

Explore Elementary Teachers' Professional Knowledge of Guiding Science Fair Product by Using Different Instruction Model*

Chow-Chin Lu

National Taipei University of Education, Taipei, Taiwan

This research is about using two different instruction models, “theory course combine with sample introduction” and “theory course combine with case method teaching”, to instruct elementary teachers on how to guide the science fair product in two courses (16 and 12 teachers in each class) and observe their guiding tactics after the instructed classes. The results show that: (1) Elementary teachers who have taken “theory course combine with sample introduction” course consider that: (a) Introducing the samples can let them clearly understand the process of how to guide students to do their science fair project; and (b) Following the description sample to make their science fair project topic, extend these topic form original science courses, draw the conception map and flow table, handle the scientific experiment, and then teach students to be familiar with the content of science fairs project; (2) In-service teachers who have chosen “theory course combine with case method teaching” course consider that: (a) Case-method teaching helps them understand the contents of the curriculums; and (b) It provides them models to observe and imitate. With such an increase of awareness, knowledge transference had been brought out. Thus, professional knowledge would be promoted. Both teachers who have accepted these courses had hiatus when guiding students to develop their product: (1) Teachers is inadequately comprehending the basic scientific theory of subjects of their science fair project; (2) Scientific verification is not scientificness; (3) Verify facts which are already known; and (4) Be careless about the control variable.

Keywords: instruction of elementary science fair, professional knowledge, case method teaching

Introduction

Rationale and Importance of This Study

The ISEF (International Science and Engineering Fair) has been held for 62 years. The Taiwan national primary school science fair has been held by the National Taiwan Science Education Center for 51 years. Science fair is an important annual event in science education circles.

Daab (1988) probed current status of American primary science fairs, and found that teachers often view science fairs as an optional homework and fail to provide students enough instruction. It might due to the deficiency of professional knowledge and enthusiasm.

***Acknowledgments:** The author appreciated the funding supported from National Science Council, Taiwan, R.O.C. (NSC98-2511-S-152-010-MY3), veteran in-service teachers who were participants in study, professors who helped to establish the reliability and validity in this study, and last but not least, the NTUE (National Taipei University of Education) study group.

Chow-Chin Lu, Ph.D., professor, Department of Science Education, National Taipei University of Education.

What professional knowledge should teachers have when they guide science fairs? Most teachers believe that scientific basis, ability to comprehend and use different teaching strategies, and ability to understand and evaluate students are the characteristics and abilities one shall have while instructing science fair (Lu, Chiang, & Hsiung, 2009).

In the process of teacher education, most institutions offer curriculums about teaching strategies, skills, assessments, and so on. For the lack of experience, many in-service teachers fail to promote professional knowledge. Classroom discussions and trial teachings are not enough to help them accomplish it, and models are needed. Thus, advisory channels are essential, such as Websites, manuals, workshops, and experienced teachers (Fredericks & Asimov, 1990; Shaffer, 2000; Shaw, Cook, & Ribelin, 2000).

Overall, in this research, we probe into the teaching lessons of instructing elementary school teachers to guide their students to finish a science fair product. We use two models, "theory course combine with sample introduction" and "theory course combine with case method teaching", to teach and observe all the teachers who have taken the class and compare the differences of their professional knowledge between both instruction, for example: Does the case method teaching provide in-service teachers and recruit a chance to combined theories with reality?

Research Objective

The main purpose of this research is to observe the difference of elementary teacher's professional knowledge after taken two different classes. The research questions are: (1) Is the elementary teachers' professional knowledge different if they have taken two different instructing model classes? (2) After taken the classes, what different behaviors will they have when designing primary science fair?

Literature Review

Strategies of Instructing Science Fair

Most teachers believe that scientific basis, ability to comprehend and use different teaching strategies, and ability to understand and evaluate students are the characteristics and abilities one shall have while instructing science fair. The strategies most teachers used when they instruct science fair are inquiry teaching method, problem-based learning model, and cooperative learning (Lu, Chiang, & Hsiung, 2009).

Inquiry teaching is totally different from didactic instruction. Students are the protagonists of learning activities. While inquiring, they have ample opportunities to announce, discuss, and operate. Through the experience similar to scientific research, students learn knowledge, attitude, and skills (Chen, Jiang, Lin, & Wang, 2001). Hsiung and Yang (1996) proposed four elements of problem-solving model as presenting situation, goals, limits, and rules. Wang (1997) suggested providing vast basics training and well-designed curriculum to make students problem-solving experts. Hilke (1990) viewed cooperative learning as a systematic way, through teamwork, students achieve the goal. As a team, everyone should exert his ability and help each other. D. W. Johnson, R. T. Johnson, and Holubec (1998) indicated that cooperative learning is a systematic and structured teaching strategy which fits for any grades and domains.

The Importance of Case Method on Education

The verb "case" is widely used in education. Zhang (2001) defined teaching case as "descriptions of real events which includes characters, stories, difficulties, and problems. And, it reports all situations and involvers

by multiple viewpoints. So, it can be applied to analyze, discuss, make decisions, and to solve problems”.

In the process of teacher education, using real events as cases would provide in-service teachers and recruits a chance to combined theories with reality. Teaching cases also emerge the problems and difficulties which could be encountered on scene (Gao & Cai, 2001). However, some cases show other solutions, and provide in-service teachers an alternative way which is more efficient and brings out more efficacy (Bencze, Hewitt, & Pedretti, 2009; Shulman, 2004).

Methodology

Research Design

First, the author interviews the professor to understand instructing model, “theory course combine with sample introduction” and “theory course combine with case method teaching”, then applies participant observation to joint both instructing courses, to understand how the professor practices her course, and how in-service teachers promote professional knowledge.

As the first model, classes of “theory course combine with sample introduction”, the professor presents theory course of guiding a science fair, such as explaining the definition of lectures, the advantages of awarded works, the standard experimental procedures, and so on. Then, professor shows plenty of science fair examples for teachers to observe.

Second model, the professor combines her theory course with case method teaching and gives in-service teachers' worksheets matched with teaching case films. Theses worksheets could be viewed as portfolios which reveal the learning behaviors. In-service teachers complete the worksheets at class and the professor leads discussions to clarify their thoughts and to criticize the strategies and processes showed in the film.

Researcher records the whole course by recording classroom video and contrasts with worksheets and science fair schemes designed by in-service teachers (triangulation). To analyze all the data to inspect how in-service teachers learn and produce their work, the features of their behavior would be revealed.

The second part of research is to analyze science fair schemes designed by the in-service teachers, by so, to understand how they design their works, what their instructing strategies are, and if their works have any relations to what they learned before.

Participants

The professor has been instructed in-service teachers to instruct primary science fair for 20 years. This time the professor opens up two courses, one of it had 16 in-service teachers attend the class and use “theory course combine with sample introduction” as instructing strategies, which lectured on science fair samples; the other had 12 in-service teachers attend the class and use the “theory course combine with case method teaching” instructing strategies. Both of the classes are divided into four groups and designed primary science fair schemes of different subjects (physics, chemistry, biology, and applied science).

Research Tools

Teaching case films. Eight films produced by experienced teachers reveal the process of how experienced teachers instruct primary students to make science fair. Films have been evaluated by CIPP (context, input, process, and products) mode (Lu et al., 2012).

Instructing science fair worksheets. These eight worksheets are designed by the professor and they are

matched with instructing science fair. By worksheets, in-service teachers make their own learning record, which allows researcher to analyze what they learned (content validity built by two science professors and one experienced teacher).

Classroom video record. Researcher films the whole course and documents the discussions between the professor and in-service teachers.

Data collection and analysis. Researcher jumps in the scene to mark, count, and integrates in-service teachers' behaviors by "participant observation" and "discourse analysis". Then, on the basis of course content, researcher analyzes the worksheets written by in-service teachers. By "cross-reference" different data, researcher generalizes some conclusions.

During data processing, researcher follows grounded theory and seeks to find out threads of different data to compile and code them all. Then, through repeated comparison and verification, the results would be generalized.

Results

Exploring the Professional Knowledge Between These Elementary School Teachers After Taking Two Different Instructing Model Classes

Comparing professional knowledge by using instructing science fair worksheets. Researcher tries to use the instructing science fair worksheets to compare teacher's professional knowledge in both classes and analyze the result shown in Table 1. The researcher finds that teachers who accept "theory course combine with case method teaching" class, the score of professional knowledge is higher than "theory course combine with sample introduction" class.

Table 1

Result of Analyzing the Professional Knowledge Using Instructing Science Fair Worksheets

How to guide students to create subjects of their science fair project	Average scores of "theory course combine with sample introduction" class	Average scores of "theory course combine with case method teaching" class
1. How to develop proper subjects	3.9	4.4
2. How to collect literatures	4.0	4.3
3. How to guide students to construct research structure	3.7	4.3
4. How to design research hypothesis	3.6	4.3
5. How to arrange experimental procedures	3.5	4.4
6. How to control the variables of experiment	3.5	3.9
7. How to guide students to prepare oral presentation	3.6	4.6
8. How to write science fairs report	4.0	4.5

Exploring the difference of teachers' professional knowledge after accepting different instructing model. *How to develop proper subjects.* Teachers in "theory course combine with sample introduction" class think that the idea way of setting the science fair subjects is to extend it from science teaching materials, which can combine the regular curriculum and the science fair project and give consideration to both academic and extracurricular activities. But six of them worry about the lengthy discussion might consume valuable times and delay handing in the science fair report.

The case teaching film provides eight principles: (1) acquiring subjects from students' ideas; (2) deciding research orientations by literatures; (3) safety first; (4) considering the limits of space and time; (5) budget; (6) students' ability; (7) interesting and scientifically significant; and (8) converging and then spreading. All in-service teachers approved "converge and then spread" and were going to instruct students by this principle. During the class discussion, only eight (67.0%) agreed to acquire subjects from students' ideas, another four said: "In order to submit the report on time, we have to decide subjects for students. Before the lengthy discussion depletes our time".

How to collect literatures. According to the content and sample introduction in "theory course combine with sample introduction" class, three-quarters teachers find their science subject literatures on-line and analyze the literature for student to do the science fair literature discussion. The other quarters of teachers choose to let students surf on Internet for science fair literature by themselves, then discuss in class and turn the literature into useful information.

In teaching case film, the experienced teacher teaches students to ponder the key words of the topic and search literatures by them and then underline the key points of those literatures to dig out new key words. At the same time, by teamwork, both the theoretical basis and research orientation are more definite. After watching teaching case film, all in-service teachers agree the strategies performed in the film, and they are going to imitate that. All in-service teachers believe that experienced teachers' strategies are efficient, with other principles mentioned in case teaching film, such as collecting data from multiple sources and with different positions, selecting literatures according to credibility and prescription and corresponding to students' ability, it would be exhaustive.

How to guide students to construct research structure. In "theory course combine with sample introduction" class, all teachers introduce science fair based on the examples that had learn in class. They use conception map to arrange experimental procedures and think that using conception map is a great method, but teachers require to practice, otherwise, the effect might be reduced; conception map can also match and extend the teaching materials, suitable in both ways.

In teaching case film, the experienced teacher brings students to national science fair on summer vacation. Taking many awarded works as examples, he expounds how to construct research structure. Nine (75.0%) in-service teachers agree and are going to follow this strategy. Another three (25.0%) indicate that under current system, only school time and summer vacation can be used to inspect national science fair. And it is not feasible. First, a primary science fair team includes students from different classes, and it is hard to find an occasion without affecting regular course; Second, by schedule, science fair schemes must be submitted before May, so it is impossible to inspect national science fair on summer vacation.

Exploring Different Behaviors of Designing Primary Science Fair After Taking Different Instructing Models

"Theory course combine with sample introduction" class. When these elementary school teachers guide their students to make science fair project, teachers tend to probe into subjects which its cardinal principle seems readily comprehensible, but complicated in fact. In order to study rich in content, teachers extend the subject and make it huge. Without enough science literature discussion, these subjects became hard to complete its experimental operation after proposing science experiment or hard to achieve the purpose of the

experiment. Sum up 16 elementary school teachers' (four groups) deficiency and behaviors when guiding students to develop science fair product, researcher describes the concrete conditions in Table 2, in which "The demonstration is inadequately scientific proven" shows the most.

Table 2

Deficiency and Behaviors When "Theory Course Combine With Sample Introduction" Class's Teacher Designing Science Fair Products

Category of deficiency	Appear times	Behaviors feature's concrete description examples
1. Unclear about the basic theory of their science fair subject	9	Biology examples: Subject: Horrible fluorescent agent Investigate the impact of fluorescent agent to biological growth. Because the science literature isn't enough, lead to the final result of experiment cannot verify the impacts.
2. The demonstration is inadequately scientific proven	20	Chemistry examples: Subject: What can paper be When testing capillary phenomenon on different materials, should have quantitative the data, rather than just showing pictures.
3. Experiment variables were poorly controlled	10	Physics examples: Subject: Chimney effect When recording the temperature in experiment, moving the thermometer out of housing model might loss temperatures and make a large experiment error.
4. Verify facts which are already known	3	Applied science examples: Subject: Block sounds The children already know that the more barrier material sounds meet, sound insulation is better, which needs no proof again.

Table 3

Deficiency and Behaviors When "Theory Course Combine With Case Method Teaching" Class's Teacher Designing Science Fair Products

Missing classification	Appear times	Behaviors feature's concrete description examples
1. Unclear about the basic theory of their science fair subject	3	Physics examples: Subject: Lightning sports car—nozzles impair speed of the sports car A sports car with the nozzle, the other has not, cannot prove if the nozzle will affect the speed, without enough science literature.
2. The demonstration is inadequately scientific proven	9	Chemistry examples: Subject: Trouble gone—the natural hair dye studies The result of hair dye is affected by pH, should be designed to quantify the observations, just showing pictures.
3. Experiment variables were poorly controlled	5	Biology examples: Subject: The water overlord—damselflies life history Using "biological observation table" to record damselflies life history, because the recorded time intervals too much, cannot complete description effectively.
4. Verify facts which are already known	1	Applied science examples: Subject: Power out—the effective way of mixing two kinds of power The children already know that wind power generation is friendlier to environment, which no need to proof again.

"Theory course combine with case method teaching" class. When these teachers guide students to do science fair projects, they follow the guideline of "Finding a small title in big question first, then make a mountain out of a molehill". After teachers guide students to search for information on the internet by using keywords, use tables to plan their science experiment equipment, experiment records, and apply pictures or photos in their science fair report. But some deficiency also occurs in the process when 12 elementary teachers

guide their students. The example is shown in Table 3, in which “The demonstration is inadequately scientific proven” shows the most.

Conclusion and Suggestion

Conclusion

Elementary school teachers, attending the “theory course combine with sample introduction” course, guide their students to develop a science fair project. But most of them draw up their science fair guidance plan by following the sample description. Like subjects of the science fair project, although this topic is extending from the science courses that students have had learn, instead of letting students raise the topic, teachers tend to lay down it. Then, teachers search it on the Internet for scientific literature, draw a conception map or flow table of scientific research, handle the scientific experiment, and then teach students to be familiar with the content of science fairs project, in order to quickly complete the cross form the lessons.

The profession in-service teachers, learning from theory course with case method teaching, obtained “3G”: (1) guiding students to develop proper subject by “converge and then spread” and other seven principles; (2) guiding students to collect literatures by keywords; and (3) guiding students to construct research structure by inspecting science fair. In-service teachers agree that teaching case films provide them models to boost learning migration. Thus, professional knowledge would be promoted.

Both teachers who have accepted these courses had hiatus when guiding students to develop their product: (1) Teachers is inadequately comprehending the basic scientific theory of the topic of their science fair project; (2) Scientific verification is not scientificity; (3) Verify facts which are already known; and (4) Be careless about the control variable.

Suggestion

Sharing the case teaching films to more teachers should be helpful to promote teachers' professional knowledge.

Administrations at all levels should encourage teachers and students to inspect science fair, provide supports, and exclude the deadline problems.

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