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探討以融入式服務學習推廣奈米科普教育成效

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摘要

服務學習的理念是一種「服務」與「學習」並重的經驗教育方式。本研究探討宜蘭大學學生推廣國小 4 至 6 年級學童的奈米科普教育，透過「服務」而獲得「學習」的效果，並能夠讓宜蘭地區小學生獲得接觸及認識奈米科技的機會。共 40 位大學生參與服務學習課程，經過 12 小時的課堂訓練，及設計活動教案與預演。教案包含活動前後測、奈米科技簡介、蓮花效應實驗及互動式問答，在九十八學年度有 10 所國小，共 822 位小學生參與此活動，經後測成績統計顯示學童餐與活動後有顯著性的進步。此教學方式不僅可有效推廣國小學生奈米科普教育，同時讓大學生透過籌畫、執行、反思和評估他們的服務經驗中「教學相長」，達到人才培育與科普推廣雙贏的成效。

關鍵詞:奈米科技、科普教育、服務學習、小學、宜蘭大學

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Evaluation the effect of promotion for popular science education of nanotechnology by service-learning methodology

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Abstract

Service-learning is an experience education which equally emphasizes the "service" and "learning". This study is focus on the promotion of nanotech's popular science education for the fourth to sixth grades elementary school students, and is performed by Ilan University undergraduate students. This design is to train these undergraduate students to "learn" through the "services" by integrated social services into science course. Moreover, the elementary school students can concern with nano-science and gain preliminary understanding of nanotechnology and its application. Forty undergraduate students achieved 12 hours classroom training as well as the experimental exercise, design of lesson plan and presentation. Lesson plan includes quiz before and after the activities which contain a brief introduction to nanotechnology, lotus effect experiment and interactive Q&A. There were 822 students from 10 elementary schools in I-Lan county participated in these activities at 98 academic year. The post-quiz exhibited that the elementary school students made a significant progress after promotion activity. These valuable results revealed that the service-learning is a desirable education methodology not only to promote the popular science education of nanotechnology at elementary schools but also to allow university students gain “teaching others teaching themselves” effect through the learning, planning, execution, reflection and evaluation. The nanotechnology human resource incubation and popular science education popularization were simultaneously performed through this service-learning activity.

Keywords: nanotechnology, popular science education, service-learning, elementary school, Ilan University

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1. Introduction

Nanotechnology has become the new hope of economy in 21th century and will change the industrial structure as well as the life style. Many researchers regard nanotechnology as the fourth industry revolution. Though economic depression still perplexes many countries, while, tens billion US dollars per year were invested worldwide in developing outstanding nanotechnology [Hullmann, 2005]. The National Science Foundation (NSF) estimates that by 2015 there will be a need for two million workers worldwide in the fields of nanoscience and nanotechnology. To meet the need of an educated populace that can work in the field as well as support its safe development, it is critical that universities, governments, and industries support nano-education efforts [Healy and Palma, 2007].

Nanotechnology is the meeting ground of engineering, biology, physics, medicine, and chemistry. It is being used in, and enriching, all these fields and it, in turn, is utilizing and building on all the elements of these pure and applied sciences. For nanotechnology to reach its full potential to contribute to our society, it must have a workforce for research, development and manufacturing. One is simply being able to attract students to nanotechnology education and training programs [Fonash, 2001].

Beyond the normal education in schools, informal science education includes museum, television, lecture, medium, network etc., are important implements to connect nano-science knowledge with population. These popular science educations offer various enjoyments from learning and facilitate effective learning by internet communication [NSET, 2003], image communication [Herbert, 2000], written communication [Bainbridge, 2004], lifelong learning, distance learning [Groves, 2008], experience communication [Crone, 2008].

The National Ilan University has recently partnered with colleges and senior high school in Ilan to promote the popular science education of nanotechnology. This study is the one of activities of project, which has been motivated by desires to establish the learning environment in nanotechnology and to help the populaces can briefly understand the nanotechnology and how it applied in their living. We integrated the nanotechnology experts as well as the trained teachers and students to disseminate nanotechnology information to Ilan populace. The dissemination approaches include popular science lecture series, communication art series, extension education curriculum and establishing nanotechnology museum.

Recently, more and more universities and colleges pay attention on service-learning. Through service-learning, the learners not only can acquire academic knowledge, but also develop their social responsibility. During the training, professional knowledge of nanotechnolog

y as well as the correct learning and teaching attitude are important. This paper represents a brief overview of the popular science education promotions for elementary school students in Ilan performed by Ilan University undergraduate students with integrated service-learning methodology. It is intended to provide insight into the motivations and challenges of such a service-learning effort.

2. Procedure

Integrated service-learning is a method of teaching, learning and reflecting that combines academic classroom curriculum with meaningful service, frequently youth service, throughout the community. As a teaching methodology, it falls under the philosophy of experiential education. More specifically, it integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, encourage lifelong civic engagement, and strengthen communities for the common good [Lin, 2007].

For examples, enthusiastic and responsible teachers design curricula related to community service to have students discuss their feelings in class after community service engagement. Teachers can also establish official courses offering credits with service activities to achieve the goal of service learning. The direction of development can help to implement the real meaning of service learning [Feng, 2005].

Three enthusiastic teachers, two nano-science experts and one promotion action expert, collaborate to design curriculum of seed teacher's camp for popular science education popularization in nanotechnology (Table 1). Forty undergraduate students achieved 12 hours classroom training to become seed teachers, included introduction and application of nano-technology, experimental exercise, design of lesson plan and presentation.

Table 1: The research and study course of seed teachers in promotion of popular science education of nanotechnology

Schedule		Course	Advisers
1st day	11:10~12:00	Introduction of service-learning and nanotechnology	Su-Der Chen
	13:10~14:00	Nano-effect and characteristics	Hui-Huang Chen
	14:10~15:00	Application of nanotechnology	Hui-Huang Chen
		Paper search and reading	Homework
2nd day	11:10~12:00	Introduction of nanotechnology camp activities	Hui-Huang Chen

		and lesson plan	
	13:10~14:40	Exercise of nanotechnology experiment	Hui-Huang Chen
	14:40~15:00	Divide into groups and design the camp activities	Su-Der Chen
		1. Afford a question for competition in camp activities	Homework
		2. Design the camp activities	
3rd day	11:10~12:00	Introduction of leading skill in camp activities	Wen-Hung Hsu
	13:10~14:40	Camp activity exercise	Hui-Huang Chen
	14:40~15:00	Discussion	Su-Der Chen
4th day	15:10~18:00	Demonstrate and validate camp activity	Hui-Huang Chen Wen-Hung Hsu Su-Der Chen

In the nano-technology course, category of nano-technology includes definition and development of nanotechnology was introduced. The classification, properties, preparation, characterization survey and application of nano-materials were also met in this class. These course aims to teach seed teachers to understand how the nano-phenomena in nature inspire the human being to develop nano-technology, and to comprehend the application of nano-materials and nanotechnology in our life. These undergraduate students not only learned the knowledge of nanotechnology and the popularization activities skill but also collected nanotechnology related fundamental knowledge and questions as homework. These databases offered them to develop the interactive teaching materials and question bank for pre- and post-quiz.

Table 2: Lesson plan of popular science education of nanotechnology promoted in Ilan

Object: 4-6th grade		**Course: 100 min**	
Promotion activities			
Subject	Programs (teaching/experiment steps)	Duration (min)	Materials
Did you know "nano"?	1. Divide students into groups (10 persons in one group). 2. Pre-quiz To understand how the 4-6th grade students know the nanotechnology	10	Pre-quiz paper
What is "nano"?	Introduce nanotechnology with PowerPoint and video. 1. definition of nanotechnology 2. nano-materials and nano-phenomena in nature	30	Projector, computer

	3. application of nanotechnology		
Nanotechnology experiment (DIY)	Exercise - the smoked paper cup (Lotus effect) 1. The bottom of paper cup, with 1/3 cup of water, was smoked by a candle. Rotate the cup to facilitate the carbon particles well spread and adsorb on the cup bottom. 2. The cup was upside down and dropped a blob of water on the smoked cup bottom. Move the cup slowly and observe the shape and rolling of water blob. 3. Repeat step 2 with the other cup without smoking. 4. Compare and discuss the difference of the water blobs shape and spreading between these two cups.	20	Paper cup, lighter, candle, dropper
Q & A of nano-school	1. The commodities in livelihood Ask: What nano-products appear at your home ? Hint: stool, refrigerator, necktie, 2. The influence of nano-products Ask: What kind of nano-products should be developed to improve your living. Hint: self cleaning tile, … 3. Competition (1) 16 questions about nanotechnology were divided to 4 grades according to its difficulty. (2) The students voluntarily answered the question and was scored.	30	Gifts
I know what is "nanotech"	1. Post-quiz Same question in pretest is examined again to inspect the efficiency in learning. 2. Score and compare d with the pretest results. 3. Award prize	10	Gifts, post-quiz paper

The final lesson plan included pre-quiz, lecture, experiment, nano-school (Q&A competition) and post-quiz as list in Table 2. There are identical 15 questions in pre- and post-quiz. Definition of nano, nano-phenomena in nature, concept of development history and application of nanotechnology were involved in this quiz. The answers of quiz were included and illustrated in the follow lecture which was performed with multimedia, including PowerPoint slides and animation. The lotus effect was introduced in DIY experiment. The smoked paper cup experiment was developed in Taiwan National Science and Technology

Program for Nanoscience and Nanotechnology (phase I). This experiment is suit elementary schools students and the beginners to learn lotus effect in nano-science. Q&A competition was design to be an edutainment activity. Twenty questions were divided to four grades of score according to its difficulty. The minus score would be recorded for the team to select the repeated answered question. The interactive Q&A activity is expected to liven up the atmosphere.

According to this lesson plan, seed teachers were divided into 10 groups. Member duty in a group included lecture, experiment DIY, competition, and administrative matters. These seed teachers had a lot of practice on their own duty and presented before the camp activity of the promotion of nanotech's popular science education.

Elementary schools (grade)	**classes**
Long-tan (5th)	2
Kai-shun (4th)	2
Li-ming (6th)	3
Guo-ling (5th, 6th)	1
Syue-jin (6th)	3
Da-li (4th, 5th, 6th)	3
Kai-shun (5th)	2
Yu-chai (6th)	2
Masai (6th)	2
Long-tan (6th)	2
Young-le (4th, 5th, 6th)	1
Kai-shun (6th)	2
Shmes (4th, 5th, 6th)	3
Li-ming (6th)	4

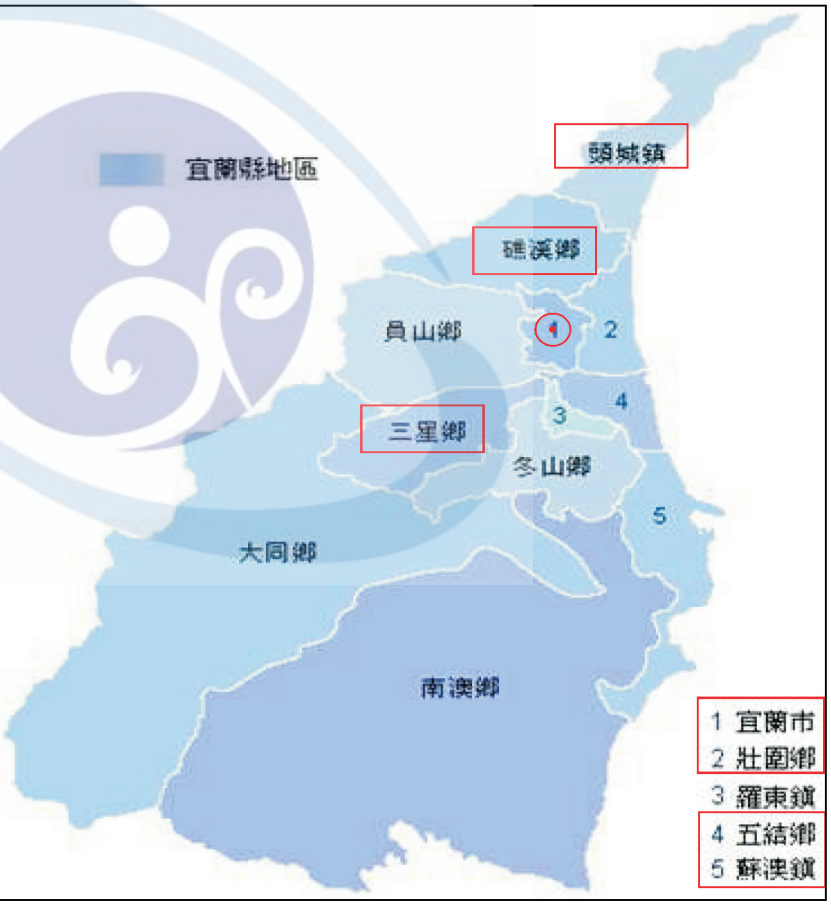

Figure 1: The classes of elementary schools participated the popular science education of nanotechnology in Ilan.

3. Results and Discussion

There were 822 students from 10 elementary schools in I-Lan county participated in

these nanotech's popular science education activities at 98 academic year (Figure 1). Almost of these elementary school's students were unfamiliar with service-learning system and nanotechnology. Both of the seed teachers and elementary schools students were shy. Therefore, it was quiet in the beginning of the camp, while, they cheered up when the lotus effect experiment started. The lotus effect was designed to burn the candle to smoke the paper cup with quarter cup of water. The incomplete burning of candle generated carbon particles and adsorbed on the bottom of paper cup to form a hydrophobic layer. The round water drop rolling over on the carbon layer as well as the fire attracted these students. They could not only learn the lotus effect but also realize the reason why water can put out a fire by decreasing temperature. The camp activity culminated in Q&A competition. The competition among groups encouraged their sense of honor. They had also learned a lot of common sense of nano-science and nanotechnology. No wonder the post-quiz looked easy for these elementary school students participated in the camp activity. After the post-quiz, they no more felt shy, and the idolatry instead of shy behavior. Some of the seed teachers were regarded as the idols, were asked to take pictures, and were requested to offer elementary school students the MSN or E-mail address.

"Reflection"is the main difference between service-learning and community service. These 40 undergraduate students wrote day record, searched and read related data, discussion and design lesson plan. It was an unfamiliar and hard work. Most of the undergraduate students were afraid and even some of them regret participating the service-learning course during training. Nevertheless, but these seed teachers grew up after the camp activity and learned more nano-science and experiments than in classroom. Almost seed teachers got the excellent score evaluated by elementary school teachers about the expression in the attitude, skill and knowledge (Table 3). The 40 undergraduate students' final reports of service-learnin g course exhibited they were overjoyed that they benefited greatly by service-learning.

Table 3: Criticism list of student behavior during service

Moral integrity and attitude	**Excellent**	**Ordinary**	**Not good**	**Poor**
1. Attend on time	4	3	2	1
2. Remedy when unable to attend on time	4	3	2	1
3. enthusiastic and devotional attitude	4	3	2	1
4. active and optimistic attitude	4	3	2	1
5. Humility	4	3	2	1
Skill	**Excellent**	**Ordinary**	**Not good**	**Poor**

1. Skill in planning and organizing	4	3	2	1
2. Communication with elementary schools teachers and students	4	3	2	1
3. Appropriate connect with elementary schools	4	3	2	1
4. Cooperation	4	3	2	1
Knowledge and application	**Excellent**	**Ordinary**	**Not good**	**Poor**
1. Understand about the functions of elementary schools	4	3	2	1
2. Recommend elementary schools some positive opinions	4	3	2	1
3. Understand and respect diverse cultures	4	3	2	1
4. Application of knowledge to service	4	3	2	1

On the other hands, we statistically sampled the pre- and post-quiz from 323 students from 4 elementary schools. The statistic results of t-test showed that the elementary school students made a significant progress after 2 hours camp activity (Table 4). The average scores, accurate answers for 15 questions, were 8.93 (8.61 to 10.03 for different schools) and 13.33 (13.13 to 14.23 for different schools) of pre- and post-quiz, respectively. The post-quiz score showed 4.39 (3.43 to 5.44 for different schools) higher than that in pre-quiz and revealed that these 4 elementary schools students made progress significantly (t value was -20.35 to -9.68, $p<0.05$). Many of the elementary schools students could correctly answer all of the questions after the camp activity. This result reflected that the elementary schools students made great progress in nano-science concept. It also revealed that the teaching effectiveness of the camp activity of the nanotech's popular science education with service-learning methodology.

Table 4: Learning effect of elementary school students participated popular science education of nanotechnology

Elementary schools	Student	Pre-quiz Score*	Post-quiz Score*	Variation	t value**
Li-ming	106	9.13±1.87	13.13±1.70	-4.00±2.02	-20.35
Kai-shun	139	8.61±1.97	13.15±1.74	-4.54±2.23	-24.03
Yu-chai	48	8.79±1.71	14.23±1.13	-5.44±1.99	-18.95
Guo-ling	30	10.03±1.77	13.47±1.46	-3.43±1.94	-9.68
Summary	323	8.94±1.92	13.33±1.66	-4.39±2.16	-36.47

* Accurate answers for 15 questions

** $p<0.05$

4. Conclusion

The undergraduate students benefited greatly and grew up through learning and service experience. Undergraduate students not only learned about the nanotechnology knowledge and skill through planning, executing, and introspection, but also become actively contributing citizens and community members through the service. These valuable results revealed that the service-learning is a desirable education methodology not only to promote the popular science education of nanotechnology at elementary schools but also to allow university students gain"teaching others teaching themselves"effect through the learning, planning, execution, reflection and evaluation.n The nanotechnology human resource incubation and popular science education popularization was simultaneously performed through this service-learning activity. The training course and camp activity was recorded to video and was communicated by Ilan Union cable TV association. This promotion modulus of popular science education of nanotechnology will perform sustainably in Ilan to create a superior nono-science learning environment.

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