How inquiry project-based instruction affect the vocational high school students’ learning performance

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INTRODUCTION

This study is part of a collaborative program between university and vocational senior high school for improving teaching and learning in engineering courses. One class of students who attended the course of "surveying practicum" was observed to evaluate the effectiveness of teaching improvement. In the practicum, students are usually guided to follow the standard operational process or cook-book like protocol to make rigid and precise measurement. After gaining exposure to project-based instructional strategies, the teacher designed a series of surveying tasks, including traverse surveying and longitudinal section surveying that allow students to discuss the methods and procedures with peers and find out the resolutions on their own. Each group of students then presented their design and result after carrying out surveys on campus. It was fairly surprising to the teacher that students generated two effective methods with one similar to that in the textbook and the other one new. Multiple sources of quantitative and qualitative data were collected during the course to explore any changes on students' views of scientific inquiry and perceptions of learning.

Analyses of the pre- and post- tests collected from the modified Views of Science Inquiry (VOSI) questionnaire indicated that students' understanding about scientific inquiry has improved after the course (average score increased from 7.45 to 9.28 based on the scoring criteria developed in this study). Qualitative data through triangulation revealed that students find this innovative instruction enjoyable and experiential because it can initiate self-directed learning and creativity. The teacher has been encouraged by seeing the improvement of student performance.

1 RESEARCH BACKGROUND

1.1 High-Scope Program II in Taiwan

The goal of science education is to enhance citizens’ scientific literacy. Ministry of Science and Technology in Taiwan has funded two High Scope Program (HSP) projects in high schools. The second-phase is a three-year program which has been in operation since 2011. The objectives of the High-Scope Program II are to (1) develop innovative and workable emerging technology curriculum so

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as to build up high-school students' scientific literacy; (2) improve teachers' professional scientific literacy toward emerging technologies, so as to inspire high-school students' attitudes toward active learning. Please refer to Fig.1 for concept introduction. (http://w1.ceels.org/chunyen/index_eng.html)

Fig. 1. High-Scope Program II in Taiwan

In our three-year project, PI, co-PIs and vocational high school teachers and university research teams incorporate to conduct collaborative action research on integrating emerging technologies into existing curriculum, including unveiling suitable study material, course development (course planning, curricula, teaching module innovation, trial teaching), innovative instruction development (collaborative learning, scientific inquiry, competition-oriented project development), and course-activities multi-dimensional evaluations whose results would feedback to the curriculum and activity development.

The first period of this project (development period) spotlights on integrating innovative approach into the approach of the existing curriculum, teaching module, competition-oriented project manufacture, multi-dimensional evaluations, etc. The second period (feedback modification period) focuses on the feedback evaluation of the developed curriculum, course modification driven by the feedback, and its effectiveness. The third period would spread our curriculum modules into several heterogeneous schools to investigate the suitability and diffusibility. Finally, seeded teacher training would be carried out to promote the developed curriculum modules that accompanied with our developed multi-dimensional evaluation to make sure that the training would be a success.

1.2 Community of Practice-PD model

Wenger et al. [1] demonstrated models and methods for developing communities of practice. They defined the PD model as 'groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis' (p. 4). In this study, the vocational high school teachers from the civil engineering devision prepared and implemented the teaching activities. University scientists and science teacher educators served as coaches and researchers. We developed a CoP to support sustained change in practice. The participants shared their (practical) knowledge and experiences in a safe and supportive atmosphere. Key components are 'mutual engagement, a joint enterprise, and a shared repertoire'.

1.3 Project-Based Learning

Project Based Learning (PBL) is a teaching methodology that students get knowledge and skills by exploring and responding to a specific question or problem. The essential elements of PBL include specific content, building student competencies, in-depth inquiry, driving questions, generating interest and curiosity, critique and revision, group audience etc. (www.bie.org)

1.4 VOSI Questionnaire

Schwartz et al. [2] developed an open-ended questionnaire that assesses views of scientific inquiry (VOSI) to understand the epistemological views of science (nature of science (NOS)) and nature of scientific inquiry (NOSI) and how they develop. This study modified the VOSI Questionnaire to fit the' HSP project's need for vocational high school students.

In this study, a case study ‘surveying practicum’ course in the Division of Civil Engineering, National Tainan Vocational High School was carried out, as well as the classroom observations, modified VOSI student questionnaire and Informal interviews.

2 COURSE OUTLINE

The project in the observed ‘surveying practicum’ course is ‘Designed a surveying tasks: longitudinal section surveying’. Fig. 2 shows the procedure of teaching and learning activities. Detailed and selected class snapshots in succession could be found in Fig.3.

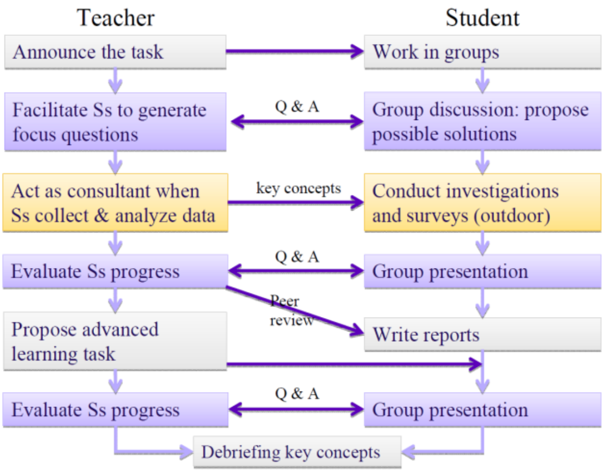


Fig. 2. Course activities

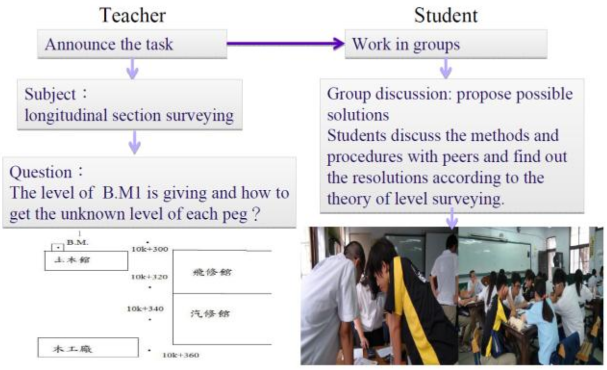


Fig.3. (a)

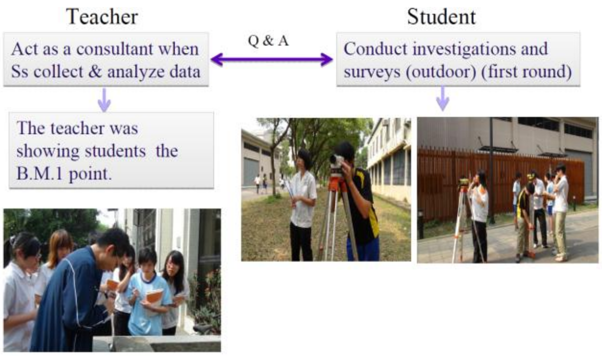


Fig.3. (b)

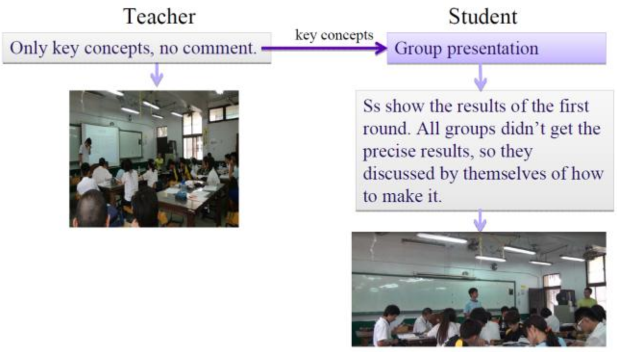
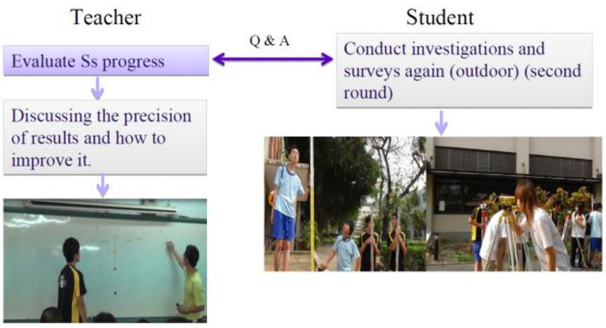


Fig.3. (c)



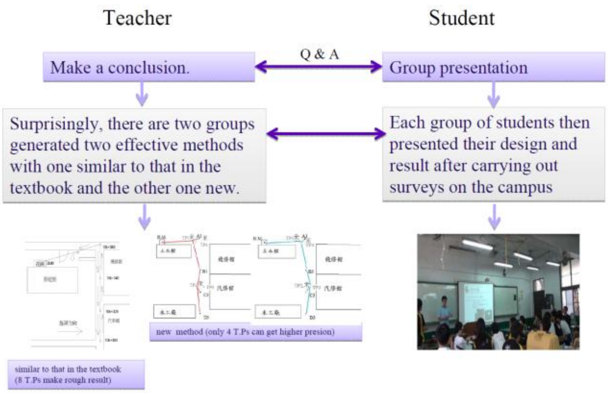


Fig.3. (d) *Fig.3. (e)*

Fig.3. Outline of the observed course in this study

3 RESULTS OF THE MODIFIED VOSI QUESTIONNAIRE

The modified VOSI Questionnaire with full score = 20 is showed in Table 1.

Table 1 The modified VOSI Questionnaire was developed and used in this study.

Category	Score	Criteria
Views about scientific work	3	"Scientific investigations involve asking and answering a question."
	2	"do research; find answers"
	1	"Do experiments to prove their ideas; follow the scientific method"
Ideas about experiments	3	No single scientific method; aware of multiple methods of scientific investigation
	2	Understand the procedure of experimental approach, but not insist the need of experiments in scientific work.
	1	"Experiment" is described as a specific step-wise procedure; conducting in laboratory
Experiment in science	2	Not all science investigations are experiments 。
	1	Science needs experiment

Category	Score	Criteria
subjectivity in science	2	Recognize that scientists may have different interpretations on the same data
	1	"if the same procedures are followed then they would get the same result"
Interpretation and acceptance of data	2	Recognize that data interpretation can vary depending on the scientist
	1	Believe that procedures are the key to the outcome

Category	Score	Criteria
Characteristics of scientific	3	"it can be considered scientific because of the use of repeated observations, identification of a pattern, and inferred correlation based on the observations."
	2	Consider it scientific, but partially describe the characteristics
	1	It's not scientific, because "there was no hypothesis" or "it was just an observation"
Distinction between data and evidence	2	"Evidence is data that has been interpreted in light of a question."
	1	Data = evidence Misinterpret functions of data and evidence
Justification of scientific claims	3	"justification criteria such as results being repeatable, results are consist, predictable, and clear evidence to support"
	2	Describe one of the criteria
	1	Simply mention the terms "proof", "experiment" or "evidence"

The modified VOSI score (n=29) increased from 7.45 in pre-test to 9.28 in post-test. Blank responses decreased from 78 times to 45 times. The result shows that students are able to write up some ideas to respond those open-ended questions. Although some of the responses in the post-test may not be sophisticated, they at least responded, which means they thought about it.

Table 2 The modified VOSI pre- & post- test results

	mean	SD	t	p
Pre-test	7.45	3.73	-2.41	0.023
Post-test	9.28	3.50		

The observed evidence to support effectiveness is that a case student, who had been identified as learning disable, showed interest in doing project, interacted well with team members and finally passed the level C technician license exam. His teacher was surprised by his performance in the license exam.

4 SUMMARY AND ACKNOWLEDGMENTS

This study is part of a collaborative program between university and vocational senior high school for improving teaching and learning in engineering courses. One class of students who attended the course of "surveying practicum" was observed to evaluate the effectiveness of teaching improvement. Analyses of pre- and post- tests collected from the modified Views of Science Inquiry (VOSI) questionnaire indicated that students' understanding about scientific inquiry has improved after the course (average score increased from 7.45 to 9.28 based on the scoring criteria developed in this study). Qualitative data through triangulation revealed that students find this innovative instruction enjoyable and experiential because it can initiate self-directed learning and creativity.

The modeling and investigated results are limited to the participated course and class. To explore the practical aspect and applications at other courses, more efforts could be made: (1) Develop featured curricula for civil engineering in vocational high school; (2) Attract more teachers to join the communities of practice (provide more PD opportunities); (3) Investigate, analyze, and document student learning and performance. Support from the Ministry of Science and Technology of Taiwan through Grant No. NSC 102-3113-S-003 -006 -GJ is gratefully acknowledged.

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[2] Wenger, E., McDermott R. A., et al. 2002, Cultivating communities of practice: a guide to managing knowledge. Boston, Mass., Harvard Business School Press.