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Qualitative Research on the Implementation of Inquiry-based Instruction

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Abstract: This research was conducted to understand how inquiry-based instruction can be implemented in vocational schools. The aim of this study was to provide (1) an understanding of teachers' ideas about teaching and an assessment of how their teaching experience will influence the implementation of inquiry-based instruction; (2) an analysis of factors that may influence the implementation of inquiry-based instruction; (3) suggestions for the future implementation of inquiry-based instruction.

Three teachers at vocational schools were interviewed to explore (1) their ideas about inquiry-based instruction and whether they anticipated adopting this approach; (2) their current teaching methods related to inquiry-based instruction (e.g., questioning or problem solving that promotes inquiry-based instruction); and (3) the effect of teaching materials and process on the effectiveness of inquiry-based instruction, the extent to which teachers were prepared for inquiry-based instruction, students' motivation for and attitudes toward learning, and students' academic abilities. The results of this research suggest that, in the future, experienced teachers should take the lead in inquiry-based instruction, with assistance from the school's administrative resources.

Key words: inquiry-based instruction, curriculum and instruction, qualitative research

1. Introduction

The rapid pace of technological and scientific advancement constitutes a megatrend that has come to dominate the training of workers for and the very nature of various enterprises. In this context, the educational aims of vocational education are not only to provide students with those skills that are currently needed for participation in the production sectors but also to train students to think so that they can succeed in the increasingly complex environments and the multiplicity of trends in which many enterprises operate.

The Republic of China's Ministry of Education issued the report "Reshaping Technological-Vocational Education, Section II" providing policies to facilitate the use of vocational education to help students acquire the skills required by various industries and to provide workers for high-tech sectors. The report addresses the use of flexible curricula, selection by substantial practices, the enhancement of pragmatic skills, and the reshaping of

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careers. Furthermore, the National Science Council of the Republic of China also proposed the High Scope Program in 2006 to help middle schools use newly developed technology to design curricula and adopt inquiry-based instruction. It encouraged students' self-motivated problem-solving, curiosity about science, and motivation to learn, and it established a learning model designed to facilitate student-initiated exploration and thinking (National Science Council of the Republic of China, 2013).

Considerable research has been conducted on inquiry-based instruction. For example, Marshall and Horton (2011) found that in both math and science classrooms, when teachers had students both explore concepts before explanations and contribute to the explanations, a higher percent of time was spent on exploration and students were more frequently involved at a higher cognitive level. Further, Marshall and Horton found a high positive correlation between the percent of time spent exploring concepts and the cognitive level of the students, and a negative correlation between the percent of time spent explaining concepts and the cognitive level. Powell-Mpmen and Brown-Schild (2011) investigated the impact of a two-year professional development program on teacher self-efficacy for inquiry-based instruction, and suggested increases in self-efficacy for inquiry-based instruction and greater focus by the teachers on the depth of content after completing the program. Pea (2012) conducted a larger study on teachers' beliefs about science teaching, one component looks at how school environmental context factors influence inquiry-based science instruction. This research showed that three broad categories of school environmental factors (human, sociocultural, design) impact inquiry-based teaching in some way.

In addition, Gormally, Brickman, Hallar, and Armstrong (2011) described their experience of developing and implementing an inquiry-based biology laboratory curriculum and believed that instructors new to inquiry-based instruction can anticipate changes to teacher and student roles, a shift that may be supported with instructor training and awareness of common student reactions. Pilitsis and Duncan (2012) suggested that teachers' beliefs are linked to the use of inquiry-based instruction. They believed that holding a constructivist belief are more likely to engage in student-centered activities in the classroom. Olde, Jong, and Gijlers (2013) compared learning from designing instruction in the context of simulation-based inquiry learning with learning from expository teaching. The result of this study showed that, in one class, students who learned by designing assignments performed significantly better on test items measuring conceptual knowledge than students who learned from traditional instruction.

In this study, we interviewed teachers who had engaged in inquiry-based instruction to understand whether their teaching philosophy and their experiences with inquiry-based instruction affected their implementation of that approach, to further explore the factors affecting the implementation of inquiry-based instruction, and to develop suggestions for the future.

2. Research Design and Implementation

2.1 Method

This research used a qualitative design involving semi-structured interviews. This approach was based on extant literature in the field and on practical needs.

2.2 Participants

Participants were selected via purposive sampling, and all participants provided consent prior to being

interviewed. Three participants were selected after being asked to participate by their supervisors. The purpose and process of this research were explained in detail to the participants.

Two males and one female participated in this study. All had earned bachelor degrees and were qualified as middle school teachers. They had an average of 11 years of teaching experience, and their average age was 38.3 years. Information about the participants is presented in Table 1.

Table 1 Basic Information about Participants

Code	Sex	Age	Qualified teacher	Administrative experience	Education	Years of teaching
T1	Female	Older than 30	Yes	No	University	3
T2	Male	Older than 30	Yes	Yes	University	3
T3	Male	Older than 50	Yes	Yes	University	28

2.3 Data Analysis

Recordings of the interviews were transcribed, analyzed, and coded. For example, T1-15 represents the fifteenth sentence of the interview with Teacher 1. The content of each transcript was analyzed according to the structure of the interview outline to identify themes.

2.4 Context

This research was conducted at a public vocational school in a remote region of Taiwan. The school had been operating for almost 50 years with the aim of training local students in practical skills. The rapid development of information technology led the teachers to acknowledge the need to change the curriculum and their teaching methods and to provide a different kind of teaching environment in the future.

This school is subsidized by the National Science Council (NSC) High Scope Project; the 14 teachers involved in this project will conduct experiments in inquiry-based instruction and assess the progress of the project in the fields of electrical engineering, electronics, and information technology. Inquiry-based instruction will be adopted in practical courses that cover theory and practice, including robotics, Internet design, and electrical machinery.

This project focuses on how students use inquiry-based instruction to learn. In implementing this approach, teachers are asked to design questions that will motivate and encourage students to find their own answers by sharing and exploring possible answers through group discussions. Inquiry-based instruction provides students with a genuine learning experience, which they can take with them when they leave school to help them to face the demands and challenges encountered in their future careers.

Because inquiry-based instruction changes the nature of the curriculum and of teaching, it presents a challenge to teachers, and participation in the “Teachers’ Professional Development Community” allows teachers to learn about the philosophy of inquiry-based instruction. After teachers understand and accept this philosophy, they can begin to develop new curricula, teaching materials, and equipment. Finally, teachers will be able establish a new curriculum for inquiry-based instruction based on teaching experience, feedback, discussion, and revisions. This research was conducted to determine the psychological changes experienced by these teachers as they participated in this training.

2.5 Research Instruments

2.5.1 Researcher

The researcher was trained in and has experience with qualitative research techniques. The researcher and a

colleague developed the interview outlines, conducted the interviews, and transcribed the recordings. We then analyzed the data obtained from the interviews through in-depth discussions.

2.5.2 Interview Guide

The semi-structured outline used to guide the interviews addressed the following four subjects: (1) the extent to which the pedagogical philosophy of the teachers who implemented inquiry-based instruction was consistent with the values and meaning of this approach; (2) teachers' experience with inquiry-based instruction and their expectations of what students would bring to this process; (3) teachers' opinions of the factors that influence the results of inquiry-based instruction; and (4) suggestions for the future development of inquiry-based instruction.

3. Results and Discussion

3.1 Results

3.1.1 Teachers identified with the values and meaning of inquiry-based instruction and were willing to implement it.

(a) Most teachers at the vocational school agreed with the values and meaning of inquiry-based instruction and were willing to adopt it.

> I am willing to try it because the High Scope Project wants to develop students' abilities for exploration and problem solving. (T1-65)
> The implementation of inquiry-based instruction will increase the workload, but we will manage if it is necessary. (T1-192)(T2-52)

(b) Most teachers recognized the value of implementing inquiry-based instruction. They agreed that developing the ability to find solutions and solve problems was important for the careers and future lives of students.

> I think it is very important that the vocational school students learn to work out problems; given enough time, they will be able to deal with problems whether in class or at work. (T1-85) (T1-90)
> I think the integration of new technologies and courses (inquiry-based instruction) should be promoted. (T3-121)

(c) Teachers were ready to implement inquiry-based instruction. They all wanted to learn new teaching methods and skills and were also willing to share their experiences.

> I want to improve my teaching by learning from other teachers' experiences. (T1-265)
> I want to learn other teachers' methods for improving students' grades and increasing their motivation to learn. (T2-270)

3.1.2 In general, teachers wanted to adopt the methods related to inquiry-based instruction, such as questioning and problem solving. They thought that students would also accept this method.

(a) Most teachers asked questions to teach problem-solving skills, and fewer discussions occurred.

> In our current teaching, we ask questions and require answers, but not in a full inquiry-based way. (T2-101)
> I think in-class discussion is a relatively ineffective approach to teaching. (T3-113)

(b) In the past, teachers usually adopted a problem-based approach that focused on skills.

> I often ask students to think about and consider future problems. (T1-100)
> I also ask them, "Why was the water pumped out when I pushed the button? Why did it stop when I pushed

the button again? How will the water stop when I push the button?" (T2-110)

(c) Teachers also thought that most students would accept inquiry-based instruction, but they also expressed concerns about this approach to teaching.

About 70% to 80% of students will probably like inquiry-based instruction. Not every student will accept it. (T1-210)
Most of them will accept inquiry-based instruction. (T2-170)
I think we can try it, and students will be fine with it. (T3-95)

(d) Teachers thought that inquiry-based instruction would be more effective in practical courses.

I think it's easier to inspire and guide students in practical courses. (T1-60)
In the practical courses, students are more motivated when they face problems, and thus inquiry-based instruction is more effective. (T2-75)
In the practical courses (e.g., interior wiring), we just give a circuit diagram to students and let them figure out how it works. They try to solve the problem and give you the answer. (T3-130)
When students cannot finish the project, teachers ask student to check their circuit diagrams to find out whether they made a mistake in wiring. (T3-140)

3.1.3 The effectiveness of inquiry-based instruction will be influenced by teaching materials and teaching process, teachers' preparation, students' motivation for and attitudes toward learning, and students' academic abilities.

(a) Teaching materials and processes will influence the implementation of inquiry-based instruction.

I think the subject is very important for the implementation of inquiry-based instruction. For example, we can give examples from real life in a theory course to guide students and make them think. (T1-62)
Inquiry-based instruction cannot be applied during the entire semester. It would be more effective if it were applied for two-thirds of the semester. (T2-120)

(b) Teachers who want to implement inquiry-based instruction should acquire knowledge about inquiry-based instruction, be able to implement it, and be fully prepared before teaching begins.

Teachers are not ignorant about the philosophy of inquiry-based instruction, but they lack confidence about its actual implementation. (T2-83)
I had some understanding of what was required after I saw the activities designed for inquiry-based instruction, but it would have been better if I had seen a practical demonstration. (T3-90)

(c) Students' motivation for and attitudes toward learning were mentioned as important influences on the implementation of inquiry-based instruction.

Teachers in a vocational school may encounter difficulties with students' attitudes when implementing inquiry-based instruction. It might not work for passive students. (T1-160)
It is very difficult to teach students who are passive and lack motivation for learning. (T2-220)

(d) The location of the school and the learning abilities of students were also identified as factors that affect the implementation of inquiry-based instruction.

Students from our school (in a remote area) are passive and lazy because there is not enough competition here. It is difficult to promote inquiry-based instruction. (T1-2) (T1-9)
Students from this school do not apply themselves to learning. They stop listening if they do not understand. This will also be the case with inquiry-based instruction. (T2-113)

3.1.4 Research suggests that, in the future, an experienced teacher should lead inquiry-based instruction, with assistance from the school's administrative resources.

(a) To achieve the best results, the teacher must be passionate and have experience in teaching to lead students via progressive questioning and guidance.

> It would be better if the Chair of the department were familiar and had experience with inquiry-based instruction because the Chair knows the most about the curriculum and the faculty. (T1-20)
> Ask good questions. For example, "The basic science of electricity includes different measurements of voltage. What are the differences between them? How do you get 110 V and 220 V of electricity?" Do not ask difficult questions that students do not want to answer. (T2-240)

(b) Access to administrative resources (e.g., funds, teaching materials, and equipment) will influence the effectiveness of inquiry-based instruction. This was an important consideration related to the implementation of inquiry-based instruction.

> More materials would be required for experiments in classes based on inquiry-based instruction (e.g., plastic tubes for wiring) than in normal classes. Hence, it would require a larger budget. The administrators of the school would need to understand this and support it. (T1-250)
> Teaching materials, equipment, plans, and other resources are all necessary for the implementation of inquiry-based instruction, and the school administration needs to be fully supportive in supplying these. (T2-260)

3.2 Discussion

This study established that teachers' ideas about teaching are very important. Those who recognize the value of inquiry-based instruction will be more likely to adopt this approach than will those who are less convinced of its effectiveness. This finding consistent with that by Pilitsis and Duncan (2012), who reported that teachers who supported a constructivist approach were more likely to implement inquiry-based instruction.

Moreover, this research also established that guidance from teachers with experience related to inquiry-based instruction will be helpful in the implementation of this approach. This is consistent with Power-Moman and Brown-Schild (2011), who believed that teachers should improve their self-efficacy related to the implementation of inquiry-based instruction. Such improvement depends on teachers' professional development and underscores the importance of such development, including guidance from teachers with experience related to inquiry-based instruction.

Finally, this research established that the effectiveness of inquiry-based instruction is influenced by the quality of the teaching materials, the teaching process, teachers' preparation for inquiry-based instruction, students' motivation for and attitudes toward learning, and students' academic ability. This finding generally matches that reported by Pea (2012), who argued that the school environment, including human and sociocultural factors, influences the implementation of inquiry-based instruction. The human environment includes students' motivation for learning, support from mentor teachers, and students' participation. The sociocultural environment includes support from the school, lesson plans designed by the teaching faculty, and community participation. Various factors influence the effectiveness of inquiry-based instruction, and the school must consider all elements in the environment in efforts to facilitate the implementation of inquiry-based instruction.

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