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# What is Value of Reform-oriented in-service Teacher Development Attempts on Inquiry Teaching for Pedagogically Discontented Science Teachers? An Expectancy-value Perspective

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**Abstract**

In this study we investigated the value of reform-oriented in-service teacher development attempts about inquiry-based teaching, focusing on those teachers that experience some degree of pedagogical discontentment. For this purpose we used case study approach to research the problem in detail and we purposively selected three science teachers who experienced moderate level pedagogical discontentment. Six means of data collection were employed; four questionnaires and two interviews. Inductive qualitative data analysis and cross-case analysis were employed. The findings showed two of the participants found graduate coursework as effective, useful, interesting, important and cost-effective (effort and time) for improving teaching ability regarding inquiry-based teaching. However one of the participants suggested the Scientific and Technological Research Council of Turkey programs as effective, interesting and useful attempts. For cost factor the participants underlined importance of long-term benefits of these attempts. One of the cases stated that scientific education congress, introduction meetings, on-line portals of Ministry of Education and written documents are cost-effective, but such efforts are not effective in engaging teachers in considering inquiry.

**Keywords**

Value of reform-oriented attempts
Pedagogical discontentment
Inquiry-based teaching
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## Introduction

Turkish policy makers are invested in improving the educational system in Turkey, and so Turkey is one of the many countries conducting educational reform evaluations. Its population and individuals in compulsory education pool represents substantial variety in terms of cultural background, socio-economic status, race and family educational background. Moreover approximately a quarter of the population includes elementary and secondary school students. Turkish Ministry of Education (MoE) is charged of increasing learning quality of such a great number of students. The ministry has made different efforts for increasing the quality such as incorporation of educational technology (Kurt, 2014) and revising curricula (Çalık & Ayas, 2008). Its young population, fast grown rate, and reform-oriented attempts emphasize the importance of Turkish educational reform attempts.

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In spite of the reform-oriented attempts, national and international student evaluation results point to the difficulty that Turkish students have in terms of learning science (Berberoğlu & Kalender, 2005; Martin, Mullis, Foy, & Stanco, 2012). For instance; Turkish science education curricula has been changed for seven times in 1968, 1974, 1977, 1992, 2000, 2005, and 2013. Despite these efforts, Turkish elementary level students do not perform well in TIMSS (Trends in International Mathematics and Science Study) and science section of national examination (Bursal, 2013; Martin et al., 2012). One of the most eminent factors in increasing science achievement is to change quality of instruction. Inquiry based science instruction is often suggested as an effective approach to science teaching and is the strategy most often highlighted in international reform documents (Akerson & Hanuscin, 2007; Dietz & Davis, 2009; Howes, Lim, & Campos, 2009; The Next Generation Science Standards [NGSS], 2014; Ministry of National Education [MoE], 2006). Inquiry-based instruction involves enabling students to identify a problem; to collect data; to interpret data; to develop alternative interpretations; to represent findings, and to verify findings (Wheeler & Bell, 2012). Inquiry based science teaching is defined as *engaging students in instruction that parallels the work of scientists* (Capps & Crawford, 2013, p. 3).

A wealth of literature speaks to the effectiveness of inquiry-based science instruction in improving science achievement. Jackson and Ash (2012) have made a three-year study by changing instruction to improve science achievement, their way of inquiry-based science teaching applied by science teachers has improved the achievement of students. In a meta-analysis study, Furtak, Seidel, Iverson, and Briggs (2012) have also supported the idea that applying inquiry-based instruction improves science achievement of students. Other researchers go further and describe that inquiry-based science instruction supports students in attaining higher-order objectives such as scientific literacy (Hodson, 1992) and conceptual understanding (Kock, Taconis, Bolhuis, & Gravemeijer, 2013; Luft, 2001; Minner, Levy, & Century, 2010).

In spite of potential in implementing inquiry based science teaching to the goals of reform efforts, science teachers do not often use inquiry based teaching in their lessons (Anderson, 2002; Capps & Crawford, 2013). The reasons for low rate of implementing inquiry-based teaching are lack of time, class size (Anderson & Helms, 2001; Luera & Otto, 2005), lack of views of inquiry based science teaching (Capps & Crawford, 2013), lack of pedagogical skills (Anderson, 2007) and conflicts between standards and real classroom conditions (Anderson & Helms, 2001). In a piece of research that nicely summarizes much of the previous efforts, Özel and Luft (2013) studied teachers' conceptualizations and enactment of inquiry in beginning science teachers. Their findings suggest that beginning science teachers have not been using essential features of inquiry-based science instruction such as making explanation based on evidence, connecting findings to knowledge, communicating explanation and also they have mostly preferred teacher-centered instruction. Inquiry-based teaching is also not used frequently by Turkish science teachers (Atıcı & Bora, 2004). Atıcı and Bora (2004) found that the science teachers mostly prefer "lecture", "question-answer" and "demonstration" rather than using inquiry-based teaching. Reform in science teaching requires change in teaching ordinary inefficient methods such as knowledge transferring and inefficient lectures, inquiry-based teaching provides processes in line with reform-minded teaching (Shaver, Cuevas, Lee, & Avalos, 2007).

Reform-minded instruction requires that teachers move away from "giving" students scientific knowledge through lectures, such teaching requires that we attend to teachers' thinking (Woodbury & Gess-Newsome, 2002). Saka, Southerland, Kittleson, and Hutner (2013) defined "reform-mindedness" as thinking and making instructional practices in line with tenets of reform. Southerland, Sowell, and Enderle (2011) recommended conceptual change process for changing science teachers' thinking and instructional practices in line with the tenets of reform. However, conceptual change theory would suggest that dissatisfaction is a precursor for any conceptual change process (Gregoire, 2003; Strike &

Posner, 1992). Indeed, Gregoire (2003) suggested that teachers might not even attend messages of reforms without pedagogical dissatisfaction. Southerland et al. (2011) classified resources of the dissatisfaction into two different groups: *pedagogical* and *contextual*. Pedagogical dissatisfaction is different from contextual dissatisfaction including teachers' assessment of his or her work's external aspects such as management support and physical appearance of classroom (Southerland et al., 2011). Pedagogical dissatisfaction includes internal aspects of teacher's affective state about teaching and teaching practice (Southerland, Sowell, Blanchard, & Granger, 2011). In this study, pedagogical dissatisfaction is in focus due to its importance in adopting reform standards and implementing reform based teaching.

Southerland et al. (2011) preferred to use "*discontentment*" term for dissatisfaction to distinguish explicitly pedagogical dissatisfaction from job or contextual dissatisfaction. Southerland et al. (2011) defined pedagogical discontentment as "*internal, personal assessment of the degree to which a teachers' practices meets the teacher's teaching goals, and it is this assessment and a teacher's reaction to it that influences their decision to participate in the reform of some aspect of her teaching. Pedagogical discontentment is a teacher's affective response to her evaluation of the effectiveness of her existing science teaching practices and goals (p.304)*". Empirical findings of Saka, Southerland, and Golden (2009) showed that high degree of pedagogical discontentment is necessary for reform-minded teaching practice. But exceeding a certain level of pedagogical discontentment might result in teacher burnout (Haberman, 1991). The main question in level of pedagogical discontentment as it relates to teacher professional development is "what is the required level of pedagogical discontentment for evoking reform-oriented practice?". For answering this question, there is a need to determine pedagogical discontentment levels of teacher and then to have teachers notice their discontentment, to provide opportunity to practice on both ordinary instruction and standard reform-oriented instruction, and finally to observe their real instruction. Conceptual change for pedagogical practice in line with reform standards is not finished until teachers have meaningfully represented change in their practice (Lee, Cawthon, & Dawson, 2013). Therefore the relationship between pedagogical discontentment level and making reform oriented practice should be investigated to provide conceptual change in science instruction towards inquiry-based science instruction.

In an attempt to better describe science teachers' pedagogical discontentment, Sowell and Southerland (2006) reported common areas of pedagogical discontentment that the ability to teach science to all students, science content knowledge, balance between depth and breadth of instruction, assessing science learning and implementing inquiry based science teaching. As seen in the areas implementing inquiry based science instruction is an important area for both pedagogical discontentment and reform standards. However inquiry based science teaching is not common among science teachers (Anderson, 2002; Capps & Crawford, 2013). To better understand the use of inquiry by science teachers, a number of studies have been conducted (Capps & Crawford, 2013; Dixon & Wilke, 2007; Grigg, Kelly, Gamoran, & Borman, 2013; Grove, Dixon, & Pop, 2009; Sandholtz & Ringstaff, 2013). But this past work has generally focused on professional development programs to increase inquiry based practice of prospective or in-service science teachers. However, we suggest that the value of reform-oriented in-service science teacher development should also be questioned.

Recognizing the value of a knowledge claim is a pre-requirement to acting on it. One of the most studied models explaining value component of motivation; expectancy-value model that see the individual as an active and rational decision maker presents a good reflective model for explaining the motivational situation of individuals who have been gaining, using and constructing knowledge for their daily lives by themselves (Pintrich & Schunk, 2002). The model states that individuals' choice, persistence and performance can be explained by their beliefs about how well they do task and how

much they value task. The model claims that expectancies and values influence directly achievement choices, performance, effort and persistence (Wigfield & Eccles, 2000). In many studies, task value component of the model was showed to be positively correlated with the other important motivational constructs such as self-efficacy, intrinsic motivation, extrinsic motivation, and control of learning beliefs (Bong, 2001; Douglas, 2006; Pintrich, 1999; Pintrich & De Groot, 1990). The correlational evidence gathered by these studies has been supporting the importance of "task value" component of the model over motivational forces which can initiate and provide action on task. Wigfield and Eccles explained that the most studied subcomponents of the "task value" were "importance", "utility", "interest" (intrinsic value) and cost(Wigfield & Eccles, 1992, 2000). They described the "importance" as the importance of doing well on a given task, "utility" as a degree of how a given task fit into an individual's future plans and "interest" as the enjoyment one gets from doing a given task. Cost subcomponent refers limitations about accessing to other activities, amount of effort required for completing an activity, and related emotional cost. The model provides an important frame for better understanding value of reform-oriented attempts about inquiry-based science teaching.

***Research Question***

Thomson (2013) has studied on value of a professional development program oriented toward science education reform. In his interviews with 20 elementary teachers he found that professional developments were not recognized by the teachers as valuable learning opportunities. Thomson and Gregory (2013) have investigated beliefs of three public elementary school teachers about US science education reform. Their study has shown that motivational readiness is a factor in adopting science education reform. Indeed, it is recognized that simply widening repertoire of science teaching activities is not effective in supporting science education reform thus reformers should also be aware about emotional and cognitive readiness of science teachers to learn from reform-oriented teacher development programs (Southerland, Rose, & Blanchard, 2009). Science teachers' interpretations and adoption of new curriculum materials are shaped by their background, knowledge and skills (Miller & Krumhansl, 2009). Motivational readiness of science teachers in terms of reform's value is another background feature for adaption of a new reform-oriented attempt. By determining the value Turkish science teachers place on inquiry-based science instruction, we can decide about meaning of a reform-oriented attempt focusing on inquiry-based science instruction in terms of science teachers. *Hence the research question of this study is that "What is value of reform-oriented in-service teacher development efforts on inquiry teaching for pedagogically discontented science teachers?". Following sub-questions were also investigated in the study.*

1. How are opinions of the *pedagogically discontented* science teachers on pedagogical discontentment regarding inquiry-based science teaching?
2. How are previous experiences and knowledge of the *pedagogically discontented* science teachers on inquiry-based science teaching?
3. How are values and effectiveness of the different reform-oriented teacher development attempts on improving teaching ability for inquiry-based teaching and on decreasing pedagogical discontentment?

## Method

In this study a qualitative, holistic multiple-case study approach was used (Yin, 2009). Holistic multiple-case study involves *inquiry that focuses on cases more than one and has one unit of analysis* (Yin, 2009, pp. 46-47). Holistic multiple-case study was used to get detailed knowledge about the problem of the study by collection data from different sources. By holistic method depth of the data and collection of first-hand data can easily be provided to form a whole picture of the problem. Participants in this research were purposefully selected from a group of 19 science education Ph.D. students that had knowledge about inquiry-based teaching. The group was composed of 10 females and 9 males, their teaching experiences ranged from 1 to 8 years in public schools. They were making their PhD in a middle-scale university in east of Turkey. All of them were investigated for determining their pedagogical discontentment levels. Then purposive sampling was used to reach moderately discontent teachers, since they did not have preventive discontentment level (high or low) to apply inquiry based teaching. We purposively selected only the participants having moderate level pedagogical discontentment. Saka et al. (2009) showed that moderate level of pedagogical discontentment is necessary for reform-minded teaching practice. Since exceeding a certain level of pedagogical discontentment might result in teacher burnout (Haberman, 1991). Low level of pedagogical discontentment is a sign of being comfortable with the teaching and it is not expected in reform studies. Also the participants are PhD students and they have more knowledge about inquiry-based teaching in detail than ordinary science teachers so they are the most representative group for evaluating reform attempts about inquiry-based teaching. From this wider group, those that experienced some degree of pedagogical discontentment were selected for further study. In table 1, descriptive characteristics of participants are represented.

**Table 1.** Descriptive Characteristics Of Participant Science Teachers

| Teacher No | Gender | Age | Teaching Experience (Year) | Discontentment Situations (High, Moderate, Low) |
|---|---|---|---|---|
| 1 (GZ) | Female | 28 | 5 | Discontented (Moderate) |
| 2 (GL) | Female | 25 | 1 | Discontented (Moderate) |
| 3 (ES) | Female | 26 | 1 | Discontented (Moderate) |

### *Study Context*

Inquiry-based science teaching is seen as a way to teach higher-order thinking skills in Turkish education system (MoE, 2013; Akpullukcu & Günay, 2013). Inquiry-based science teaching is a required strategy to teach science to Turkish middle school students. Moreover the science curriculum involves example activities of inquiry-based teaching for the teachers (MoE, 2013). In line with this emphasis on inquiry-based science teaching, pre-service science teaching programs also involve inquiry-based science teaching applications in both laboratory courses and science teaching courses. However science teachers mostly preferred to use "lecture", "question-answer" and "demonstration" (Atıcı & Bora, 2004). For changing the teaching ways different reform services such as introduction meetings, on-line portals of Ministry of Education, in-service training and written documents have been provided.

### *Reflexivity*

The lead researcher in this work is an associate professor (33 years-old, male) in the field of science education in which he has been actively researching and teaching for 10 years; however, the study subject in this research was a new area for him. Indeed, the methodology employed in this work was new to him and his past work has largely focused on using quantitative methods, so in this work

he actively worked against any bias to evaluate problems by using numbers. For overcoming this bias he brought in an expert from the field of qualitative study.

***Data Collection***

In the study three different aspects of the research question required three different data collection processes. The three aspects included knowing about pedagogical discontentment levels of the participants, knowing about their information about inquiry-based science teaching and knowing about their value perceptions about different in-service teacher development attempts for helping decrease their pedagogical discontentment and professional development towards the reform. Before applying data collection processes focusing on the three aspects, we used a questionnaire named as *Previous experience questionnaire for inquiry-based science teaching and reform-oriented teacher development attempts(PEQ)* to determine previous experiences about inquiry-based science teaching and reform-oriented teacher development attempts. The questionnaire was prepared by asking the two experts in educational research about its appropriateness to the purpose and sufficiency of its content.

For the first aspect, four open-ended questions (*Questionnaire for pedagogical discontentment regarding inquiry-based science teaching, QFPD*) were asked to the participants for determining their pedagogical discontentment situations in applying inquiry-based science teaching. The questions were: "*What is your opinion on your pedagogical discontentment level for preparing your students for new learner roles required in inquiry-based science teaching?*", "*What is your opinion on your pedagogical discontentment level for applying inquiry-based science teaching to all course subjects?*", "*What is your opinion on your pedagogical discontentment level for assessing your students' understanding in inquiry-based science teaching?*", "*What is your opinion on your pedagogical discontentment level for planning inquiry-based science teaching activities effectively?*", The questions were based on four aspects of pedagogical discontentment model of Southerland et al. (2011). After collecting preliminary data by open-ended questions, on-line follow-up semi-structured interviews (IFPD) were done. In the interviews we asked about lack parts in the answers to open-ended questions, so the interview questions were based on the answers to open-ended questions. The interview questions were: "*How do differences in your students' educational backgrounds affect your pedagogical discontentment level in preparing your students for new learner roles required in inquiry-based science teaching?*" "*How do differences in your students' personalities affect your pedagogical discontentment level in preparing your students for new learner roles required in inquiry-based science teaching?*", "*How does your need to apply inquiry-based teaching to all lessons affect your pedagogical discontentment level in applying inquiry-based science teaching*", "*How does your need to evaluate understanding in inquiry-based teaching to all lessons affect your pedagogical discontentment level in applying inquiry-based science teaching?*", "*How does your giving long time to plan inquiry-based teaching affect your pedagogical discontentment level in inquiry-based science teaching?*" and "*How does complicated nature of planning on inquiry-based teaching affect your pedagogical discontentment level in inquiry-based science teaching?*". Time for the interviews changed from 35 min. to 50 min. The questions were asked by on-line approach in the office of one of the researchers.

For the second aspect, one open-ended question was asked to the participants that "*Could you describe inquiry-based teaching?(QFDI)*". Then we prepared a scenario describing use of ordinary teaching process by a teacher despite of higher-order objectives requiring inquiry-based science teaching and we asked two questions (SBQ) based on this scenario: "*Is there any difference between teaching process represented in the scenario and inquiry-based teaching? Could you explain it with examples?*" and "*What process do you suggest to the teacher for making the process inquiry-based teaching?*". The scenario is represented below.

*Teaching Process Scenario*

*Subject: Diffusion*

*Time: 40 min.(For one lesson)*

*Objectives:*

**Designing an experiment about diffusion*

**Conducting an experiment about diffusion*

**Reporting and representing findings of an experiment about diffusion*

*Teaching Process:*

*At the beginning of the lesson, the teacher enters to the class and says good morning to everybody. Then students also give answer to the teachers' salutation. The students sit on desks for two students and desks are put in an order. Whole class involves 40 students. First of all the teacher checks attendance and then he/she asks the question; "what is diffusion?". The teacher listens answers of two students. Then he/she draws a cell shape on the blackboard and uses two different colors to show different sides of cell membrane. In one side water is in high concentration while salt is in higher concentration in the other side. After the drawing the teacher explains features of cell membrane and defines diffusion by using the drawing. The teacher also mentions about daily life examples of diffusion (e.g. salting cucumber and observing water exit). Then the teacher asks questions about the subject to the students for gathering information about learning level of students. After the checking learning levels, the teacher gets students to write about important concepts and processes of diffusion. At the end of the lesson, he/she summarizes the subject and gives homework to the students.*

By this scenario the participants' knowledge about inquiry-based science teaching was examined in detail. Since only asking about definition of inquiry-based teaching might not give insight into understandings of the participants about process of inquiry-based teaching. Therefore we decided to use *Scenario-based Questionnaire for Inquiry-based Teaching*. Similar to the previous experience questionnaire, the questionnaire was prepared by asking the two experts in educational research about its appropriateness to the purpose and sufficiency of its content

For the third aspect, we used open-ended questions (*Questionnaire for value of reform attempts, QVRA*) focusing four aspects of expectancy-value model of motivation: importance, interest, utility and cost (Knekta & Eklöf, 2015). First, we asked about the participants' *general ideas on effectiveness or ineffectiveness of different teacher development attempts* towards inquiry-based teaching. In Turkey the most frequently used attempts for teacher development in line with educational reforms emphasizing inquiry-based teaching are term seminars, master or doctorate level courses, conferences, TUBITAK (The Scientific and Technological Research Council of Turkey) teacher development programs, Teacher portal applications of Ministry of Education (MoE), Congresses of Educational Sciences, Briefings by Staff of MoE, Curriculum introduction meetings and Providing a written copy of curriculum. After taking the general ideas about the attempts, we made on-line structured interviews (*IVRA*) with the participants. The questions in the interview were; "*Could you explain your ideas on importance of the following teacher development attempts for improving your ability to apply inquiry-based science teaching?"* , "*Could you explain your ideas on your interest regarding the following teacher development attempts for improving your ability to apply inquiry-based science teaching?"*, "*Could you explain your ideas on utility of the following teacher development attempts for improving your ability to apply inquiry-based science teaching?" and "Could you explain your ideas on costs of the following teacher development attempts for improving your ability to apply inquiry-based science teaching?".* In these questions we focused four aspects of expectancy-value model of motivation to participate in these activities.

***Data Analysis and Rigor***

For the data analysis, inductive qualitative data analysis was used (Elliott & Gillie, 1998, p. 331; Jain & Ogden, 1999, p. 1597; Hoepfl, 1997). The process of analysis can be seen in figure 1. First all raw data were transferred into papers verbatim and organized for reading. Then all raw data were read three times by a researcher and coding frame based on the three focuses (pedagogical discontentment, knowledge about inquiry-based teaching and value of reform attempts) of the study was developed. Then open coding was used to find preliminary codes for further analysis. During the processes of analysis some codes were added and excluded (eg. purpose of inquiry-based teaching) from the frame. After the initial emerging codes, the relationships among codes were examined by axial coding and finally themes were set by examining categories established on the relationships among codes (see table 2). All of the analysis was done by a researcher. At the final stage of analysis cross-case analysis was done by comparing three participants in terms of the categories of this study. In cross-case analysis, similarities and differences among the cases were determined and reported (McClintock, O'Brien, & Jiang, 2005).

Rigor in the analysis was assured through the use of member checking to ensure that the assertions drawn from the participant's interviews were sound (Rager, 2005). To the use of multiple methods of data collection allowed for triangulation of the research findings.

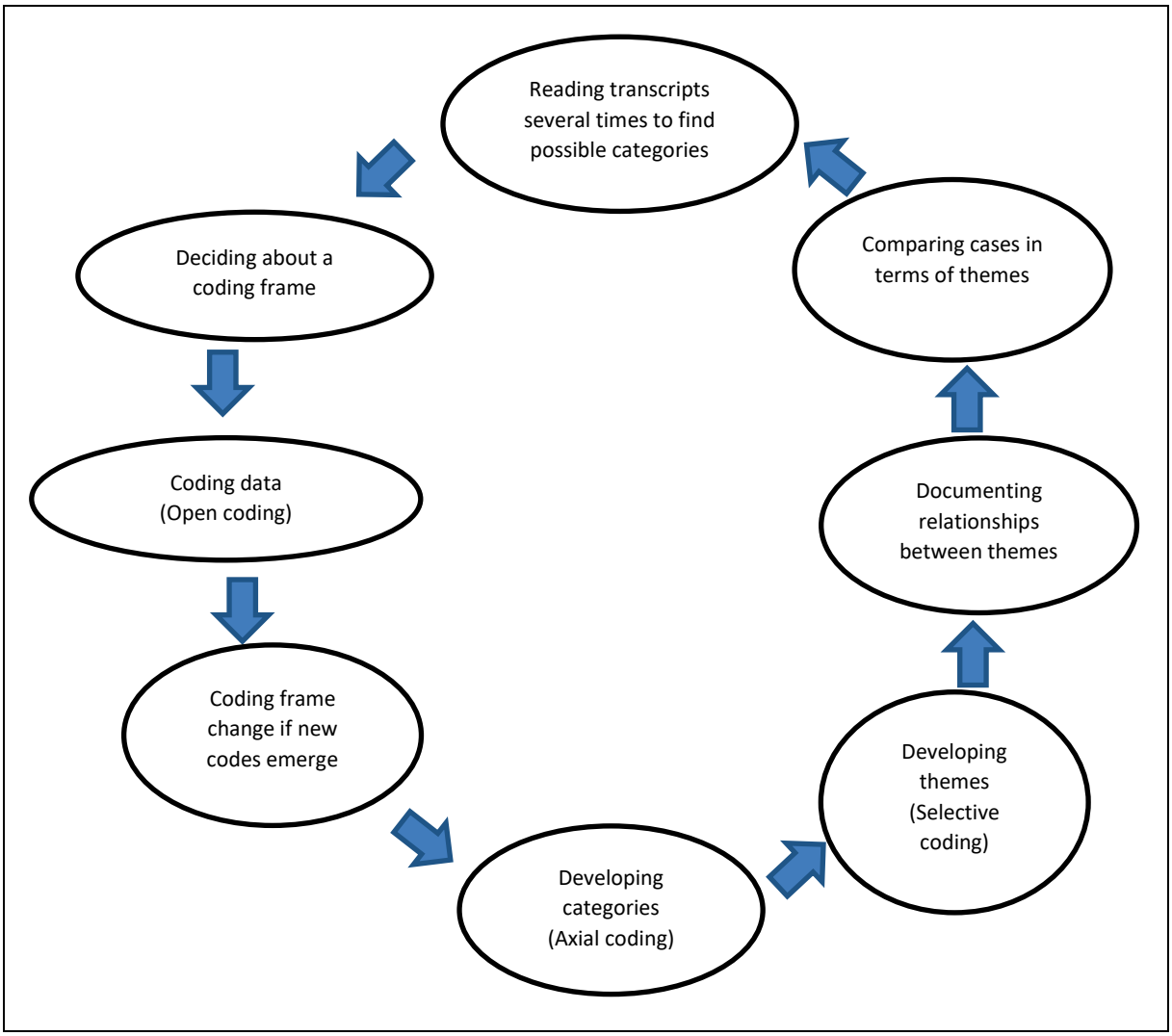


**Figure 1.** Illustration of Inductive Data Analysis Procedure (Elliott & Gillie, 1998, p. 331; Jain & Ogden, 1999, p. 1597; Hoepfl, 1997)

**Table 2.** Codes and Categories Emerged in the Analysis of Data

| Initial Codes (Open Coding) | Categories (Axial Coding) | Research Questions (Themes) |
|---|---|---|
| Level of pedagogical discontentment about preparing students for new learner roles in inquiry-based teaching | Pedagogical discontentment about preparing students for new learner roles in inquiry-based science teaching | How are situations of the cases on pedagogical discontentment regarding inquiry-based science teaching? |
| Reasons of pedagogical discontentment about preparing students for new learner roles in inquiry-based teaching | | |
| Effects of differences in students' educational backgrounds on pedagogical discontentment about preparing students for new learner roles in inquiry-based teaching | | |
| Effects of students' individual differences on pedagogical discontentment preparing students for new learner roles in inquiry-based teaching | | |
| Level of pedagogical discontentment about inquiry-based teaching in applying it to all lessons | Pedagogical discontentment about applying inquiry-based science teaching to all subjects | |
| Reasons of pedagogical discontentment about inquiry-based teaching in applying it to all lessons | | |
| Effects of being in need of applying inquiry-based teaching to all lessons on pedagogical discontentment about inquiry-based teaching | | |
| Level of pedagogical discontentment about inquiry-based teaching when evaluating understanding | Pedagogical discontentment about assessing students' understanding in inquiry-based science teaching | |
| Reasons of pedagogical discontentment about inquiry-based teaching when evaluating understanding. | | |
| Effects of being in need of evaluating understanding on pedagogical discontentment about inquiry-based teaching | | |
| Level of pedagogical discontentment about planning inquiry-based teaching activities | Pedagogical discontentment about planning inquiry-based science teaching activities | |
| Reasons of pedagogical discontentment about planning inquiry-based teaching activities | | |
| Effects of being in need of making teaching plans requiring long time on pedagogical discontentment about inquiry-based teaching activities | | |
| Effects of being in need of making complex teaching plans on pedagogical discontentment about inquiry-based teaching activities | | |
| Definition of inquiry-based teaching | Definition and features of inquiry-based teaching | How are previous experiences and knowledge of the cases on inquiry-based science teaching? |
| Components and process of inquiry-based science teaching | | |
| Components which should not be in inquiry-based science teaching | | |

**Table 2.** Continued

| Initial Codes (Open Coding) | Categories (Axial Coding) | Research Questions (Themes) |
|---|---|---|
| Citations to objectives in line with inquiry-based science teaching | Definition and features of inquiry-based teaching | How are previous experiences and knowledge of the cases on inquiry-based science teaching? |
| Purpose of inquiry-based teaching | | |
| Criteria of successfulness and effectiveness in inquiry-based teaching | Effectiveness and successfulness in inquiry-based teaching | |
| Criteria of failure and ineffectiveness in inquiry-based teaching | | |
| Previous experience about inquiry process during pre-service years | Previous experiences about inquiry-based teaching | |
| Ideas about importance of science teaching reform attempts | Value of reform-oriented science teacher development attempts | How are values and effectiveness of the different reform-oriented teacher development attempts on improving teaching ability for inquiry-based teaching and to decrease pedagogical discontentment? |
| Ideas about usefulness of science teaching reform attempts | | |
| Ideas about how much are science teaching reform attempts interesting | | |
| Ideas about cost of science teaching reform attempts | | |
| Effectiveness of different teacher development attempts to decrease pedagogical discontentment regarding inquiry-based teaching | Perceptions on effectiveness of reform-oriented science teacher development attempts | |
| General idea about science teaching reform attempts' value | | |

## Results

In this section of the paper, findings will be represented case-by-case and then cross-case findings on the value of reform attempts will be represented under a separate title. As an important reminding, the participants experienced pedagogical discontentment about applying inquiry-based science teaching and had knowledge about inquiry-based science teaching. Therefore their pedagogical discontentment situations and knowledge about inquiry-based science teaching will be represented before and then value of reform attempts for them will be represented later. As another important point, we located data by using three abbreviations in parenthesis (ES, QFPD, Q1), the first one was for the participant, the second one was for data collection tool and the last one was for question number in related data collection tool.

***The ES' Pedagogical Discontentment on Inquiry-Based Science Teaching and Knowledge about Inquiry-Based Science Teaching***

ES was a 26-years old female science teacher and she was also studying on her Ph.D. dissertation in science education department. She graduated from science education program and she was teaching middle school science for one year. Now she has been teaching in a rural elementary school.

*How was situation of the ES on pedagogical discontentment regarding inquiry-based science teaching?*

At the time of this research the *ES* was working on her dissertation. As one relatively new to science teaching (she was in the field for 4 years) her pedagogical discontentment increased when new teaching method as like inquiry-based teaching were examined. She suggested that her pedagogical

discontentment increases when she has to prepare her students for their new learner roles required in an inquiry approach. For her discontentment level, she explained that

> *"My discontentment level is increasing day-by-day about preparing my students for new learner roles in contemporary teaching methods*." (ES, QFPD, Q1).

At the same time she thought that differences in educational backgrounds and individual characteristics exacerbated her pedagogical discontentment on teaching new learner roles in inquiry-based teaching. In spite of low number of her students she believes she was not contented pedagogically to teach new learner roles to her students in inquiry-based teaching. She explained this aspect by the following quotas.

> *"I have a few numbers of students so differences in their educational background might be glaring and sometimes I need to apply a lot of different contemporary methods for every student who should know new learner role. Giving more attention to every student leads to increase my pedagogical discontentment, it is very tiring*" (ES, IFPD, Q1).

Actually she did not confine her discontentment resource to the need for giving more attention, she also complained about direct contribution of the differences in educational background and individual characteristics to her pedagogical discontentment.

> *"Individual differences of students might increase my pedagogical discontentment by only this way that some students understand the subject better than the others and then the difference between them affects the activities of lesson. In this situation I have to do more to make the lesson effective and to teach new learner roles, hence my pedagogical discontentment increases for teaching new learner roles if I use a new teaching method [inquiry-based teaching].*" (ES, IFPD, Q2)

Not only did she have pedagogical discontentment about teaching new learner roles in inquiry-based science teaching, but also she experienced pedagogical discontentment in case of applying inquiry-based science teaching to all subjects. She asserted that

> '*Personally I believe that inquiry-based teaching is not appropriate to all my science lessons*' (ES, QFPD, Q2).

> '*If I need to apply inquiry-based science teaching to all my science lessons, I would feel increased discontentment*' (ES, QFPD, Q2)

The participants also experienced the discontentment about assessing understanding of students in inquiry-based science teaching as another aspect of pedagogical discontentment. The following quota described the situation well.

> *'After making teaching activities, assessing students' understanding might lead to my bias in assessing understanding due to my personal experiences about differences of the students during the activities. Hence it is a serious discontentment resource for me in my assessment*." (ES, IFPD, Q4).

> But she believed that "*When I am able to apply inquiry-based teaching as it is, I guess I would not feel high discontentment about evaluating understanding*" (ES, QFPD, Q3).

For the planning aspect of inquiry-based teaching, she believed she was not contended about making an effective plan for inquiry-based science teaching. Three of her explanations in the questionnaire and interview summarized the situation.

> *"I think I feel increased discontentment about planning an inquiry-based teaching*" (ES, QFPD, Q4).

"*If the planning takes long time for new teaching method [inquiry-based teaching], it will be an important problem for my pedagogical discontentment especially in large classes."* (ES, IFPD, Q5).

"*Also I think feeling of making insufficient planning on a new teaching [inquiry-based teaching] due to its complicated nature might be another resource of my pedagogical discontentment*" (ES, IFPD, Q6).

Based on the personal beliefs and reasons of ES, it can be said that she experienced pedagogical discontentment for applying inquiry-based teaching.

*How were previous experiences and knowledge of the ES on inquiry-based science teaching?*

Previous experiences of ES on inquiry-based teaching during her pre-service years were very limited. She stated that she saw only a few applications in lab studies in her undergraduate years however they were not effective for her.

"*I have not experienced inquiry-based teaching except for a few applications made in our lab activities*"(ES, PEQ, Q1).

"*I can say I have limited experiences but I think my experience in lab is even far from inquiry-based teaching. As far as I remember I have taken prepared knowledge from assistants and we have been trying to re-discover existent knowledge"* (ES, PEQ, Q1).

When asked about definition and features of inquiry-based teaching, she defined inquiry-based teaching as a problem solving approach. She also gave steps of problem solving as purposes of inquiry-based teaching.

"*It is a problem solving approach. The purpose of this teaching approach [inquiry-based teaching] is to make individuals proficient in defining problems, reaching knowledge about the problems, using knowledge for problems and solving problems at least requiring application level learning by using scientific research processes in school or out of school*" (ES, QFDI,Q1)

Similarly she also mentioned about components of inquiry-based science teaching. She pointed out that students should be active and teacher should be guide in inquiry-based teaching. Moreover students should experience analysis, comparison and scientific process skills by themselves. After indicating the roles of teachers and students she gave details about the components of inquiry-based teaching. Following quotas summarized the process of inquiry-based teaching from the perspective of ES.

"*In inquiry-based teaching, students should organize data, analyze them and use scientific process skills*" (ES, SBQ, Q2)."*Students should experience scientific process skills by themselves and make comparisons in a laboratory environment*". (ES, SBQ, Q2).

*How were values and effectiveness of the different reform-oriented teacher development attempts on improving teaching ability for inquiry-based teaching and to decrease pedagogical discontentment?*

As seen in the quotas represented above, ES know about definition, components and roles in inquiry-based science teaching in spite of her limited experience on inquiry-based teaching. Also she had pedagogical discontentment about applying inquiry-based science teaching. After these background characteristics of ES, value of reform-oriented in-service teacher development attempts for applying inquiry-based science teaching effectively and hence decreasing pedagogical discontentment was asked. She evaluated alternative attempts frequently used in teacher development programs. She saw master and doctorate level courses as effective ways while she did not accept seminars, conferences, congresses, briefing meetings, introduction meetings as effective ways.

"*I think seminars, conferences, congresses, briefing meetings and introduction meetings do not have any effective communication and examples of effective applications of inquiry-based teaching. They involve both speakers and listeners and they are based on only verbal introductions. Hence I do not believe they can decrease my pedagogical discontentment and improve my teaching ability. However if some application components and sample easy ways of applying inquiry-based teaching are added to these alternatives, their effectiveness will be increased*". (ES,QVRA, Q10).

She gave an important place for master and doctorate level courses for improving ability to apply inquiry-based teaching and decreasing pedagogical discontentment.

*"Master and doctorate level courses provide individual opportunity to analyze teaching process in detail, hence I think they have potential to decrease pedagogical discontentment and are more effective than the other alternatives" (ES, QVRA, Q10).*

*"At the same time these courses provide more time and opportunity for individual study on the subject than the other alternatives. Therefore I think these courses contribute to decrease pedagogical discontentment*." (ES, QVRA, Q10).

After she introduced her ideas about effectiveness of the attempts for applying inquiry-based teaching and decreasing pedagogical discontentment, she expressed value perception about the attempts. For all the attempts she suggested giving more attention to application components and making the activities for willing individuals without any compulsory participation.

"*I think increasing weight of application components of the attempts will give better results than only lecture-type attempts".(ES, IVRA, Q1) "Moreover willingness should be an important condition for participation for getting better results*" (ES, IVRA, Q2).

After she gave general conditions for effectiveness and value of the attempts she talked about usefulness, interestingness and costs of the current attempts.

"*I think all of the attempts might be useful for science teachers in terms of applying inquiry-based teaching and decreasing pedagogical discontentment, however I do not believe that teachers can easily apply inquiry-based teaching in their classrooms" (ES, IVRA, Q3).*

*"I also think that these attempts are only interesting for teachers who are willing to develop themselves in terms of inquiry-based teaching, but they are not interesting for every teacher" (ES, IVRA, Q1).*

*"For the cost of the attempts, I think they do not have high costs when we look at the long-term benefits of inquiry-based teaching to students, hence they all are not time and effort consuming activities*". (ES, IVRA, Q4).

***The GZ's Pedagogical Discontentment on Inquiry-Based Science Teaching and Knowledge about Inquiry-Based Science Teaching***

GZ was a 28-years old female science teacher and she was also studying on her Ph.D. dissertation in science education department. She graduated from science education program and she was teaching middle school science for five years. GZ taught science in both rural and urban schools. Now she has been teaching in an urban elementary school.

*How was situation of the GZ on pedagogical discontentment regarding inquiry-based science teaching?*

GZ experienced moderate level pedagogical discontentment for inquiry-based science teaching. She gave examples for all aspects of pedagogical discontentment regarding inquiry-based science teaching. She believed that she could not effectively prepare her students for new learner roles.

*'I think I have moderate level pedagogical discontentment for preparing my students for new learner roles. Since preparing students for new learner roles requires change in teacher roles and teacher has to care about class levels, it is not an easy task."* (GZ, QFPD, Q1).

Moreover she also believed she could not effectively apply inquiry-based science teaching to all subjects.

*'Similarly I have moderate level pedagogical discontentment about applying inquiry-based teaching to all lessons." (GZ, QFPD, Q2).*

Similarly she also felt discontented about evaluating understanding in inquiry-based teaching.

*'I have moderate level pedagogical discontentment for evaluating understanding of students. Since 'I cannot use everything required for making a good evaluation of understanding and I think it is very hard to make process-based evaluation for understanding due to giving attention to too many criteria'(GZ, QFPD, Q3).*

For the final aspect of pedagogical discontentment; planning teaching, she accepted herself as discontented. She extended that she did not have enough practical experience on planning inquiry-based science teaching.

*'I have moderate level pedagogical discontentment for planning inquiry-based teaching in spite of the fact that I have experience on planning.' (GZ, QFPD, Q4).*

*'I think it is not enough to know about planning process I have to make practice on planning on inquiry-based teaching so my experience is not enough to make a good teaching plan about inquiry-based teaching'(GZ, QFPD, Q4).*

*How were previous experiences and knowledge of the GZ on inquiry-based science teaching?*

GZ had some experiences about inquiry process and but she stated that her experience was not enough for applying inquiry-based teaching. She had knowledge about inquiry-based teaching but she did not experienced active participation to the teaching applications.

*"I have limited previous experience about inquiry process. In spite of the fact that I know the definition and steps of the process I cannot actively apply it as a teaching method in my lessons." (GZ, PEQ, Q1).*

*"In my undergraduate years I have experienced the process in my lab applications. We have been designing and making experiments with provided tools and materials. At the end of our studies we have been explaining purposes and processes of our experiments to observers. Actually my experiences include problem solving processes. " (GZ, PEQ, Q1).*

GZ defined inquiry-based science teaching as a process driven teaching and she made emphasis on knowledge structuring by active individual efforts and using science process skills during this process. She explained her ideas as in the following quota.

*"It is process-focused teaching approach which purposes to teach for higher-level cognitive objectives and also students use scientific process skills actively and reach knowledge by their individual learning efforts in inquiry-based teaching" (GZ, QFDI,Q1)*

When asked about components and processes of inquiry-based science teaching, she gave detailed examples by taking into account activities in the scenario and active participation requirement of inquiry-based teaching.

*"I think students should prepare experiment by their individual experiences for reaching purposes of this lesson. At the same time, the teacher might have started to the lesson by getting students to observe movement of a drop of ink in a glass of water and by asking them to share their observation with class rather than asking about "what is diffusion?", since inquiry-based teaching requires active participation. Students should write their notes down and should prepare reports rather teacher-driven writings, this way is appropriate to inquiry-based teaching" (GZ, SBQ, Q1).*

She extended her examples by talking about class-size, class structure and activities. She also gave examples of using science process skills in the classroom.

*"I think classroom should be organized in a plan in which the teacher should be among desks of students' groups that are small groups. And classroom size should be 20-24 students for applying inquiry-based science teaching effectively. Teacher should use questions for linking current knowledge and old knowledge, for example the teacher in the scenario might have asked 'how can we provide transfer of matter between two sides of biological membranes without using energy?'. After the question the teacher might have used discussion method in the lesson." (GZ, SBQ, Q2)*

She recommended using questions and discussion as way to start lesson, however she also suggested adding activities including use of science process skills. Following quota summarized her suggestions.

*"The teacher prepares activities for getting students to set hypothesis based on their previous knowledge in inquiry-based teaching. Then the students should design their experiments to test the hypotheses in their groups with the guide of the teacher. Findings of their experiments are shared in their groups and are discussed; the teacher guides the whole process. At the final stage, findings of the experiments are written in a report and are shared with all class, hence the processes of inquiry-based teaching is completed by discussion of the findings with the whole class members." (GZ, SBQ, Q2)*

*How were values and effectiveness of the different reform-oriented teacher development attempts on improving teaching ability for inquiry-based teaching and to decrease pedagogical discontentment?*

GZ had the most experienced science teacher among the participants in this study; hence she participated in different teacher development programs. When asked about the effectiveness of different teacher development efforts in terms of improving inquiry-based teaching ability and decreasing pedagogical discontentment, she favored of master and doctorate level courses.

*"The most effective attempts for teacher development on inquiry-based teaching, I think, are master and doctorate level courses. Since time limitation to develop yourself is not as important problem as the other attempts. Also I think experts provide more effective activities for improving abilities." (GZ, QVRA, Q10).*

*"I see scientific meetings on education (education congress) as effective ways but they are not sufficient in our country." (GZ, QVRA, Q10).*

But she saw the other attempts as insufficient and unsuccessful. She stated that on-line portals provided by MoE, seminars, briefing meetings, program introduction meetings and providing written documents to the teachers were not effective and useful for teacher development.

*"I do not think seminars are fruitful since I could not get any benefit from seminars I have participated before." (GZ, QVRA, Q10).*

*I do not think the on-line portals of MoE are beneficiary for improving teachers' ability to apply inquiry-based teaching." (GZ,QVRA, Q10).*

*"Briefings made by MoE staff are not useful for me." (GZ,QVRA, Q10).*

*"Similarly program introduction meetings provide only introductory information, so they are not sufficient." (GZ,QVRA, Q10).*

*"Written documents explaining new program cannot overcome high discontentment problem of teachers, I think teachers should be enrolled in active application programs. Since gaining ability needs making applications. "* (GZ,QVRA, Q10).

In terms of expectancy-value components, she differentiated the alternative attempts she saw master and doctorate level courses as the most useful, important and interesting. However she did not see the courses as cost-effective.

*"I think master and doctorate level courses have importance in improving teaching abilities of teachers in inquiry-based teaching." (GZ, IVRA, Q1).*

*"Just the courses, I believe, have been providing context and process for improving teaching ability." (GZ, IVRA, Q3).*

*"The courses provide positive benefits for improving teaching ability." (GZ, IVRA, Q3).*

*"The courses are selected in line with individual's interest and teachers can make applications about inquiry-based teaching during the courses, hence I think the courses are the most interesting attempts for improving inquiry-based teaching abilities." (GZ, IVRA, Q2).*

*"However teachers should spend effort and time for ability improvement in the courses." (GZ, IVRA, Q4).*

Her ideas on the other reform-oriented teacher development attempts changed across types of the attempts. For example she saw seminars as improvable attempts while she did not see the portals and MoE supported programs as important, interesting and useful as master and doctorate level courses.

"*Seminar might be useful and fruitful if it is done in line with its purposes and it considers teachers' personal interests." (GZ,IVRA, Q1).*

*"Conferences might only increase awareness about the teaching processes in inquiry-based teaching". (GZ, IVRA, Q1).*

*"On-line portals of MoE, I believe, cannot improve teachers' ability to apply inquiry-based science teaching so they are not useful for teachers". (GZ, IVRA, Q1).*

*"Introduction meetings conducted by MoE staff are compulsory and lecture-based, so it is not useful for improving teachers' ability to apply inquiry-based science teaching."* (GZ, IVRA, Q1).

More specifically she extended her beliefs on seminars by giving examples for importance, cost, usefulness and interestingness of the attempts.

*"I think seminars do not have importance if they are applied as their current ways and they are time-consuming for teachers." (GZ, IVRA, Q4).*

*"Seminars are not also fruitful and useful since they are prepared for a determined group of teachers and they neglect applications required for teaching ability improvement." (GZ, IVRA, Q1).*

*"Seminars are also far from being interesting for the teachers because their ways of representation are not effective and useful." (GZ, IVRA, Q2).*

*"However seminars provide advantages in time and effort consumption". (GZ, IVRA, Q4).*

She also saw scientific education congress, introduction meetings, on-line portals of MoE and share of written documents as advantageous in terms of cost aspect. So they were economic for time and effort consumptions.

*"I think on-line portal of MoE is very economic for saving time and effort." (GZ, IVRA, Q4).*

*"Conferences are also economic for saving time and effort and also you can reach more participants." (GZ, IVRA, Q4).*

*"Similarly briefing provided by MoE staff is economic in terms of all cost components." (GZ, IVRA, Q4).*

*"Program introduction meetings are also cost-effective." (GZ, IVRA, Q4)*

*"Written document share is also economic for teachers in terms of time and effort." (GZ, IVRA, Q4).*

In spite of advocacy of the attempts in terms of cost component, she saw majority of the teacher development attempts as uninteresting for teachers. For this aspect she provided following beliefs.

*"TUBITAK programs, despite lack of my knowledge, might be interesting since I hear about the programs from the other teachers." (GZ, IVRA, Q2).*

*"Interest in conferences depends on speakers, if their previous studies are interesting the participants will probably be interested in the subject." (GZ, IVRA, Q2).*

*"On-line portal of MoE, I think, does not have interesting activities for improving teachers' ability." (GZ, IVRA, Q2).*

*"Briefings of the MoE staff are not interesting because the staffs are not generally sufficient to teach inquiry-based science teaching." (GZ, IVRA, Q2).*

*"Similarly program introduction meetings involves only representations of program features, hence they are not interesting for me." (GZ, IVRA, Q2).*

*"The least interesting attempt, I think, is to share written program documents with teachers." (GZ, IVRA, Q2).*

For the usefulness aspect of expectancy-value frame in this study, she did not see majority of the teacher development attempts as useful for improving teaching ability of the teachers for inquiry-based science teaching.

*"On-line portals of MoE do not have strong technical background and their content purpose is to give knowledge about teaching and related documents. Therefore they are not useful for improving teachers' inquiry-based science teaching ability." (GZ, IVRA, Q1).*

*"Scientific educational sciences congresses give also knowledge about teaching and learning so they are not useful to reach application objectives." (GZ, IVRA, Q1).*

*"Briefings provided by MoE staff are not useful actually I think they cannot provide any benefits in terms of teaching." (GZ, IVRA, Q1).*

*"Introduction meetings for new programs are conducted by only oral presentations; I do not expect any benefit from the meetings for applying any teaching method." (GZ, IVRA, Q1).*

*"I believe that TUBITAK programs might be useful for improving teaching ability of science teachers." (GZ, IVRA, Q1).*

*"Sharing written documents with teachers on new program can only provide awareness about the requirements of new improvements in teaching but it is not useful for teaching ability improvement." (GZ, IVRA, Q1).*

***The GL's Pedagogical Discontentment on Inquiry-Based Science Teaching and Knowledge about Inquiry-Based Science Teaching***

GL was a female science teacher graduated from department of science education and she taught science for 1 year. She also completed her master degree on science education and she was studying for her Ph.D. degree in department of science education.

*How was situation of the GL on pedagogical discontentment regarding inquiry-based science teaching?*

She saw her general pedagogical discontentment level as moderate to apply inquiry-based teaching. In particular she saw her experience for teaching new learner roles insufficient in applying inquiry-based teaching. She had prejudgment about society's learning, thinking and changeability for new learner roles.

*'I think experience of a teacher is an important factor for feeling discontentment`(GL, QFPD, Q1).*

*"I see my discontentment level as moderate for preparing my students to new learner roles." (GL, QFPD, Q1).*

*'In general society does not have a tendency to scientifically thinking and socio-economic status of students increases their tendency to learn by memorization so these problems are effective in my feeling of discontentment for preparing them to new learner roles' (GL, QFPD, Q1).*

GL also extended her discontentment feeling to applying the method to all lessons. She actually liked and had knowledge importance of inquiry-based teaching however she felt pedagogical discontentment for applying the method to all lessons.

*'In spite of my positive views on using inquiry-based teaching, I think it is very hard to apply it to all courses for me, because I feel my students expect lecture and writing activities in their lesson since I am studying in a small village school'*(GL, QFPD, Q1).

*"When I look at my undergraduate education and my experience on inquiry-based teaching and its features, I can see that there is an association between my insufficient undergraduate education and my problems for using inquiry-based teaching. Most of time these previous experiences make me feel pedagogical discontentment since I feel I am not ready to apply the method to all lessons." (GL, IFPD, Q1).*

GL felt better for evaluating understanding and planning in inquiry-based science teaching than for previous two aspects while she was still discontented about them.

'*As a new teacher, I cannot completely apply inquiry-based teaching but I feel less discontentment for evaluation.'* (GL, QFPD, Q1).

*'Actually I am not so bad for planning an inquiry-based teaching, so I feel moderate level discontentment`*(GL, QFPD, Q1).

*"I think I may not be proficient in preparing required assessment tools and their alignment with the purposes of inquiry-based teaching due to my insufficiency in applying the method as it is required" (GL, IFPD, Q3).*

For the planning aspect, she believed that she could not apply the plan as it was, in spite of the fact that she could overcome the application problems.

> *"Let's assume that I have overcome my application problem about the inquiry-based teaching, I believe I cannot follow the plan as I prepare it and the discrepancy between the teaching and the plan makes me pedagogically discontented about planning and applying the plan. It is about my insufficiency to follow my plan." (GL, IFPD, Q4).*

*How were previous experiences and knowledge of the GL on inquiry-based science teaching?*

GL limited experience on inquiry-based teaching resources of her experiences were undergraduate courses and preparation textbooks for teacher selection examination. Actually we were more interested in undergraduate experiences of GL. For undergraduate years, she said;

> *"When I have seen the method [inquiry-based teaching] in my undergraduate years, I have only known about a few characteristics of the method [inquiry-based teaching]. Hence I have not thought about importance and applications of the method." (GL, PEQ, Q1)*

> *"My experiences about the inquiry-based teaching are limited to my undergraduate courses and reading textbooks for preparation to national teacher selection examination." (GL, PEQ, Q1)*

She extended her thinking on the method by defining method. Her definition was based on problem solving process and use of scientific research methods.

> *"I think inquiry-based teaching is to use scientific research methods to solve a problem (GL, QFDI, Q1).*

> *"In this method the emphasis is on developing thinking ability of students from different perspectives by questioning, researching and observing the environment and on developing critical thinking ability of the student." (ES, QVRA, Q1).*

After she gives definition of the inquiry-based teaching method, she mentioned about components of inquiry-based science teaching by giving examples from the scenario. While she talked about the components, she gave examples for the components.

> *"If I were the teacher in the scenario, I would have brought a bottle of cologne and I would have opened the lid of bottle. Then I would have asked about distribution process of cologne smell into the class. I think the first step in inquiry-based teaching is to take attention of the students." (GL, SBQ, Q1).*

> *"I would have given a sample of experiments to the students, then I would have asked them to design their experiments and then I would have explained general features of the diffusion to the whole class." (GL, SBQ, Q2).*

> *"At the end of the teaching, I would have provided some cases and I would have asked them to compare the cases with diffusion." (GL, SBQ, Q2).*

She also made suggestions about making the teaching in the scenario similar to inquiry-based teaching. In her suggestions number of students, time, teaching process and homework format were criticized.

> *"A teacher experiences difficulty in applying inquiry-based science teaching when the teacher has to complete teaching in 40 min. and have to teach number of students over 40." (GL, SBQ, Q1).*

*"I think the teacher decreases motivation of the students by asking about an unknown concept [diffusion] and this way also increases anxiety of the students. Hence this beginning is not in line with inquiry-based science teaching." (GL, SBQ, Q1).*

*"As another problem in terms of inquiry-based science teaching, the teacher gets only two students to participate in the beginning of the lesson. The other students listen passively and also the teacher does not give any feedback. I think the most important problem in the teaching is about using lecture and visual representation." (GL, SBQ, Q1).*

*"When I look at the evaluation, I can see that the teacher asks only a few simple questions and the teacher also gives a reading task as homework. I think these applications are not appropriate for inquiry-based science teaching." (GL, SBQ, Q1).*

*How were values and effectiveness of the different reform-oriented teacher development attempts on improving teaching ability for inquiry-based teaching and to decrease pedagogical discontentment?*

GL represented moderate level pedagogical discontentment and she had knowledge about definition and components of inquiry-based teaching. Based on her these characteristics, we can say that she was in need of developing her teaching ability on inquiry-based teaching and of decreasing her level of pedagogical discontentment. However number of alternatives on teacher development in Turkey was not as high as we expected. Hence we should determine value of existent reform-oriented teacher development attempts for GL. First of all she mentioned about effectiveness of the attempts for her development.

*"I think the most effective two alternatives involve TUBITAK programs and introduction meetings, since they are providing simple knowledge that is easily understandable by teachers." (GL,QVRA, Q10).*

*"For the seminars, conferences and scientific educational science congresses, I can say that they are represented in the same way by using only oral way of communication. At the same time the same person talks about the same subject in these activities, so they are boring for teachers." (GL, QVRA, Q10).*

*"Effectiveness of master and doctorate level courses depends on lecturer's sufficiency and at same time, these courses are only for limited number of teachers. They are useful only for followers hence their effect is limited, I think." (GL, QVRA, Q10).*

*"We are using portals of MoE, I think if they are organized well they will be effective." (GL, QVRA, Q10).*

After she gave her ideas about effectiveness of alternative teacher development attempts and she pointed out values of the attempts in terms of usefulness, importance, interestingness and costs.

*"In general I think all of attempts have importance for overcoming current problems about inquiry-based teaching and for transforming theory to practice." (GL, IVRA, Q1).*

She extended her ideas about the attempts that they all could provide benefits for learning about nature of science during inquiry-based teaching.

*"We have a misperception that science is done in labs, scientists wear white coat and glass and they also use tools with glass. Moreover true knowledge can only be obtained by only one method. As a requirement of inquiry-based teaching, I think teachers can learn about nature of science by the teacher development programs you have mentioned. All of them are useful to learn about nature of science, I think." (GL, IVRA, Q3).*

She also saw all of the attempts as interesting. She said that

"*Particular attention to these attempts are given by authorities and experts, this attention makes it interesting for teachers. Since the attempts are different from current school programs*." *(GL, IVRA, Q2).*

For another aspect; cost, she did not think all of the attempts consume time and effort without any benefit. She said that

*"I think we have to think benefits of these attempts in a long-time projection, actually they are time and effort consuming activities. However if a teacher gains the expected outcomes and transfers them into their classrooms, I think extended benefits of the attempts are seen clearly. So they are not time and effort consuming in long-time projection." (GL, IVRA, Q4).*

***Cross-Case Analysis for Value of In-service Science Teacher Development Attempts to Increase Ability of Applying Inquiry-based Science Teaching and to Decrease Pedagogical Discontentment***

We determined previous experiences and knowledge about inquiry-based teaching of the participants. In spite of limited or no experiences of the participants, they had knowledge about processes and components of inquiry-based teaching. They used problem solving in their definitions of inquiry-based teaching. Helgeson (1994) said that problems solving is synonymous with inquiry-based science teaching. And also they mentioned about use of questions, experiments, hypothesis testing, science process skills and scientific research methods in their definitions. Hamm, Cullen, and Ciaravino (2013) stated that students should demonstrate their skills (science process skills) to conduct scientific inquiry in inquiry-based teaching. Lederman et al. (2014, pp. 67-71) also suggested the following aspects as necessary components of inquiry-based teaching process for K-16 students. Specifically, students should develop an informed understanding of the following aspects of SI:

*(1)scientific investigations all begin with a question and do not necessarily test a hypothesis; (2)there is no single set of steps followed in all investigations (i.e. there is no single scientific method);(3) inquiry procedures are guided by the question asked; (4) all scientists performing the same procedures may not get the same results; (5) inquiry procedures can influence results; (6) research conclusions must be consistent with the data collected; (7) scientific data are not the same as scientific evidence; and that (8) explanations are developed from a combination of collected data and what is already known.*

In these definitions, we can see common points between the definitions of the participants and the definitions in the literature. As another point, in the participants' answers on inquiry-based teaching, they gave emphasis on active participation and learning by individual experience in teacher guidance. Hamm et al. (2013) stated that inquiry-based teaching is a student-centered teaching approach in which students construct their own knowledge. Moreover Tomlinson and McTighe (2003) pointed out that effective inquiry-based teaching is provided in active environments for students and scaffolding (guidance by teacher) is also incorporated to the teaching process. Hence it can be advocated that the participants of this study can define inquiry-based teaching and they are aware of the components of the teaching method.

Although all of the cases had different experiences on inquiry-based teaching and science teaching they represented similarities in their value perceptions regarding in-service science teacher development attempts to increase ability of applying inquiry-based science teaching and to decrease pedagogical discontentment. ES and GZ saw master and doctorate level courses the most effective way for improving ability for decreasing teachers' sense of pedagogical discontentment through their continued participation in inquiry-based science. However, it was important to note that they did not see seminars and introduction meetings as equally effective. They also suggested adding application sections to the existent teacher development attempts for improving their quality for inquiry-based teaching ability.

In spite of the similarities between the cases, differences were also seen particularly in terms of teachers' value of in-service science teacher development attempts. Firstly GZ saw master and doctorate level courses interesting, useful and important while she did not think that the courses were cost-effective as one considered the entire teaching population of Turkey. However ES looked all the attempts from teachers' eyes and she claimed that the attempts were only interesting for teachers who were willing to participate in them, emphasizing that they would not be interesting for every teacher. Secondly GL did not give a discrete place for master and doctorate level courses and she believed that all of the attempts were interesting and useful but she thought that the most effective two attempts were TUBITAK programs and introduction meetings. GL also suggested that the effectiveness of master and doctorate level courses depends on lecturer's sufficiency and at same time, these courses were only for limited number of teachers.

In a third point that is important to highlight, GZ described that on-line portals of MoE, briefing meetings and written documents about new methods and developments were not effective, important and useful. However she saw seminars as improvable attempts due to their cost-effective nature. She also saw scientific education congress, introduction meetings, on-line portals of MoE and share of written documents as advantageous in terms of cost aspect. In contrast she did not see them as interesting. Moreover she did not see majority of the teacher development attempts as useful for improving teaching ability of the teachers for inquiry-based science teaching. But she believed in usefulness and interestingness of TUBITAK programs for improving inquiry-based teaching ability of science teachers.

## Discussion and Suggestions

The findings of this study represented differences in the value placed by pedagogically discontented science teachers on reform-oriented in-service teacher development attempts. As seen in the findings, the participants experienced pedagogical discontentment around inquiry-based science teaching practices due to different reasons. When we look at the two aspects of this study: Pedagogical discontentment about applying inquiry-based teaching and knowledge about inquiry based teaching, we can advocate that the participants have moderate level pedagogical discontentment and they are knowledgeable about inquiry-based science teaching. Their level of pedagogical discontentment is the first focus of this study, since moderate level pedagogical discontentment is a necessary situation to participate in and evaluate reform-minded professional development attempts. Also pedagogical discontentment is necessary for the implementation of reform-minded teaching methods. In Golden, Southerland, and Saka's (2009) study they found that participating into professional development programsis associated with being pedagogically discontented. Moreover Blanchard, Osborne, and Albert (2010) found strong association between tendency to change teaching practice and being pedagogically discontented. By considering their pedagogical discontentment level we can claim that these three teachers were actively keen on participating in professional development programs. As the second focus of the study they have knowledge about processes and components of inquiry-based science teaching, here we can claim that they can evaluate effectiveness of current reform-oriented in-service teacher development attempts for improving teaching ability regarding inquiry-based teaching. Hence we investigated values of reform-oriented in-service teacher development attempts for improving teaching ability regarding inquiry-based teaching and decreasing pedagogical discontentment.

Inquiry-based teaching is not used frequently by science teachers, Atıcı and Bora (2004) found that teachers mostly prefer "lecture", "question-answer" and "demonstration" rather than using inquiry-based teaching. Similarly our science teachers in this study do not have experience on applying inquiry-based science teaching. However they participated into different reform-based attempts to improve teaching of science teachers. Actually various studies on reform-based implementations (attempts) have been conducted by researchers for increasing use of inquiry based science instruction by science teachers (Capps & Crawford, 2013; Dixon & Wilke, 2007; Grove et al., 2009; Grigg et al., 2013; Sandholtz & Ringstaff, 2013). But these implementations (attempts) require higher costs than short-term

practice activities and they need longer times. For example Sandholtz and Ringstaff (2013) conducted two-year long professional development program and they suggested need of longer time for changes in instructional practices of science teachers. In fact the problem about teacher development programs focusing on inquiry-based teaching is not limited to cost and time, value of the programs of the attempts in terms of importance, interestingness and usefulness should also be questioned. Saka (2013) also suggested that development of professional teacher development attempts should recognize characteristics and objectives of teachers seeking professional development opportunities. In this study we looked at the value of the programs of the attempts in terms of importance, interestingness, cost and usefulness. The participants mentioned about different professional development attempts; master and doctorate level courses, seminars, conferences, scientific congress, TUBİTAK programs, on-line portals of Ministry of Education, written documents and meetings. Two of the participants did not see seminars and meetings as effective attempts to improve inquiry-based teaching ability of teachers. Previous studies showed that ineffectiveness of seminar programs is related to insufficiencies in professional staffs, collaboration between teachers and feedback (Bayrakcı, 2009). Moreover teachers do not also see content of seminars as relevant to real classrooms. Similarly conferences, congresses, written documents and meetings are not seen valuable attempts, this situation might be related to their similar format that experts talk about different subjects and teachers listen passively. At the same time these attempts are obligatory so there is choice of teachers. However TUBİTAK programs activate teachers to do new things since experts are moderators in these programs. The findings showed that master and doctorate level courses are seen important, useful and interesting by the participants whereas they are not accepted as cost-effective attempts. When looked at the literature, there are some important examples for showing effectiveness of the courses in teacher professional development. The postgraduate and master or doctorate level courses are used in different countries for teacher professional development. For example, as similar to Turkey, Japan and English teachers can also take master degree and postgraduate courses from universities (Sato, 1992, p. 163; Weinberger, 2000). Weinberger (2000) studied effectiveness of postgraduate courses on teacher professional development in UK, the findings of the author based on 14 participants' data showed that the courses contributed positively to the professional development of the teachers. Courses, even in undergraduate courses with supervised practice are the most effective ways for improving teaching ability (Jackson & Leroy, 1998). In Turkey master and doctorate level courses involve assignments, independent study and in-depth reading sections. These parts might be related to expectations of the PhD level students to improve their ability to apply science teaching methods (Hood, Creed, & Neumann, 2012). Yan (2005) stated that teachers benefit reform-oriented attempts when they see them as efficient in providing practical needs and expectations. One of the participants in this study stated that time number of teachers taking these courses is very limited and so the courses need effort and time from preparation to application. These situations make master or doctorate level courses advantageous to teacher professional development. At the same time they see the courses as cost-effective. Hence it can be said that the participants of this study see master and doctorate level courses as potentially valuable attempts for science teacher development.

The findings of the study provided valuable reform attempts for the participants with moderate level pedagogical discontentment to learn about inquiry-based teaching. TUBİTAK programs, master and doctorate level courses are seen as valuable attempts by the participants. We can say that initiating a reform in teaching needs to use these ways since the participants effectively initiate and provide effort and persistence on task by these ways (Wigfield & Eccles, 2000). However the participants did not see seminars and meetings valuable attempts to learn about inquiry-based teaching. According to expectancy-value theory, the participants are not as ready as in TUBİTAK programs and the courses to initiate and to provide action in these programs (Wigfield & Eccles, 1992). When the findings are examined in detail, it is seen that value of the TUBİTAK programs, and master and doctorate level courses is related to their importance, utility, cost and interest for the participants (Wigfield & Eccles, 2000). Importance of these attempts for the participants might be related to their expectancy about current job performance (McCourt et al., 2017), they see these attempts as effective ways to improve their current teaching. Moreover the participants also see utility of these two attempts as high because

their future teaching achievement might also be effectively improved by these ways (McCourt et al., 2017). In spite of their confusion about cost-effectiveness of the two attempts, they see them interesting. Interestingness might be associated with format of the attempts because they involve enjoyment opportunities such as hands-on activities, discussion sections and face-to-face dialog about the problems of teaching. The enjoyment maximizes development opportunities (Xie, Kim, Cheng, & Luthy, 2017) and intrinsic motivation (interest) in a task (McCourt et al., 2017). All of the value components aforementioned are also important to predict initiation a task, and persistence and performance on the task (Wigfield & Eccles, 2000).

In conclusion it is seen that increasing teachers' perception of the value of reforms is a requirement for the effectiveness of any professional development effort. These findings suggest that graduate level coursework is seen as more successful in this effort than other attempts for teacher development that these Turkish teachers experienced. However the participants believe that values of some of the other attempts might be improved by changing their format and content.

The study has also some limitations. The participants of the study were limited to three young science teachers studying PhD students and data collection tools were also limited to three tools. Inferences about the findings sould be made carefully. Both the characteristics of the participants and the tools require careful attention in future studies. Moreover the study is also limited to expectancy-value theory to evaluate task value, different theories using different components from importance, interestingness, cost and usefulness should be applied to the future studies.

The findings of this study suggest that master and graduate level courses have potential to improve ability of inquiry teaching and decreasing pedagogical content knowledge. Preparing a teacher development program involving TUBITAK programs and graduate level courses might be effective and valuable in developing pedagogical abilities of science teachers about inquiry based teaching. Also existent programs involving seminars, conferences, scientific congress, on-line portals of Ministry of Education, written documents and meetings should be revised in line with expectations and values of participating teachers. Before making a professional development program, pedagogical discontentment levels of teachers should also be determined to decide about appropriateness of the attempts to the group of teachers.

Based on the findings of this study it can also be suggested that more diverse participants should be investigated for their value perception about different teacher development attempts for inquiry-based teaching. Value of different format and content of the teacher development attempts might be investigated with similar cases. Face-to-face interviews and observations might be combined in data collection process and then values of the attempts in this study might be studied again. To improve trustworthiness of the study, independent coders should be integrated into the future studies.

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