration of the IBDA into the course using a 10-point Likert scale
- IBDA training improved your food identification skills.
- IBDA training improved your food quantification skills.
- IBDA training should be integrated into the dietetic training program.
- IBDA is an important method of dietary assessment.

Overall performance of the IBDA

Figure 3 shows a steady improvement in the IBDA performance in food portion size quantification across the first semester, pretest, and second semester. Estimated calories within ±10% also increased (first semester: 23%, pretest: 28%, and second semester: 32%) (Figure 3A). In contrast, the proportion of >±50% of the estimated error decreased from 19% and 20% to 7%, respectively (Figure 3A). Improvement in accuracy of food quantification also resulted in an overall reduction in the absolute estimated error of calories of 27%, 19%, and 16% for the first semester, pretest, and second semester, respectively (Figure 3B).

Figure 3 Students' overall performence of total calorie estimations (A) and absolute estimated errors (B) in the first semester (*n*=84), the online pretest (*n*=74), and the second semester (*n*=81) of the nutrition practicum course.



Effects of repeated IBDA training on those who were the poorest performers on the first semester

Figure 4A shows, among the poorest performers on the first semester exam (*n*=14), a border line inverse correlation between self-ranking score of usefulness of IBDA intergation into the course and the median estimated error was observed. However, repeated training decreased the estimated errors from 47% in the first semester to 25% on the second semester test for those who were the poorest performers on the first semester exam.

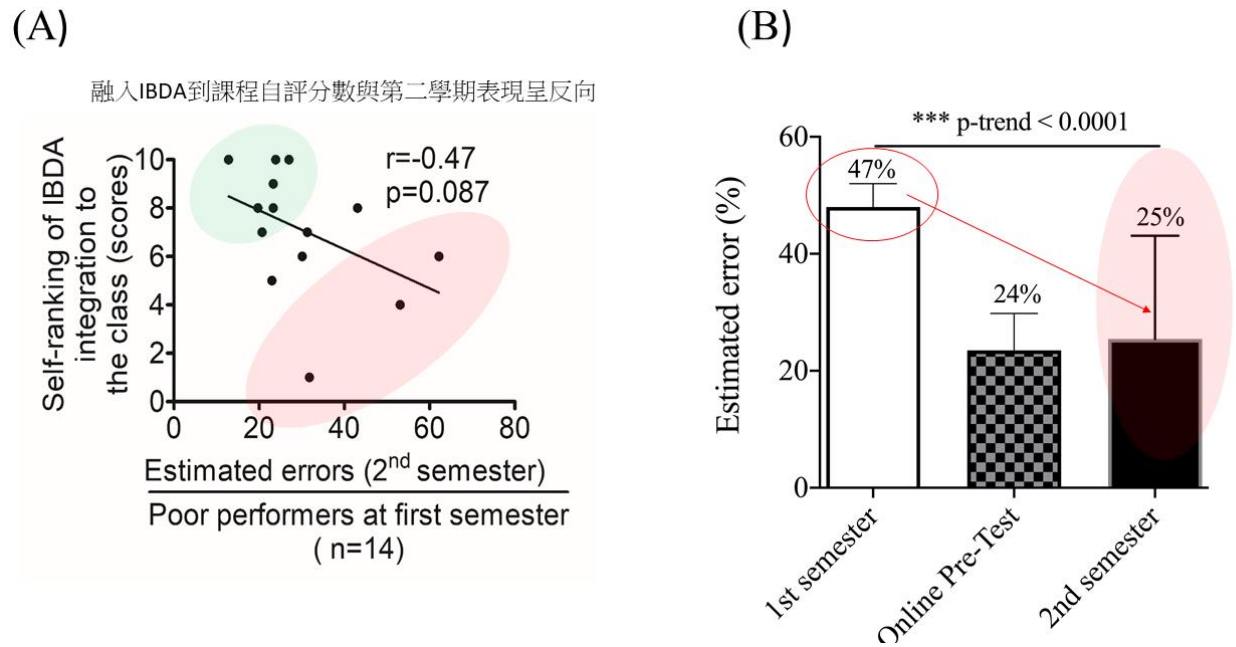


Figure 4 Effects of repeated image-based dietary assessment (IBDA) training on the poor performers (defined as ≥3 answers within >50% of the ground truth kcal on the first semester exam) (*n*=14). Spearmen correlation coefficiency analysis of self-ranking scores of usefulness of IBDA intergration

into the course and the median estimated error among poor performers (*n*=14) (A). Absolute estimated errors of poor performers in the first semester, pre-test and second semester (*n*=14) (C).

6. 建議與省思(Recommendations and Reflections)

Repeated IBDA training improved the digital dietary assessment skills of dietetic students; however, innovative technologies to assist human analysts to reduce measurement errors of the IBDA are also needed. Further research is also encouraged to unravel questions of how to implement "e-dietetics" in dietetics training programs and how to improve students' digital food-viewing skills for the future eHealth era.

二. 參考文獻(References)

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三. 附件(Appendix)

與本研究計畫相關之研究成果資料，可補充於附件，如學生評量工具、訪談問題等等。