CHANGES IN A SCIENCE TEACHER'S PEDAGOGICAL PRACTICES AND BELIEFS FOLLOWING ABI: ONSITE ONGOING PROFESSIONAL SUPPORT

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ABSTRACT

CHANGES IN A SCIENCE TEACHER'S PEDAGOGICAL PRACTICES AND BELIEFS FOLLOWING ABI: ONSITE ONGOING PROFESSIONAL SUPPORT

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The purpose of the current study was to investigate how a middle school science teacher's pedagogical practices and beliefs about teaching and learning has changed during implementation of argument-based inquiry (ABI). In this context, one-on-one onsite ongoing professional support was provided to the teacher by considering teacher's needs.

The participant of this study was one middle school science teacher. The multiple data sources were collected as part of the research: video records of teacher's classroom implementations, teacher interviews, audio records of briefings and informal conversations, researcher's field notes and onsite observations. The video-recorded lessons and the semi structured interviews were two main data sources. Data analysis was conducted by using RTOP scores and constant comparative method.

The results indicated that ongoing-onsite support contributed to teacher’s advancement in her ABI practices in the classroom. The participant teacher shifted her pedagogical practice from traditional teacher centered teaching to a more student-centered approach. Additionally, the teacher’s beliefs about teaching and learning shifted. There is a change in teacher’s beliefs to a more student-focused pedagogy over the professional development period. The present study showed that the teacher’s beliefs about learning is the central belief which is the reference point of the other beliefs. Furthermore, the results showed that there is a bi-directional relationship between beliefs and practice which confirms Thompson's (1992) theoretical model that there is a dialectic relationship between beliefs and practice. At the end, this study provided recommendations for teacher professional development.

Keywords: Onsite Ongoing Professional Support, Argument-Based Inquiry, Teacher Beliefs, Teacher Professional Development

ÖZ

ATBÖ EŞLİĞİNDE BİR FEN ÖĞRETMENİNİN PEDAGOJİK UYGULAMALARI VE İNANÇLARINDAKİ DEĞİŞİKLİKLERİN İNCELENMESİ: İŞBAŞI DEVAMLI PROFESYONEL DESTEK

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Bu çalışmanın amacı, bir ortaokul fen bilgisi öğretmeninin bir yıl boyunca yaptığı argümantasyon tabanlı bilim öğrenme (ATBÖ) uygulamaları süresince pedagojik uygulamaları ve öğretme ile öğrenmeye ilişkin inançlarındaki değişimi incelemektir. Bu bağlamda öğretmene bir yıl boyunca ihtiyaçları dikkate alınarak bire bir yerinde sürekli profesyonel destek sağlanmıştır.

Çalışmada yer alan katılımcı, bir ortaokul fen bilgisi öğretmenidir. Araştırma kapsamında çeşitli veriler toplanmıştır: öğretmenin sınıf içi uygulamalarının videoları, öğretmen mülakatları, bilgilendirme ve ders dışı konuşmaların ses kaydı, araştırmacının alan notları ve yerinde yapılan gözlemler. Video kaydına alınan dersler ile yarı yapılandırılmış mülakatlar iki ana veri kaynağını oluşturmaktadır.

Veri analizi, RTOP puanları ve sürekli karşılaştırma yöntemi kullanılarak yapılmıştır.

Araştırmanın sonuçları, sürekli ve yerinde verilen desteğin öğretmenin sınıfta yaptığı ATBÖ uygulamalarında ilerleme kaydetmesine katkı sağladığını göstermiştir. Katılımcı öğretmen, pedagojik uygulamalarında geleneksel öğretmen merkezli öğretimden daha öğrenci merkezli olan bir yaklaşıma geçmiştir. Ayrıca öğretmenin öğrenme ve öğretmeye ilişkin inançları da değişmiştir. Öğretmenin inançlarında, profesyonel gelişim süreci boyunca daha öğrenci merkezli bir pedagojiye doğru yönelme şeklinde bir değişiklik olmuştur. Bu araştırma, katılımcı öğretmenin öğrenmeye ilişkin inançlarının diğer inançlarının referans noktası olan merkezi inancını oluşturduğunu göstermektedir. Ek olarak sonuçlar, inançlar ile uygulama arasında iki yönlü bir ilişki olduğunu ortaya koymaktadır ki bu da Thompson'un (1992) inaçlar ve uygulama arasında diyalektik bir ilişki olduğunu savunan teorik modelini desteklemektedir. Son olarak bu çalışma öğretmen mesleki gelişimine ilişkin öneriler sunmaktadır.

Anahtar Kelimeler: İşbaşı-Devamlı Profesyonel Destek , Argümantasyon Tabanlı Bilim Öğrenme (ATBÖ), Öğretmenlerin İnançları, Öğretmen Mesleki Gelişimi

To My Family

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABI	Argument-Based Inquiry
ATBÖ	Argümantasyon Tabanlı Bilim Öğretimi
CCM	Constant Comparative Method
MONE	Ministry of National Education
NGSS	Next Generation Science Standards
NRC	National Research Council
PD	Professional Development
PISA	Programme for International Student Assessment
RQ	Research Question
SWH	Science Writing Heuristic
TIMSS	Trends in International Mathematics and Science Study

CHAPTER 1

INTRODUCTION

The aim of the science education in Turkey is to educate scientifically literate individuals (Turkish Ministry of National Education [MoNE], 2013). MoNE has made some radical changes in science programs in 2004, 2013 and lastly in 2018. Under the vision of scientific literacy, science curriculum played an essential role in innovative learning strategies (Duruk, Akgün, Dogan, & Gülsuyu, 2017). Scientific literacy has been defined in variety of ways in the literature. According to National Research Council (NRC), scientific literacy means that an individual is able to seek and find answers to the questions originated in curiosity related to daily experiences. It is an ability of explaining, describing and predicting the facts of nature. Scientific literacy implies the ability to describe, explain and predict natural phenomena,to read scientific articles in the popular press by understanding, and to involve socially conversations regarding the validity of the outcomes. Furthermore, it means that an individual is able to read scientific concerns between the lines of national and local purposes and mentions the steps which are suitable for science and technology. It is expected from a literate citizen being able to evaluate the quality of scientific information depending upon its sources and the methods preferred to produce it. The competency of posing and evaluating arguments depending on evidence and applying relevantly conclusions from these arguments is regarded as scientific literacy (NRC, 1996, p.22).

In general, a scientifically literate person is able to use basic scientific attitudes, processes, reasoning skills, and scientific information to get consequence by manipulating (Martin, Sexton, Franklin, Gerlovich, & McElroy, 2009). To be able to evaluate the quality of scientific information, there is a need to develop or increase the capacity of posing and evaluating arguments. Researchers have argued on how to achieve these goals and they stated that the students should be actively involved in scientific investigations (Wallace, Hand, & Prain, 2004). Actually the point is as in an ancient proverb stated: “Teach a person how to fish, feed the person for a life time.”

In this manner, scientific literacy is a kind of umbrella term in science education (Norris & Phillips, 2003). Turkish Ministry of Education refers -with this term- to inquirer, effective decision maker, problem solver, self-confident, open to cooperation, effective communicable and conscious lifelong learner about sustainability. Argument-based inquiry (ABI) is an approach through which students can gain all these traits in the classroom. ABI approach develops learners’ conceptual understanding and ability to defend their ideas by means of strong interaction between peers and teachers. Moreover, this process benefits students’ critical thinking skills and body of knowledge (Hand, 2008). According to Cavagnetto (2010) there are three different instructional models of argumentative discourse considering students: (1) explicit instruction in the structure of argument, (2) an understanding of the socio-scientific aspects of science, (3) immersion in argumentative practice and structure. In present study, third one is expected to transfer into practice; because, it requires the hidden elements of argumentation in terms of inquiry based education to trigger, scaffold and sustain critical thinking skills (Cavagnetto, 2010; Martin & Hand, 2009). Furthermore, Cavagnetto (2010) stressed that immersive approaches as being the most beneficial one for use within science classrooms. Pieces of argument should be embedded in instructional context in order for students to use these embedded argument elements as an important tool of constructing understanding scientific concepts (Prain & Hand, 1996). At the time of building understanding around an argument framework, students experience research activities like scientists (Cavagnetto, 2010; Cavagnetto & Hand, 2012; Cavagnetto, Hand, & Norton-Meier, 2010; Prain & Hand, 1996). Researchers generally use ABI approach to enable students an inquiry process around an argument framework they produced (Akkus, Gunel & Hand, 2007; Gunel, 2006; Hand & Keys, 1999; Prain & Hand, 1996).

It is important to highlight that the adoption of any immersive approach necessitates that teachers’ adjustment in their perspectives toward teaching and learning has to change from transfering information towards to understanding and implementing cognitive perspectives of learning. This change is what all teachers experience in adopting the ABI approach (Hand, Norton-Meier & Jang, 2017). Also adopting ABI approach does not require adopting a new curriculum but a different adjustment to the existing curriculum (Hand, Norton-Meier & Jang, 2017). On the other hand, this change process is not easy for teacher as a key person of this shift. For example, although ABI stands in the curriculum regulated by MoNE recently, teacher have difficulty to implement it. Attending an inservice training or a workshop is not sufficient to transfer a new approach into the classroom (Gunel & Tanriverdi, 2014).

The reasons of the incompetency for argumentation implementations are stated as the deficiency of teachers' pedagogical practice with respect to classroom discourse, anxiety of completing national curriculum and system of its assessment (Newton, 1999), and the problem of mediating the argument-based learning environments (Duschl, 2007). Therefore, at this point teachers need assistance during the implementation of this new approach so that they can make necessary changes in the classroom to provide this learningful environment. Within the context of the present study, it was aimed to give both onsite and ongoing support to a science teacher after an ABI oriented inservice training during the implementation of this innovative approach in the classroom and to make onsite ongoing orientation to the teacher. This support may actually cause a big shift in the classroom's learning environment. In order to make this change, there is a variety of things to do. It can be called as a "process". This innovation movement in science education requires important teacher change in their teaching practices. Making change in teaching practices is a big challenge for teachers. When teachers are changing their practices, they develop new skills, knowledge, and beliefs. This process actualizes in the scope of professional development program.

Professional development can impact on teachers' beliefs and practices in their classroom (Pajares, 1992). Bybee (1993) asserts that teachers' beliefs and their teaching are the main elements for the shift in education and eventually for the successful educational progress. As national and international education reforms are increasingly enacted to enhance the teaching and learning in today's classrooms, it is obvious that teachers' beliefs are critical if significant shifts are to eventually occur.

Since the belief system of each person is complicated (Bryan, 2003; Boulton-Lewis, Smith, McCrindle, Burnett, & Campbell, 2001; Crawford, 2007; Peterson, Fennema, Carpenter, & Loef, 1989; Wallace & Kang, 2004), there is not just one way to describe the relationship between teachers' beliefs and practices. There are various studies claiming teachers' beliefs are represented in their classroom practices (Borko & Putman, 1995; van Driel, Beijaard & Verloop, 2001; Yerrick, Park & Nugent, 1997), while some of the studies indicate sometimes teachers' practices form their beliefs (Anderson, 2002; Simmon et al., 1999). There is an interrelation between teachers' beliefs and practices; however, their sequence is not always linear (Marx, Blumenfeld, Krajcik, & Soloway, 1997). Teachers may sometimes change their beliefs differently than their classroom practices because of some factors (Prawat, 1992; Tobin, Tippins, & Gallard, 1993; Wetzel, 2001). This study is an attempt to describe the relationship between teacher beliefs and practice.

The objective of this study was to investigate how a middle school science teacher's pedagogical practices and beliefs about teaching and learning changed when implementing ABI approach through onsite ongoing professional support during a year. The present study was conducted within a professional development program which specifically focused on the required characteristics of ABI approach. The professional development program consists of two parts: an inservice teacher training and onsite ongoing support. In the first part, science teachers attended to an ABI oriented three-day inservice teacher training program incorporating diverse workshops. Second part of the program is based on voluntariness and willingness of teachers and one-on-one onsite ongoing professional support was given to a science teacher in the context of the present study. Professional development programs which require systematic follow-up and ongoing support are strongly recommended in the reform movements (Danielson, 2006; DuFour & Eaker, 1998; Feiman-Nemser, 2001; Gunel & Tanriverdi, 2014; Kent & Lingman, 2000; Killion, 2000; Lewis, 1997). Therefore, in the context of this study the effect of onsite ongoing support on a teacher’s pedagogical practices and beliefs about teaching and learning was examined.

1.1. Research Questions

The specific research questions addressed in the present study are:

1- What changes occur in science teacher’s pedagogical practices following implementation of ABI accompanied by onsite ongoing professional support?

2- What changes occur in science teacher’s beliefs about teaching and learning following implementation of ABI accompanied by onsite ongoing professional support?

1.2. Significance of the Study

Turkey has made revisions in its science curricula. ABI is highlighted in the last version of the science curriculum of Turkey (MoNE, 2018). All of the specific skills for science in the curriculum (science process skills; life skills: analytical thinking, decision making, creative thinking, entrepreneurship, communication, team work; engineering and design skills: innovative thinking) can be experienced within the context of ABI approach. Furthermore, the main purpose of the science curriculum is raising scientifically literate individuals (MoNE, 2018). Scientific literacy continues to progress through years as a piece of lifelong learning. Since argumentation in science classroom fosters scientific literacy (Erduran & Jimenez-Aleixandre, 2007), the aim of scientific literacy has caused a consistent rise in argument-based interventions in science education contexts (Cavagnetto, 2010). Despite a wealth of studies on the effectiveness of argumentation as an educational goal and instructional approach in science education literature (Duschl & Grandy, 2007; Osborne, Erduran, & Simon, 2004), argumentation has been rarely observed in science classrooms (Driver, Newton, & Osborne, 2000). Bricker and Bell (2008) see the reason of this as partly the failure of teachers or curriculum in reflecting argumentation practices found in professional scientific practice. Since ABI is present in the curriculum in

Turkey, the problems of the teachers remain. Teachers need courage and support in terms of implementing these kind of innovative activities matching up with the curriculum. From this point of view this study may have a small but important contribution for teacher development, professional development projects, improvement of teacher pedagogy and curriculum development.

As it is stated above, there is scarce of studies about science teacher preparation and reflecting these preparations into the classroom (and) especially from the ABI perspective. Sparks and Hirsh (2007) propose that the professional development programs most teachers experience are not highly qualitative. Many of the teacher development programs are frequently one-shot workshops and lack of follow up support, and for this reason these programs fail to make the necessary changes (Schmocker, 2006; Sparks & Hirsh, 1996). In this sense, the present study gave a middle school science teacher an opportunity of a year-long onsite ongoing support after a 3-day ABI oriented inservice teacher training. This support was not an element of a package program as in many studies; on the contrary, this research was custom-made which means that the teacher was worked in line with her needs and given onsite ongoing support during preparation, in-class implementation and assessment process of ABI implementations. The findings of the present study can particularly be useful to the researchers for efficiently developing professional development programs in which science teachers can totally immerse themselves in ABI approach. Therefore this study had worthy of being searched.

Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are two international examinations. TIMMS proposes a rational and support for educational reform needed in many countries and PISA has become an impulse at the time of improving skills such as ability to coordinate evidence and claims (Erduran & Jiménez-Aleixandre, 2008). Turkey has also participated these assessments; however, the scores of Turkey in these studies are quite low. This research may present a model for both teacher and student education in the field of science to enhance learning environment for better

PISA and TIMSS results in the future. It is expected that ABI approach would provide related strategies which positively affect students performance in these tests.

Limited number of study investigated teacher beliefs in the context of case study (Martin, 2008). Most studies prefered larger sample size and quantitative approach. The powerful side of this study is being centered on one inservice science teacher through qualitative approach and being an in-depth investigation of this teacher's pedagogical practices and beliefs about learning and teaching as the teacher was running an ABI oriented reformed science program. Therefore, broad information about the teacher and the change in her beliefs and practice during the implementation process of ABI approach were provided in this study. Teacher beliefs are essential factors in understanding pedagogical practices and conducting teacher education considering how prospective and inservice teachers improve their thinking and practices (Richardson, 1996). The present study has the potential to inform teacher education programs about the importance of teacher beliefs regarding teaching and learning.

The present study was an attempt to draw a clearer picture of the relationship between practice and beliefs. On the one side there are studies indicating beliefs affect practice and on the other side some studies proposing practice affects beliefs. Additional studies show the relationship may be bidirectional and even tenuous. Therefore, there is a complication about the relationship and directionality between practice and beliefs. This study may be a step for uncluttering in this area.

To sum up, this research is a step to present rich information related to the changes of a middle school science teacher's experiences in terms of beliefs and practices as she makes an attempt to change her pedagogical practices in the classroom.

1.3. Definition of Important Terms

Argument-Based Inquiry (ABI): ABI approach is an argumentative instructional cognitive and social apparatus guiding students and teachers in productive activities in order to provide them learning and teaching context in which the negotiation of meaning among learners are actualized through inquiry explorations (Keys, Hand, Prain & Collins, 1999). Moreover, ABI is an instructional tool by embedding argumentative discursive actions into inquiry learning and inquiry teaching through mainly using hands-on and minds-on inquiry activities by means of verbal and written scaffolding (Nam, Choi & Hand, 2010).

Belief: Pajares (1992) defines belief as “attitudes, judgments, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action theories, rules of practice, practical principles, perspectives, repertories of understanding, and social strategy” (p. 309). The present study attempted to describe a teacher's beliefs by analyzing what she says, what she intends to do, and what she does (Clark & Peterson, 1986; Pajares, 1992; Rokeach, 1968;). Furthermore, in this study teacher beliefs are defined as teacher’s opinions, perceptions, expressions, attitudes and judgements as her beliefs since they are based on her understandings.

Onsite Ongoing Professional Support: Onsite ongoing support is the backup provided from the researcher both onsite (in the school) personally and offsite (out of the school) personally or with various communication tools (phone calls, emails, whatsapp messages) requiring systematic follow-up in an ongoing manner. Because the possibility of teachers’ transfering new learning into their classrooms increased by ongoing support provided by instructional coaches (Cooter, 2003; Cranton & King, 2003; Loucks-Horsley & Matsumoto, 1999; Zemelman, Daniels, & Hyde, 2005).

CHAPTER 2

LITERATURE REVIEW

In this chapter, the literature related to this study was examined in order to present a theoretical framework for answering research questions. In this literature review, the content focused on ABI, teacher professional development and teacher beliefs.

2.1 Inquiry Through Argumentation: Argument Based Inquiry

In this part, ABI was presented from starting to explain inquiry, argumentation and science argumentation in school setting. Then the concept of ABI was introduced, SWH was mentioned as an ABI learning and research on ABI was presented in detail.

2.1.1. Inquiry

As an old proverb stated perfectly: "Tell me and I forget, show me and I remember, involve me and I understand." This sentence refers to inquiry by saying involving and understanding. In the National Science Education Standards (NSES), inquiry is stated as in below:

> Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as, an understanding of how scientists study the natural world. (NRC, 1996, p. 23)

In the reform movements in science teaching, emphasis has been placed on changing pedagogical practices from teacher-centered didactic practices to student-centered constructivist principles, or teaching through inquiry. Inquiry approaches involve students in activities and thinking practices which scientists use in order to improve their comprehension of the natural life (Akkus et al., 2007; Bliss, 2008; Chinn & Malhotra, 2002; Jiménez-Aleixandre & Erduran, 2008; Kuhn, Black, Keselman, & Kaplan, 2000; Ruiz-Primo et al., 2010; Sandoval, 2005). NRC has informed that the main purpose of science teaching and learning is students' learning "scientific knowledge with understanding" (1996, p. 21). Involving students in science through inquiry supports student learning (NRC, 2000). Scientific inquiry learning has a crucial role for students to think in a higher level with the teacher guidance (Gillies, Nichols, Burgh, & Haynes, 2012); however, teachers have difficulty when they are trying to teach higher order thinking in science classrooms (Zohar, 1999).

There is no single method of inquiry teaching (NRC, 2000). According to Cavagnetto (2010) 5E learning model, model-based inquiry and ABI approaches are the three main inquiry-based approaches. Inquiry is a broad array of strategies that at its core has a problem to be solved or a question that needs answering (Deboer, 2006). Crawford (2000) suggested that an inquiry approach involves supporting students in using data as evidence to investigating authentic questions. In the science inquiry classroom, students' role is changed from passive receivers to active learners (Anderson, 2002). Science as inquiry promotes students to think as if they were scientists (Duschl, 2008), enhances their scientific ability, and advances their learning by understanding (NRC, 2000). Blumenfeld, Max, Patrick, Krajcik, and Soloway (1997) argue that when learners start to discuss about science "they learn the ways of knowing in the discipline, what counts as evidence, and how ideas are validated and communicated" (p.154-155) as it happens in the nature of inquiry. In this manner, inquiry-based teaching focuses on the development of scientific reasoning and requires opportunity for constructing and supporting claims by using evidence, and communicating findings in a scientific framework (NRC, 1996; Wallace, & Kang, 2004).

2.1.2. Argumentation

Argumentation is seen as a main characteristic of scientific inquiry (Kuhn, 1991; Newton, Driver & Osborne, 1999). There is a variety of meanings of argumentation in the literature. According to van Eemeren and Grootendorst (2004), “argumentation is a verbal, social and rational activity aimed at convincing a reasonable critic of the acceptability of a standpoint by putting forward a constellation of propositions justifying or refuting the proposition expressed in the standpoint” (p. 1). Kuhn (1992) interprets argumentation as “rhetorical” and Boulter and Gilbert (1995) interpret this as “didactic”. From this explanation people conduct arguments, which are mostly used in science lessons, either to say others or to convince them of their arguments’ power (Driver et al., 2000). In the rhetorical form of argument, teacher shows evidence and make arguments for students, which is one-sided, has limitations and from that reasons not preferable; on the other side, in the second explanation of argument named dialogical or multi-voiced, different views are considered and the aim is to agree on apt ideas (Driver et al., 2000). Argument is not a final output of a process, instead it is the major mediation tool of knowledge co-construction (Hand, 2008). Since participation of learner in argument improves “communication skills, metacognitive awareness, critical thinking, understanding of the culture and practice of science, and scientific literacy” (Cavagnetto, 2010, p. 336). Duschl and Osborne (2002) proposed that argumentation is a core practice and advised for science learning and teaching. This is also stated in NGSS (2013).

Many studies on including argumentation in science education have been published in both national and international journals in the past few years (e.g., Aymen Peker, Apaydın & Taş, 2012; Cetin, Metin, Capkinoglu, & Leblebicioglu, 2016; Clark & Sampson, 2007; Driver et al., 2000; Erduran, Simon, & Osborne, 2004; Kelly & Takao, 2002; Kuhn, 1993; Lawson, 2002; Lawson, 2003; Maloney and Simon, 2006; McNeill, & Pimentel, 2010; Osborne et al., 2004; Ozdem, Ertepinar, Cakiroglu & Erduran, 2013; Zohar, 2008). Argumentation has a core role in the construction of explanations, models and theories (Siegel, 1995). Therefore the importance of teaching students scientific argumentation has been pointed out ever-increasingly by the researchers and reformers from the area of science education in the last decade (Chin, & Osborne, 2010; Duschl, 2008; Jiménez-Aleixandre, & Erduran, 2008; Kuhn, 2005).

2.1.3. Science Argumentation in School Settings

The importance of argumentation in science education is declared by both national and international institutions (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2009; MoNE, 2005; NRC, 2007; Organization for Economic Co-operation and Development [OECD], 2003). Argumentation is a fundamental aspect of scientific inquiry (Duschl, 1990; Kelly, Drucker, and Chen, 1998; Kuhn, 1991, 1993; Newton, Driver, & Osborne, 1999; Osborne et al., 2004; Richmond and Striley, 1996) since it makes students informed about the changeable nature of scientific knowledge and the significant role of empirical data to the enterprise (Maloney, & Simon, 2006). Science is the generation of socially constructed knowledge, and within scientific community argumentation is essential for the establishment of scientific knowledge (Newton, Driver, & Osborne, 1999). Science argumentation can be stated as developing knowledge claims, providing evidence for these claims, and criticising of those evidence and claims by listening, talking and writing (Duschl, Schweingruber, & Shouse, 2007).

In their book "Argumentation in Science Education", Erduran and Jiménez-Aleixandre (2008, p.5) presented connected dimensions or possible contributions in case of introducing argumentation in science classrooms:

- Supporting the access to the cognitive and metacognitive processes identifying expert performance and providing modelling for students (e.g., Von Aufschnaiter, Erduran, Osborne, & Simon, 2008).
- Supporting the improvement of communicative competences and specifically critical thinking (e.g., Sampson, & Clark, 2009).

- Supporting the attainment of scientific literacy and strengthening of students to talk and to write the languages of science (e.g., Gott, & Duggan, 2007).
- Supporting the enculturation into the practices of the scientific culture and the development of epistemic criteria for knowledge evaluation (e.g., Nussbaum, Sinatra, & Poliquin, 2008).
- Supporting the progress of reasoning, especially the choice of theories or positions depending upon rational criteria (e.g., Dawson, & Venville, 2009).

In addition to the five function introduced by Erduran and Jimenez-Aleixandre (2007), Driver et al. (2000) pointed three emphases of argumentation in science education: (1) argumentation for developing conceptual understanding, (2) argumentation for increasing investigational capability, and (3) argumentation for understanding scientific epistemology. They asserted that these points are of significant importance to the decision-making in socio-scientific issues and so the development of scientific literacy (Driver et al., 2000). Examining the research on the impact of argumentation on investigational capability, it was found that most of the research applied laboratory activities to evaluate investigational competence. Investigating student performance by changing the nature of traditional laboratory instruction, Sampson, Grooms, and Walker (2011) developed a model, called Argument Driven Inquiry (ADI) in which students would be more reflective as they work. It is a profound and meaningful point that authors required students to engage in many inquiry based lab activities through ADI. Differently from the traditional laboratory environment, ADI model provided students opportunities to participate in argumentation and peer review.

In both review of Sadler (2004) and Driver et al. (2000), it was found that students exert themselves for argument construction and consideration of evidence contradicting their initial views. Driver et al. proposed that students could gain competence related to argument and argumentation by repeating them in the classroom. Moreover, they also asserted that teachers could have a critical role in promoting student involvement in argument. However, teachers were not experienced in promoting discussions during their ABI implementations (Hand et. al, 2017).

Cavagnetto (2010) also suggested in his review that students participating in argumentation develop communication skills, critical thinking, metacognitive awareness, scientific literacy, and an understanding of the culture and practice of science. Erduran and Jiménez-Aleixandre (2008) addressed two purpose of science education: “science for all” and “science for prospective scientists” in which argumentation is able to contribute both. Because of its important role, argumentation should be supported in science classrooms (Duschl, & Osborne, 2002; Jiménez-Aleixandre et al., 2000; Kelly, Druker, & Chen, 1998). However, this is not possible to occur in a classroom in which traditional teaching takes place and teacher voice dominates student voice. For argumentation to take place in science classrooms, students need to have an active role in discussions (Erduran, & Jiménez-Aleixandre, 2008). Therefore, to let student involvement in discussions there is need for teachers to coordinate and intercede the relevant scientific applications in classroom as a vital issue in argumentation (Duschl, 2008; Simon, Erduran, and Osborne, 2006). Newton (1999) found that discussion supported activities do not take place in the course of teacher-dominant practices in science lesson. Moreover, he pointed out the reasons of the incompetency for argumentation implementations as the deficiency of teachers’ pedagogical practice with respect to classroom discourse, anxiety of completing national curriculum, and system of its assessment. Similarly, Bricker and Bell (2008) argued that the lack of argumentation practices in science classrooms arises from the failure of teacher or curriculum in reflecting the dimensions of it. Another problem is about teachers to mediate the argument-based learning environments (Duschl, 2007). Furthermore, teachers’ lack of pedagogical strategies to support students’ argumentation is a major barrier for the implementation of argumentation in school science (Driver et al., 2000).

Science teaching has given little emphasis to practice of argumentation as instructional approach (Driver et al., 2000). In the existing literature, it was shown that students seldom found the chance of joining authentic science argumentation in the classroom (Roth et al., 2006; Weiss, Banilower, McMahon, & Smith, 2001). It is proposed that altering the type of classroom discourse requires both illuminating roles of teachers and also students. According to Kuhn and Reiser (2006) teachers should permit their students to engage in critical thinking processes as in the form of argumentation in responding conflictions of science. When argumentation provided, students start to pose "why" questions rather than "what" questions (Duschl, 1990). "Why" questions warrant that students make discussions and review on data and evidence like scientists (Bricker & Bell, 2008). Questioning increases student talk (Gunel, Kingir & Geban, 2012; Martin & Hand, 2009), starts and guides the negotiation in the classroom (Gunel et al., 2012; Kawalkar and Vijapurkar, 2013). Presenting students a step of dialogical discourse in which they can talk about their ideas and discuss them with their friends is one of the main roles of teachers (Driver et al., 2000; Ritchi and Tobin, 2001; Simon et al., 2006). Moreover, argumentation gives students opportunities to conceptualize others' ideas and this improves students' way of thinking (Vygotsky, 1987). Teachers should present opportunities for students to practice comfortably by creating a supportive learning environment in order to stimulate argumentative learning environment in a science class (Berland & Reiser, 2009). Erduran et al. (2004) suggested teacher trainings to create learning environments for students in order to participate in construction of explanations and evaluation of evidences as well as in inquiry-oriented activities. In the present study it is intended to give a science teacher onsite ongoing support for her preparations and classroom practices after an inservice teacher training within the context of ABI oriented teacher professional development program.

Zohar (2008) proposed that there is a need for science teachers to experience a major change in their pedagogical understanding and practice in order to apply argumentation in science lessons. Driver et al. (2000) drew implications for investigating teachers' beliefs and values to change their implementations. Science teachers first need to be convinced on the importance of argumentation to change their practices (Driver et al., 2000). Promoting the practice of argumentation in science lessons is highly related with development of appropriate pedagogical strategies (Osborne et al., 2004). In this process teachers need time for practicing (Richardson, 1990).

Argumentation finds more and more place for itself in science curriculums in all around the world (e.g., in the United States, the United Kingdom, Spain, South Africa, Australia) (Jimenez-Alexiandre & Erduran, 2008). Reform efforts in national Turkish science curriculum focused on the adopted strategies and methods for the middle-schools related to argumentation:

1. Learning process comprises exploration, questioning, argument building and product design.

2. The environments should be provided where students can discuss their advantage-disadvantage relationship related scientific facts so that they can express their opinions comfortably, support their ideas with different warrants, and develop counter-arguments in order to refute their friends' claims (MoNE, 2018, p.11, researcher's translation)

2.1.4. Argument Based Inquiry (ABI)

As a definitional approach ABI refers to as an argumentative instructional cognitive and social apparatus guiding students and teachers in productive activities in order to provide them learning and teaching context in which the negotiation of meaning among learners are actualized through inquiry explorations (Keys, Hand, Prain & Collins, 1999). Accordingly, ABI also stands for an enhancing instructional tool by embedding argumentative discursive actions into inquiry learning and inquiry teaching through mainly using hands-on and minds-on inquiry activities by means of verbal and written scaffolding (Nam, Choi & Hand, 2010). According to Hand and Norton-Meier (2011), ABI approach is engaging students in inquiry activities based on a questions, claims and evidence structure. For a brief explanation, ABI approach is the junction of inquiry, argumentation and language (Keys et al., 1999). An ABI approach gives rise to a better understanding of the epistemology of scientific knowledge which is a basic objective of scientific literacy as well as advanced social skills (Cavagnetto, 2010; Driver, Asoko, Leach, Scott & Mortimer, 1994; Driver et al., 2000; Duschl, 2008). Furthermore, ABI gives students the chance of engaging in authentic science discourse where their own ideas can be challenged on the qualities of argument given above (Newton et al., 1999). In other words, ABI is a kind of tool providing the scientific inquiry classroom in a sense of enabling all of the students to communicate and reflect upon their reasoning by offering claims and evidence to construct new knowledge (Driver et al., 1994, 2000; NRC, 1996). Osborne, Erduran, and Simon (2004) asserted that, "learning to think is learning to argue" (p. 998). This means that argument and learning go hand in hand. Furthermore, ABI is a process of negotiation and argumentation in which learners have to be immersed in and play an active role over the processes of raising claims, constracting evidence, and negotiating their ideas with friends through getting involved in the activities (Milar & Osborne, 1998; Siegel, 1995).

Adopting the ABI approach is compelling and needs time for both teachers and students (Gunel, 2017). After various studies, Gunel (2017) found that teacher development needed shifts in beliefs related to learning and teaching practices and such basic shift needs time, practice and cooperation. Because in the Turkish educational system test-oriented learning environment and a dense national curriculum make things difficult for teachers about seeing the advantages of change for them and their students. Considering aforementioned reasoning, in the context of this study it is needed to give onsite ongoing professional support to the teacher in the preparation and implementation process, and examine the effects of this professional support on teacher's pedagogical classroom practices and beliefs. It is important to highlight that the acception of any immersive approach necessitates teachers' adaptation toward teaching and learning. The change during this adaptation period should be from previous information transfer perspectives towards to understanding and applying cognitive perspectives of learning (Hand, Norton-Meier & Jang, 2017).

2.1.4.1 The Science Writing Heuristic (SWH) Approach as an Argument-Based Inquiry Learning

The Science Writing Heuristic (SWH) approach was developed by Hand and Keys (1999) to facilitate student learning from scientific inquiry through writing-to-learn strategies (Hand & Keys, 1999; Keys et al., 1999; Hand & Prain, 2002). Hand, Norton, Staker and Bintz (2009) emphasized the importance of SWH to encourage students about actively participating in collaborative and constructive inquiry activities. The SWH approach comprises both teacher and student frameworks that provides suggested strategies for reasoning in writing and for laboratory activities. The SWH approach has a framework modeled to lead science inquiry activities, embed science argumentation as a basic element of students' inquiry experiences, and give metacognitive support to arouse student reasoning related to data (Keys et al., 1999). As presented in Table 1, the SWH approach consists of two heuristic templates which are used as a structured teaching and learning tool and necessitate both teachers and students to be active and interactive in laboratory investigations (Burke, Greenbowe, & Hand, 2006). The teacher template is a kind of pedagogical and conceptual reasoning tool for teachers' preparations related to in-class argument-based activities. Soysal (2017) defines the teacher template as "a tool of teacher learning for teaching." (p.39). The student template encourages students to investigate their own question(s), apply scientific methods during their investigations and use their own language to share their findings. Furthermore, in this study these templates were applied.

Table 1. The Two Templates for the SWH: The Teacher Template and the Student Template

Teacher Template	Student Template
1. Exploration of pre-instruction understanding through individual or group concept mapping or working through a computer simulation.	1. Beginning ideas - What are my questions?
2. Pre-laboratory activities including informal writing, making obscrvations, brainstorming, and posing questions.	2. Tests - What did I do?
3. Participation in laboratory activity	3. Observations - What did I see?
4. Negotiation phase I - writing personal meanings for laboratory activity. (For example, writing journals).	4. Claims - What can I claim?
5. Negotiation phase II - sharing and comparing data interpretations in small groups. (For example, making a graph based on data contributed by all students in the class.)	5. Evidence - How do I know? Why am I making these claims?
6. Negotiation phase III - comparing science ideas to textbooks for other printed resources. (For example, writing group notes in response to focus questions.)	6. Reading - How do my ideas compare with other ideas?
7. Negotiation phase IV - individual reflection and writing. (For example, creating a presentation such as a poster or report for a larger audience.)	7. Reflection - How have my ideas changed?
8. Exploration of post-instruction understanding through concept mapping, group discussion, or writing a clear explanation	8. Writing - What is the best explanation that explains what I have learned

Source: Hand, B. (2008). Introducing the science writing heuristic approach. In B. Hand (Ed.), *Science inquiry, argument and language: A case for the science writing heuristic.* Rotterdam, The Netherlands: Sense Publishers

Hand (2008) also describes the nature of the discussion if SWH approach is applied as follows:

> The SWH is designed to promote classroom discussion where students' personal explanations and observations are tested against the perceptions

> and contributions of the broader group. Learners are encouraged to make explicit and defensible connections between questions, observations, data, claims, and evidence. When students state a claim for an investigation, they are expected to describe a pattern, make a generalization, state a relationship, or construct an explanation (p. 7)

By comparing an inquiry-based approach known as the SWH with the traditional science teaching practices, Akkus et al. (2007) found a significant difference on the quality of teacher's implementation of scientific activities and students' achievement level. The researchers concluded that the SWH helped students to develop big ideas of science contents through constructing and testing questions, justifying their claims with evidence, comparing their views with others and considering how their views have changed. In order to get abovementioned efficiencies, teachers should know how to carry out argumentative activities and need to have pedagogical knowledge related to teaching argumentation (Zohar, 2007).

Tucel (2016) investigated the effects of SWH approach on eighth grade students' scientific epistemological beliefs, metacognition, and science achievement by comparing with traditional teaching. She applied a non-equivalent control group post-test only design in two eighth grade classes. One of the classes was selected as experimental grup and the other one was chosen as control grup. Epistemological Belief Questionnaire, Metacognitive Awareness Inventory, and Science Achievement Test for Eight Graders were employed as pre-test and post-test in experimental grup. The analysis of the data was made through MANOVA and t-test. Pre-test outcomes showed that there was no statistically significant mean difference between the two groups; on the other hand, post-test results indicated that there was a statistically significant mean difference between the comparison and the experimental group, in countenance of the experimental group.

Argument Based Inquiry (ABI) and Science Writing Heuristics (SWH) are used most of the time interchangeably within the existent literature. In this study ABI is used as terminology.

2.1.4.2 Research on ABI

In the literature, there has been growing number of studies related to ABI in the last twenty years. During the literature review it was remarked that most of the studies on ABI approach were focused on the students.

There are many studies (e.g., Akkus et al., 2007; Burke, Hand, Poock, & Greenbowe, 2005; Cavagnetto, Norton-Meier, & Hand, 2006; Hohenshell & Hand, 2006; Keys, Hand, Prain & Collins, 1999; Mohammad, 2007; Nam, Choi, & Hand, 2010; Omar & Hand, 2004; Greenbowe, Poock, Burke & Hand, 2007) which reported that students' conceptual understanding and cognitive engagement in science becomes deeper if the degree of the teachers' implementation level of ABI increases. The analysis of the implementation level was made through the video analyses, field notes, and observations. In these studies, the modified Reformed Teaching Observation Protocol (RTOP) was applied during the scoring of the ABI implementation quality. For example, the study of Greenbowe et al. (2007) showed that the implementation quality affects achievement on standardized tests and positively affects the achievement of low achieving students and females.

Researchers generally investigated the effect of ABI on students' achievement and attitudes towards science together (e.g., Günel, Kabataş Memiş, & Büyükkasap, 2010; Kıngır, 2011; Oğuz Çakır, 2011). In Kıngır's (2011) research, the effect of ABI approach on 9th grade students' comprehension of chemistry concepts and chemistry achievement in the subjects of chemical changes and mixtures was investigated. The tests related to the subjects were administered as pre-test, post-test and by the end of the year interviews were made with students from both control and experimental group. The results of the interviews showed that students from experimental group presented better scientific understanding of chemical change and mixture concepts in comparison to those from control group. Moreover, the outcomes indicated that students from experimental group enhanced positive attitudes toward chemistry and ABI approach. Similarly, Oğuz Çakır (2011) administered in her study the Science Attitude Scale developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) as pre-test and post-test to examine the impacts of instructional strategies of ABI on students' attitudes toward science. The results of the study revealed that students from the experimental group developed more positive attitudes toward science than students from the control group.

Akkus et al. (2007) examined the efficiency of the ABI approach on students' post-test scores with respect to students' science achievement level and teacher's implementation of ABI. Seven teachers and 592 students from grades 7 to 11 took part in the study. All of the teachers involved in 2-day workshop related to employing the ABI approach before their implementations. Teacher observational data was used to define the quality of teacher implementation level and test scores was applied to determine students' science achievements. At the end of the study researchers proposed that high-quality implementation of the ABI approach played a crucial role in declining the achievement gap in the science classrooms.

Furthermore, Yeşildağ-Hasançebi and Günel (2013) investigated the effects of ABI approach on low-achieving, socioeconomically disadvantaged students' science content understanding and argument development in the properties and structures of matter unit. Two eighth grade classes of one science teacher from a school in a disadvantaged social economic area were participated and quasi-experimental, pre-posttest design was preferred. The treatment group, engaged in ABI activities and the students wrote activity reports. Moreover all students did chemistry subject based tests as pre and post assessments. They presented evidences of scaffolding science learning for disadvantaged students. ABI significantly helped low-achieving students as compared to traditional teaching approach.

In a different study, Choi (2008) examined the quality of argument found in student science writing in chemistry laboratory classes in which ABI was applied. The quality of students' arguments in their writings was evaluated by using two scoring frameworks: an analytical and a holistic framework. In this study, producing a high quality of argument required generating strong evidence to support a claim and the results showed that integration of argumentation into science classrooms triggers higher-order scientific thinking skills of the students. Students were able to use to produce reasonably good quality arguments in the context of ABI.

In a quasi-experimental, pretest-posttest design mixed-method study, Hohenshell and Hand (2006) presented the advantages of integrating the startegies of writing-to-learn into ABI implementations. The study was applied to 91 ninth and tenth grade students in advanced biology course. There were three student groups: SWH group (writing in SWH format and summary writing to the teacher), peer review group (writing in SWH format and summary writing to peers) and control group (writing traditional in format and summary writing to the teacher). The researchers compared the students report writing in ABI format and in traditional format, and also administered a summary report of concepts explored in the inquiry activities. The results indicated that ABI affected students' performance better on conceptual questions and there was no difference on recall questions. Moreover in ABI classes, the students who wrote to their peers had higher scores than those wrote to their teacher. Furthermore the reseracher stated that the students in ABI and peer review groups were more aware of their own learning at the time of writing.

Chen, Hand and Park (2016) examined fifth grade students' development of oral and written argumentation practices in 16 weeks through ABI. Data sources consisted of five times of whole-class discussion focused on arguments of the groups that happened over 11 class periods; interviews with six target students and the teacher; students' group writings; and the researcher's field notes. The outcomes presented that five remarkable tendency in students' development of oral and written argumentation practices in time. Students came to use more critique elements as they involved in much times of whole-class discussion focused on arguments of the groups; students came to use evidence to defend, support, and reject arguments; by challenging the arguments of each other, students came to concentrate on the convenience of the argument and the evidence quality; the quality of students' writing constantly developed in time; and students interrelated oral argument skills to written argument skills as they found chances of revising their writing after discussion and developed awareness related to the benefits of critique from their friends.

There are also studies in the literature that focused on teachers. For example; Gunel et al. (2012) conducted a study to analyze the ABI approach implementations by focusing on questioning in the classrooms. The purpose of the study was to investigate the relation between levels of questioning and negotiation of ideas. The participants were 3 teachers and 146 students. The transcripts of the videos gathered from participant teachers' classrooms were analysed through discourse analysis. The results showed that the questioning and implementation level of the teachers were two important elements in starting and sustaining the negotiation of ideas in the science classrooms. Furthermore, a relation was found among teachers' questioning patterns, number and question types posed by the students. Lastly, the talk moves used by the teacher allowed for students' talk and negotiation.

In another study related to teacher questioning, Kılıç (2016) described the characteristics of teachers' different implementation levels of ABI teaching (middle and high) on questioning. From a longitudinal professional development program chosen participants were two science teachers, teaching from sixth to eighth grades. Multiple cross-case comparison was used during the analysis of the video records of the teachers' classroom implementations. The medium and high-level ABI classrooms were compared and the results showed that teacher's close-ended questions significantly reduced while meta-cognitive questions significantly increased within the high quality science classrooms.

Benus (2011) examined the patterns of dialogue that were demonstrated and showed up during the implementation of ABI by a fifth-grade science teacher and the ways in which these patterns of dialogue and consensus-making were used toward the building of a grasp of science practice. Collection of data included classroom video including transcriptions, semi-structured interviews, conversations after lessons, and field notes of the researcher. Three findings revealed in this study. First, the teacher generally attempted to three forms of whole-class dialogue with students; talking to, talking with, and thinking through ideas with students. The teacher's interplay in whole-class dialogue focused progressively on thinking through ideas with students over time, while students also dialogued more as each unit went forward. Second, this teacher insistently attended the activities with students toward consensus-making at the time of whole-class dialogue. Third, the classroom did not take part in critique and development of knowledge necessarily like the community of science but rather used agreeing and disagreeing and justifying the reason with intentional dialogic interactions to build a grasp of science classroom practice.

In another study, Pinney (2014) characterized the forms of teaching practice in a classroom continuing first semester implementation of an ABI approach changes in whole-class discussion. A basic qualitative approach was used after collection of multiple source of data: classroom video, teacher interview, student questionnaire, teacher lesson plans from previous years, field notes, and student journals. The results of this study contributed to the literature related to the practice of whole-class dialogue, science argumentation, and the understanding of practice in four facets: First, obvious lack of comprehension regarding big ideas and how to take advantage of them as the central organizing characteristic of a subject; second, development of dialogue and argument independently; third, obvious lack of comprehension regarding the construction of argument and use of basic nomenclature with argument and big ideas; fourth, challenges of ABI implementation.

As a different context, Promyod (2013) made a research about the change of five Thai teachers' views of learning and their pedagogical practices from the traditional approach to be more centered on ABI approach. The teachers and learners in Thailand have been accustomed to the lecture-based tradition for a long time. After fourteen weeks the results showed that the three teachers who stated a positive attitude toward the ABI approach and stated their enthusiasm to practice began to change their practices and views of learning toward a student-centered model. Despite the fact that each teacher displayed a different beginning within the three observed criteria, all of them started to change their practices first, before considering on their beliefs. Unlike these teachers, the other two teachers were hindered by some obstacles (such as lack of teaching practice, time constrains, curriculum, testing, college pressure) and thus failed to implement ABI.

Williams (2007) examined a teacher group for shifts in their practice and beliefs during their implementation of ABI approach accompanied by long-term in-class support. Moreover, the relationship between the teachers' beliefs and the amount that their practice changed was also found out. Both qualitative and quantitative methods were used in this research. The results of William's study proposed a few emerging themes. Despite some of the obstacles related to the teachers' skills, knowledge and beliefs, two of the three teachers did make progress towards more efficient ABI implementations. The teachers' beliefs seemed to play an important role in the efficient implementation of inquiry and the amount that their practice shifted. Moreover, the time that the teachers spared for implementing the ABI approach in their classroom also seemed to play a crucial role in the amount of change in practice happened.

In another study related to beliefs and practice, Martin (2008) examined the relationship between one experienced elementary science teacher's beliefs and her practices, and the factors that influenced this relationship by utilizing from single case study. The participant made ABI implementations during two semesters. Data were collected from interviews, classroom observations, field notes, audio-tapes of student discourse, student responses, RTOP scores, video-tape analysis, teacher's written reflections, professional development liaison reflections, think-aloud protocol, and metaphor analysis. Constant comparative method and RTOP scores were used during data analysis. The findings show that this teacher's central belief was her beliefs about how students learn which is intertwined with other peripheral beliefs. As the teacher innovated her central belief from traditional to more constructivist view, her peripheral beliefs also changed. Additionally, as teacher's beliefs shifted, so did her practice, which appeared that teacher's beliefs and practice were consistent and entangled during the whole study.

In a study conducted in Turkey, Yeşildağ-Hasançebi and Kıngır (2012) examined the potential problems faced during implementation of ABI approach and the ways that teacher used to handle those problems. They applied a case study as methodology. The participant science teacher made ABI implementations in his classroom for two years. Semi-structured interviews and classroom videotape recordings were the data sources. The findings presented the problems the teacher faced with during comprehending ABI approach: questioning (both student and teacher questioning), classroom management, accessing resources and equipment, and classroom interaction.

Most studies on ABI in the literature agree on the idea that argument building is not easy and solely obtained by the way of practice (e.g., Gunel, 2017; Martin & Hand, 2009). Furthermore, most studies emphasized the importance of longtime and ongoing professional development of ABI in teaching practice.

2.2 Teacher Professional Development

Professional development, in-service education, professional growth, teacher development, career development, human resource development, staff development, and teacher training are used in the literature alternatively (National Staff Development Council, 2006). According to Victoria Deneroff, "Professional development could be designed to facilitate reflexive transformation of identity within professional learning environments." (2013, p. 33).

The traditional teaching approach causes scientific concepts to be understood poorly, declines popularity of science and reduce number of the students who choose scientific subjects as an expertise because science teachers generally introduce science as a conglomeration of facts, theories and principles have to be memorized and practiced by the students (Millar & Osborne, 1998). By investigating the changes in science teaching, it shows up that inquiry has considerable significance because of having the potential of involving students in active learning environments (Kılıç, 2016). In the variety of resources the teacher professional development is the most important one which needs to be supported for effectiveness of inquiry based teaching and learning in science (Smith et al., 2007). Professional development programs have a fundamental role for teacher to develop understanding of teaching science as an inquiry and experience inquiry as a learner (NRC, 1996 and 2000). Moreover, professional development programs are the major resource of reforms in education and the most effective way to transfer innovations to teachers (Supovitz & Turner, 2000). According to Borko (2004), professional development is an opportunity for teachers to upgrade their knowledge and improve new teaching practices.

Reform based professional development has been found to be more efficient than traditional professional development (Loucks-Horsley, Stiles, Mundry, Love & Hewson,, 2010; Putnam & Borko, 2000) and includes more comprehensive involvement than traditional professional development (Easton, 2004). Traditional professional development programs included courses and presentations in which teachers improve their certain instruction skills and knowledge, but then this understanding has shifted and now the school is seen as a learning environment for everyone and an ongoing inquiry for teachers, students, and administrators (Fullan, 2001; Knight, 2002; Loucks-Horsley, 1995; Loucks-Horsley, Stiles & Hewson, 1996).

Hand (1996) accepted teachers as learners and built a model on the conceptual change model of Posner and colleagues (1982). Hand suggests five subsequent stages for a constructivist teaching approach oriented professional development: teacher’s knowledge of own pedagogy and science concept knowledge, identification of teacher’s knowledge of classroom practice, teacher’s identification of students’ knowledge of science, teacher’s implementation and connecting science concepts and pedagogical knowledge, and building of a constructivist teaching framework.

Sparks and Hirsh (2007) argue that most of the teachers do not attend high quality of professional development programs. These programs are focused on just filling required time and meeting state requirements. Also workshops are for one time and there is no following and supporter program, which makes positive change in student learning (Schmocker, 2006; Sparks & Hirsh, 1996). Darling- Hammond and McLaughlin (1995) have proposed that teachers are seen both as learners and as teachers in the effective professional development which supports them to compete with the uncertainties that go along each role. Argyris and Schon (1974) found that presenting teachers new content knowledge or instructional strategies is not enough for efficient professional development. It should be assisted by a change in teachers' beliefs. Because beliefs and perceptions of teachers are the barriers standing in front of reform based professional development (Penuel, Riel, Frank, & Krause, 2009; Schmocker, 2006). In other words, the professional development programs which do not consider attitudes and beliefs of the teachers have been seen as ineffective (Stipek & Byler, 1997). Furthermore, successfully changing teachers' beliefs and practices needs involvement of teacher (Borger, 2012).

Researches about the quality of professional development programs reported that teachers should experience the process as learners (Radford, 1998). Also adult learners wish to see before learning a new initiative that this is relevant. Furthermore, best learning occurs when their learning is positioned in a real context and they need time for connection between new learning and their variety of backgrounds (Knowles, Holton & Swanson, 2000). Educators concentrate on teaching and learning with the long term, strategically planned professional development programs as more of an inquiry: job-embedded learning, individual and systematic improvement, and student learning outcomes (Loucks-Horsley, 1995).

Professional development should be consisted of "follow-up experiences with multiple interactions" (Luft, 2001, p.552). Systematic follow-up and ongoing support are strongly recommended for the structure of reform based professional development (Danielson, 2006; DuFour & Eaker, 1998; Feiman-Nemser, 2001;

Gunel & Tanriverdi, 2014; Kent & Lingman, 2000; Killion, 2000; Lewis, 1997). Teachers cannot conveniently get ready without continual training in the context of ongoing professional development (Wood, 2013). The purpose of follow-up activities is enabling teachers to implement what is learnt in professional development programs in their own classrooms (Danielson, 2006; Darling-Hammond, 2000; DuFour, Eaker & DuFour, 2005). In the current study, onsite ongoing professional support was provided to the participant science teacher in order to apply what she learned in the trainings of the professional development program to her classrooms.

Teachers need time to become fully adopted and see the ground theory beyond the new teaching approach. For inservice programs to be efficient and fruitful “teachers must begin to engage in practices that have built-in support for the changes they have made; otherwise, the changes are likely to erode over time" (Franke, Carpenter, Fennema, Ansell & Behrend, 1998, p. 67). Bryan (2012) stated that mentoring and coaching relationship positively affects the revision and readjustment of science teachers’ beliefs and practices. Important trait of a successful professional development is constructing a support system for teachers requiring continued communication with and support from the professional development facilitators and participants in order to lighten the teachers’ implementation of training ideas (Kazempour, 2009; Banilower, Heck & Weiss, 2007).

Teachers’ enthusiasm for engaging with a new teaching approach is an essential element throughout the implementation process (Ghaith & Yaghi, 1997). Teachers need to be persuaded about applying innovations in order to make better instruction. Therefore, in the way of sustaining learning, follow-up workshops or ongoing support is important (Kubistky & Fishman, 2007). It is obvious that professional development should be accepted as a process, not an event (Loucks-Horsley et al., 1987, 1998). Gaining proficiency at something new and clearing the meaning up of this new way is not easy and from time to time exhausting. All innovations requiring great promise of enhancing individuals’ qualification or extending an organization’s efficiency is probably gradual and involve overwork (Huberman & Miles, 1984).

On the other side, teachers have some concerns when trying to implement a new teaching approach (Omar, 2004). The lack of administrative support, large class sizes, and the lack of planning time are presented by the teachers as obstacles during the implementation of instructional methodologies (Hootstein, 1999). Moreover teachers stated obstacles related to inquiry teaching as the lack of materials (Anderson & Helms, 2001; Blumenfeld, Krajcik, Marx, & Soloway, 1994), covering the mandated curriculum and preparation for state-mandated tests (Ladewski, Krajcik & Harvey, 1994; Schneider, Krajcik & Blumenfeld, 2005). According to social learning theory of Bandura (1986), if the teachers believe that the consequences outweigh the risks and cost to themselves in time and energy invested in applying differentiation, if the teachers have sufficient confidence in their self-efficacy to organize and do the actions necessary to achieve the desired results, and if teachers believe they can influence student learning, they generally do.

Efficient professional development programs should be long duration and aim many complicated values such as; beliefs, perceptions, and pedagogy which influence classroom practices of the teachers (Yager, 2005). Loucks-Horsley et al. (2003, 2010) presented basic principles related to the quality of professional development for science and mathematics teachers which also support the common visions of noted science and mathematics education standards (NCTM, 2000,2006; NRC 1996) and current standards for professional development (NSDC, 2001). According to these principles effective professional development experiences

- are designed to address student learning goals and needs. Based upon student data, professional learning experiences help teachers develop knowledge and skills to focus enduring content to improve student learning.
- are driven by a well-defined image of effective classroom learning and teaching. The images of a science classroom would include inquiry learning, investigations, applications of ideas, and an in depth understanding of core

concepts, challenges to learning faced by students, and a clear means to measure meaningful achievement.

- provide opportunities for teachers to build their content and pedagogical content knowledge and skills and investigate and reflect on practice critically. The process supports teachers in learning science content, learning how students learn, and learning how to integrate curriculum and learning experiences.
- are research based and engage teachers as adult learners in the learning approaches they will use with their students. The process needs to start where teachers are and provide ample time for meaningful investigations, collaborative work, reflection, and connect explicitly with other professional development experiences.
- provide opportunities for teachers to work with colleagues and other experts in learning communities to continually enhance their practice. When consistent learning is a part of the school culture teachers are willing to take risks, learn together, and share best practices.
- support teachers to amplify their professional expertise throughout their career and serve in leadership roles. Teachers become supporters of other teachers, agents of shift, and prompter of reform.
- provide connections to other parts of the educational system. It is integrated with district initiatives, state and district curriculum frameworks and assessments and has supports within the community.
- are consistently evaluated to make certain of a positive impact on teacher effectiveness, student learning, the school community, and leadership (Loucks-Horsley et al., 2010, p. 70-71).

2.3 Teacher Beliefs

Despite considerable research attention in the field of belief recently there is no agreed description of the theme (McLeod & McLeod, 2002). Ajzen and Fishbein (1980) describe belief as anything that an individual regards as true. According to Pajares (1992) beliefs must necessarily be inferred from the words or actions of individuals. In the literature researchers either define beliefs by interpreting the meaning of the term, or by attempting to distinguish it from the notion of what constitutes knowledge. Knowledge is vitually explained as a factual and rational idea based on facts and experiments (Gess-Newsome, 1999), while belief is described as an emotional element originated from people's attitudes, experiences, and values (Bryan, 2003; Gee-Newsome, 1999; Richardson, 1996). According to Nespor (1987) belief systems are much more effective than knowledge in determining how individuals frame and organize tasks and problems and are stronger indicators of the behavior. Therefore, rather than focusing on knowledge versus beliefs, studies should better target on the relationship between beliefs and actions and the factors that affect that relationship (Kagan, 1992; Kane, Sandretto, & Heath, 2002; Nespor, 1987; Pajares, 1992; Prawat, 1992). Because to change teachers' practices to a constructivist learning approach, deciding their beliefs, perceptions, values, and attitudes should be the principal focus (Ghaith & Yaghi, 1997; Martin & Hand, 2009; Richardson, 1998).

Bryan (2003) summarized the reviews and analyses of the related studies in the literature that there is a general agreement that beliefs are psychological structures that (a) involve images, propositions, understandings, or assumptions that are felt to be right (Kagan, 1992; Richardson, 1996); (b) motive a person's actions and support judgments and decisions (Goodenough, 1963; Pajares, 1992); (c) have highly changeable and unclear connections to episodic, emotional, and personal experiences (Nespor, 1987); and (d) despite undeniable connection to knowledge, vary from knowledge in that beliefs do not include a condition of truth (Dewey, 1933; Richardson, 1996).

Rokeach (1968) described beliefs as "any simple proposition, conscious or unconscious, inferred from what a person says or does, capable of being preceded by the phrase, 'I believe that…' " (p. 113). Some of the theoretical assumptions in this study are guided by Rokeach's seminal work (1968). He argued that all beliefs have a cognitive, an affective and a behavioral constituent. Cognitive constituent represents knowledge, affective constituent is capable of arousing emotion, and behavioral constituent is activated when action is necessary. Cognitive researchers (e.g., Nisbett & Ross, 1980) delineate beliefs as a subset of knowledge, Rokeach delineates knowledge as a subset of beliefs. According to him, understanding beliefs involves making inferences about individuals' underlying cases, inferences full of difficulty since individuals are generally unable or reluctant to exactly show their beliefs. Therefore, beliefs cannot be directly observed or measured. However, they must be inferred from what people say, intend, and do (Pajares, 1992). Rokeach's (1968) work has three principles:

- beliefs vary in intensity and power;
- beliefs differ along a central-peripheral dimension;
- the more central a belief, the more it will resist change

As Martin (2008) also referred in her study, Rokeach (1968) compared a belief complex to an atom, in which there is a nucleus and particles around it. Central beliefs form the nucleus. He explained the centrality with the term of connectedness, so the more connected a belief is to other beliefs the more central it is. He suggested that centrality of a belief is determined by four assumptions: beliefs touching on personal identity; beliefs shared with others; beliefs created in an underived or derived manner; or if it is a matter of taste. Central beliefs are those related to a sense of self or personal identity, shared with others, or created in an underived manner, through which formed by a direct encounter with a belief object. This underived belief is thought to hold more importance considering its connection to an existential "self". Peripheral (less central) beliefs then are those that are derived-learned from others, and beliefs about matters of taste. Rokeach (1968) proposed that attitudes and values are connected to beliefs and they altogether form an individual's belief system. The connection of attitudes and values to the beliefs varies in strengths and the extent of the power is related to how they are connected to beliefs.
One of the models in the related literature is "Sociocultural Model of Embedded Belief Systems" which was developed as a tool for understanding the construction

and development of beliefs and attitudes (Jones & Carter, 2007).

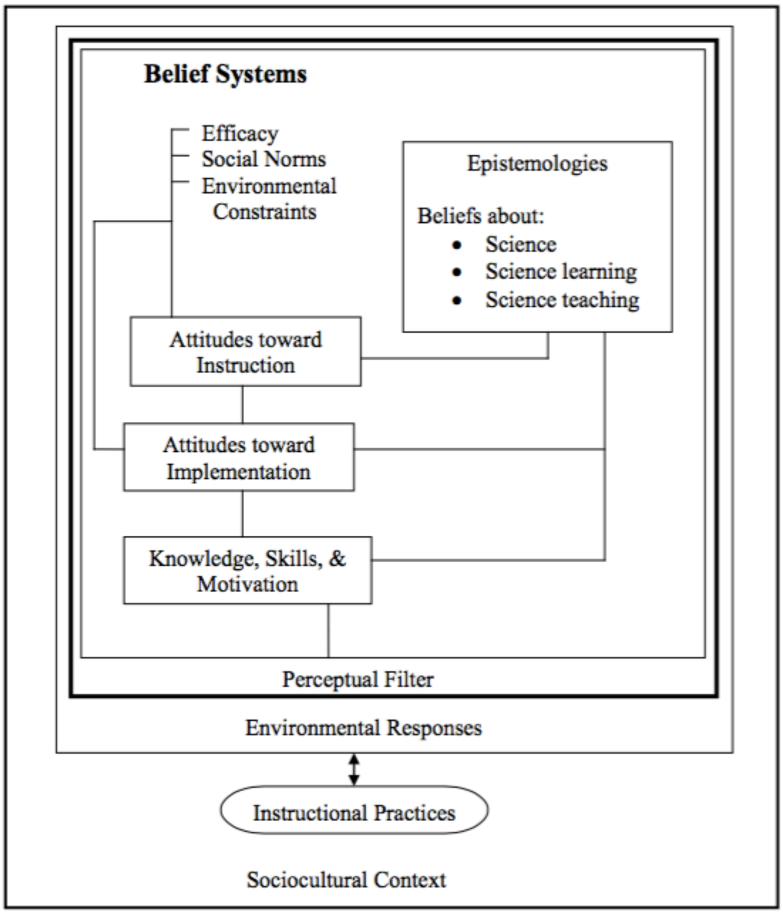


Figure 1. Sociocultural Model of Embedded Belief Systems (Jones & Carter, 2007, p. 1074)

This model has a cyclic nature and no starting point that is bound by the sociocultural context of the teacher (peers, students, culture, etc.). Knowledge, skills and motivation are prerequisites for attempting in a particular instructional practice. According to this model, motivation is influenced by attitudes toward implementation and attitudes toward instruction. Each set of attitude includes related belief system and can be either positive or negative. In this model, science teachers' attitudes are strongly affected by epistemological beliefs. Epistemologies represent beliefs about science, beliefs about learning and beliefs about teaching. Another group of component includes efficacy, social norms, and environmental constraints.

Jones and Carter (2007) explain self-efficacy as “beliefs about one’s ability to successfully implement an instructional strategy” (p. 1075). Social norms are teachers’ perceptions related to others’ expectations with regard to their teaching. Environmental constraints are barriers to successful implementation of an instructional practice, such as a lack of time or resources. According to Jones and Carter, beliefs are very connected to each other: “For example, a teacher’s beliefs about using cooperative learning in the science classroom cannot be separated from her beliefs about science, science teaching, science learning, her motivation, her self-efficacy, her knowledge of constraints, her knowledge of cooperative learning, her skills using cooperative learning, prior experiences, the class and school context, as well as the larger cultural contexts.” (p. 1070)

Another model is Ajzen’s Theory of Planned Behavior (1985) in which beliefs are used to predict an individual’s intention to engage in a behavior. This model consists of three constructs: attitude toward behavior, subjective norm, and perceived behavioral control. Attitude toward behavior (AB) is described as “the individual’s positive or negative evaluation of performing the particular behavior of interest” (Ajzen, 2005, p. 118). Subjective norm (SN) is a person’s perceived social pressure coming from such as school principals, colleagues, parents, and classmates when having or not having a behavior. Perceived behavioral control (PBC) is “the sense of self-efficacy or ability to perform the behavior of interest” (Ajzen, 2005, p. 118). Alhamami (2018) examines language students’ attitudes toward learning in a face-to-face language learning (FLL) group and an online language learning (OLL) group. The degree to language students attending face-to-face and online language classes positively or negatively valued shows their AB. In Alhamami’s study, SN implies the perceived behavioral expectations of important individuals or groups, such as a student’s spouse, family, friends, teachers, or classmates, about attending and learning in FLL and OLL classes. Furthermore, PBC represents for example beliefs about the existence of elements that may facilitate or hinder attending and learning in FLL and OLL classes (Alhamami, 2018). Ajzen’s Theory of Planned Behavior is seen one of the most popular models for explaining, predicting, and changing human behavior (Alhamami, 2018).

Teacher beliefs are important since as Dewey (1933) stated “They cover all the matters of which we have no sure knowledge and yet which we are sufficiently confident of to act upon and also the matter that we now accept as certainly true, as knowledge, but which nevertheless may be questioned in the future” (p.6). Fenstermacher (1979) predicted that the study of beliefs would become the focal point of teacher effectiveness research. In the related literature, Pajares (1992) said that beliefs are “the best indicators of the decisions individuals make throughout their lives” (p. 307). As a similar finding, beliefs structures are important in teacher decision-making related to curriculum and instructional tasks (Nespor, 1987; Pajares, 1992; Richardson, 1996). It is claimed that teachers trust their core belief systems rather than academic knowledge at the time of determination of classroom actions (Nespor, 1987). Many studies in the literature revealed that beliefs are origin of teachers’ understanding of pedagogical practices, of how students learn, and how they choose to act within the classroom (Abd-El-Khalick, Bell & Lederman, 1998; Brickhouse, 1990; Bryan, 2003; Clark & Peterson, 1986; Cronin-Jones & Shaw, 1992; Feldman, 2002; Lew, 2001; Luft, 1999; Pajares, 1992; van Driel et al., 2001). On the other hand, understanding beliefs necessitates researchers to make inferences about a person's internalized thinking which is a difficult task (Rokeach, 1968). However, studies on understanding the beliefs of teachers have been scarce (Clark & Peterson, 1986). It is stated that in actuality little is known regarding the content of teachers’ beliefs and the nature of the relationship between beliefs and practice (e.g., Kagan, 1992; Luft, 2001; Pajares, 1992; Richardson, 1996; Skamp and Mueller, 2001). This present study is also an attempt to contribute teacher belief research.

There has been considerable amount of research on the phenomenon that teacher beliefs are strongly affected by the school culture (Tobin & McRobbie, 1996; Yerrick et al., 1997; Munby, Cunningham & Lock, 2000). Greater number of research in the literature discusses teacher’s beliefs about teaching (Levitt, 2001; Bryan, 2003). In other respects, teacher beliefs related to how learning occurs help teachers to reorganize beliefs about the teacher and the students' role in the classrooms, which thereby affect the way they teach (Levitt, 2001; Luft, 2001; Richardson, 1996).

Haney, Czerniak, & Lumpe (1996) presented in their quantitative study that teacher beliefs were a powerful predictor of their intentions to apply innovative approaches. They found out that the most remarkable four beliefs below to predict teachers' intention for initiating inquiry:

1. increase interest and enjoyment of student in science;
2. promote positive scientific attitudes and habits of mind;
3. support students learn to think independently;
4. do science related to the students' daily lifes.

Furthermore, the study implied that experienced teachers desired training related to inquiry approach and the most impressive element of lasting reform may be the chance to experience accomplishment with inquiry-based teaching.

2.3.1. Belief-Practice Relationship

Beliefs and practices are interrelated, and beliefs are reliable signals of the resolutions people have the potential to take (Bandura, 1986; Czerniak & Lumpe, 1996; Kang and Wallace, 2004; Luft & Roehrig, 2007; Nespor, 1987; Pajares, 1992; Roehring and Luft, 2004). However, there are studies proposing little or no relationship between beliefs and practice (Bauersfield, 1988; Hoyles, 1992; Simmons et al., 1999; Wilcox-Herzog, 2002). The form and course in which teachers' beliefs and practices change is complex and differ, as occasion requires. Most of the studies promote the idea that teacher beliefs directly influence teaching practices (Bryan, 2003; Clark & Peterson, 1986; Crawford, 2007; Deford, 1985; Ernest, 1991; Fang, 1996; Kamil & Pearson, 1979; Mangano & Allen, 1986; Nisbett & Ross, 1980; Pajares, 1992; Richardson, Anders, Tidwell, & Lloyd, 1991; Schoenfeld, 1992; Tobin, 1993; Wallace & Kang, 2004), whereas others defend that teaching practices influence teacher beliefs (Cobb, Wood, & Yackel, 1990; Cobb & Yackel, 1996; Guskey, 1986; Ruthven, 1987). One more agreement is that there is a two-way relationship where beliefs impact practice and then the outcome of those experiences in turn impacts beliefs (Cobb et al., 1990; Thompson, 1992). William (2007) found logical that change in teachers' beliefs should come before the change in their practice and hence should be the main focus of professional development efforts. Luft (2001) proposed that novice teachers generally start with changing their beliefs, whereas experienced teachers shift their classroom practices at first. However, the opposite situation is also possible. Many teachers may first try a new curriculum and then may shift or think about shifting their beliefs if they find the new approach produces positive effects in their students (Anderson, 2002; Arora, Kean & Anthony, 2000; Guskey, 1986; Hand & Treagust, 1997; Huberman & Miles, 1984; Simmon et al., 1999).

Beliefs have a key role in affecting science teachers' practice and may ultimately decide if teachers choose to implement a new practice (Pajares, 1992; Richardson & Placier, 2001). There are many studies that have proposed that teachers' beliefs characteristically represent the actual practice happening in the classroom (Boulton-et al., 2001; Haney, Lumpe, Czerniak & Egan, 2002; Luft, Roehrig & Patterson, 2003; Richardson et al., 1991; Yerrick et al., 1997). On the other hand, inconsistencies between teachers' belief and their actual classroom practice have been interpreted by some of the researchers (Kang & Wallace, 2005; Luft, 2001; Murray & MacDonald, 1997; Simmons et al., 1999); in most of these studies the teachers supported student-centered beliefs but were intended to have teacher-centered pedagogical practices. Teachers who have old and new ideas about teaching at the same time; their learning and actions mix simultaneous and change based on the case and personal factors (Bryan, 2003; Hancock & Gallard, 2004; Marx et al., 1997). Change in teachers' beliefs to constructivist learning does not certainly imply that their teaching behavior in classroom will meet with a similar change (Duit & Treagust, 2003; Fischler, 1994). When a teacher is dissatisfied with his/her beliefs, shifts in beliefs exist by means of a conversion or a gestalt shift (Feldman, 1997;

Nespor, 1987; Pajares, 1992). On the other side, Hand (2008) claimed in the sense of implementing ABI, if teachers change their classroom practice from teacher-centered to student-centered, the purpose of science learning should be constantly shifted from concentrating on ‘content’ to ‘concept’ or ‘big idea’.

It should be stated at the end of the literature review that several assumptions guided this study:

- Beliefs are the set of all things that we believe
- Knowledge is a subset of beliefs;
- People have belief systems that involve beliefs, attitudes and values
- There is a relation between beliefs and practice

To sum up, ABI approach was administered in this study as teaching and learning environment. Providing this environment is not an easy task for a teacher since it is not a sudden action. This requires a long process in which the teacher shifts their practice and beliefs about teaching and learning with the help of well-structured professional development program related to ABI approach.

CHAPTER 3

METHOD

The main focus of this study was to investigate how a science teacher's pedagogical practices and beliefs were changed in the context of Argument Based Inquiry (ABI) accompanied by onsite ongoing professional support. The method chapter adresses the procedure selected for this study including research design, data collection, participants, data coding and analysis, trustworthiness and limitations of the study.

3.1. Research Design

3.1.1. Design of the Study

Qualitative research approach was applied in this study. Qualitative research is interested in collecting data in a natural setting or in a place that the participants take part in the study (Creswell, 2007; Stake, 1995). In this sense, most of the data in the present study were collected from the school settings especially from the classrooms.

As one of the qualitative research designs case study was prefered for this research. The case study design was the appropriate methodology to address each research question of this study since it helped the researcher to investigate and ensure deep and detailed characterizations of the participant teacher's beliefs and pedagogical practices from teacher's authentic ABI implementations in the classrooms. Merriam (1998) discriminated case studies from other types of qualitative research by characterizing them as "intensive descriptions and analyses of a single unit or bounded system" (p. 19). Depth of individual cases is a substantial feature of using the case study approach (Creswell, 1998). Crabtree and Miller (1999) expressed that one of the advantages of qualitative case study approach is the close cooperation between the researcher and the participant by providing participants to tell their stories. By means of these stories the participants are able to define their views of actuality and this provides the researcher to better comprehend the participants' moves (Lather, 1992; Robottom & Hart, 1993).

In the literature, there is an agreement between researchers that the relationship between practice and beliefs is not apparently understood (Kagan, 1992; Luft, 2001; Pajares, 1992; Richardson, 1996; Skamp & Mueller, 2001). For instance, Pajares (1992) said that "Beliefs cannot be directly observed or measured but must be inferred from what people say, intend, and do - fundamental prerequisites that educational researchers have seldom followed." (p.207). In the belief research it is seen that qualitative approaches are mostly used (Martin, 2008). Generally, single case studies have been used in teacher beliefs research (Bryan, 2003; Marsh, 2002; Tobin & LaMaster, 1995; van Veen, Sleegers & van de Ven, 2005) . Since the change process of teachers in their instructional practices and beliefs is complicated, a qualitative case study approach which makes rich and thick descriptive data available was used by the researchers (Geertz, 1973). For data collection, observation and interviews are the most commonly used tool of measurement in antropological research (Richardson, 1996). Patton expressed that the aim of the interviewing is learning what is "in and on someone else's mind" (p.278). According to Merriam (1997), carrying out an interview is "the best technique to use when conducting intensive case studies of a few selected individuals" (p.72). For that reason, in the present study case study design was used and data were collected via observations and semi-structured interviews.

3.1.2. The Context of the Study

3.1.2.1. The School

This study was set in a public middle school located in a district where low-income families lived in the capital of Turkey, Ankara. The school has one laboratory insufficiently equipped with mostly old materials. The laboratory is smaller than an average class. A typical class period consisted of 40 minutes, and was represented four times in two days in a week. Break time between periods was ten minutes.

3.1.2.2. The Participant

In the present study, researcher used purposive sampling. At the beginning, 4 participants were selected from the 48 middle school science teachers involved in 3-day inservice teacher training program (The program will be discussed below.) by considering their willingness to make ABI implementations and take onsite ongoing professional support. The reseacher met all of the teachers during inservice training as one of the trainers in the program and also considered the school locations of these teachers during sample selection. The researcher asked them if they want to support during the implementation of innovative approach that they experienced in the inservice training. The teachers accepted to make ABI implementations accompanied by onsite ongoing professional support and they volunteered for this study. At the beginning of the study four participants involved in the study in the first semester; however, only one of them was able to continue in the second semester. The researcher prefered to focus on this teacher in the present study with the aim of deeper analysis of the process related to pedagogical practice and beliefs about teaching and learning.

The purposefully selected teacher in this research enabled a unique situation because she was in her first semester of professional development using the ABI approach with the 36 students who had experience in traditional teaching for years. The 30-year-old teacher in this study held a bachelor degree of elementary science education and she said that she had five years of experience in teaching in direct instruction method. The teacher did not claim that she was a really good teacher; however, she gave herself 60 points out of 100 since she made great effort for it. The teacher had just started implementing ABI approach to promote student-centered approaches to learn at the beginning of this study and experienced inservice training just prior to the semester starting. Furthermore, she was willing to participate in this study.

Participant teacher's beliefs about how she should teach science were characteristic of a teacher-centered classroom where she was the transmitter of knowledge. Prior to the study, the teacher taught science through the use of the science textbooks by direct instruction. If students had questions, they asked them to the teacher and she answered. Also she was preparing herself for the lesson by considering high-stakes testing (TEOG) in Turkey and took care of multiple-choice questions. Moreover, students made experiments in which the teacher determined what to examine, gave the materials and told students what to do as it is in the cookbooks. However, she is open to innovative approaches, attends different inservice trainings of the prominent universities of Turkey and follows different scientific programs. For example, she conducted a scientific project of TUBİTAK (in which students prepare their own projects and present them to school students, parents, teachers, guests and TUBİTAK committee in a specified day at the end of the year) in the school besides this study. Moreover, she wants to get a master degree. The teacher's explanation (after inservice training and before ABI implementations in the classroom) of which type of teacher she is presented below:

> In spite of the fact that I am a middle school science teacher, there is so much that I do not know and learn together with my students but of course I do my best to learn and question how to teach better. Certainly at times I have difficulties yet I try to do my best. Since I come a little bit from rote learning, I tend to multiple-choice tests actually and I was not a teacher who would do activites in the class so far but I really want to be this kind of teacher, because I quite enjoy doing activities with students and learn together. Our generation mostly internalized the parrot fashion and direct instruction method. Now the new generation is more inclined to use scientific activities and constructivism. I do not know how much I can but am trying to be so.

3.1.2.3. Professional Development Program

The purpose of the professional development (PD) program was to enhance the teachers' comprehension and implementation skills of ABI teaching in the middle school science classrooms. The teachers were able to construct pedagogical skills and knowledge with the aim of allowing their students to encounter enthusiasm and challenges of investigative and experimental science as well as to improve skills recommended by the recent science reforms. So as to reach this purpose, the design and content of the PD program were constructed through regarding practice-based understanding, data-driven evidence and expectations about national science reform in relation to the classroom practices. In this part, the structure and content of the PD program was presented in detail.

PD program in this study consisted of two main stages. The first stage was a 3-day-long (approximately 24 hours) inservice teacher training and the second stage was onsite ongoing professional support over a year. Bowyer, Ponzio, and Lundholm (1987) proposed that eight to sixteen hours of inservice training program time is needed to successfully make shift in teacher's pedagogical practice. The professional development program mentioned in this study was in line with their proposal. Furthermore, much more time was devoted to the second stage of the PD program which made this study significant. The structure of this PD program was based on the theoretical framework stated in the literature review.

3.1.2.3.1. Inservice Teacher Training Program

The teacher was selected among participants enrolled in a 3-day inservice teacher training program at the beginning of the school year (2014-2015) that was carried out in a university in Ankara in Turkey. Phases of the in-service teacher training program incorporate diverse workshops. Pinney (2014) stated five key features of workshops in his study as examining the role of language in learning science, involving in a SWH lesson enabling the participants to experience the lesson as students would, practical and pedagogical matters regarding implementation, discussing alignment of one's teaching practice with learning theory, and assisting teachers to construct instructional units built around a "big idea" in science that are consistent with the SWH approach and standards of NGSS. The workshops of the present program contained the key features, which Pinney mentioned.

In the preset study, the program began with theoretical negotiations on learning and teaching in order to see teachers' pre-existing beliefs, perceptions and postures related to teaching, learning and learners. Then the first day of the program continued with ABI content related activities. Within the scope of these ABI activities, teachers were involved in hands-on inquiry experiences within the selected curriculum-based unit. In these activities teachers were treated "as if they were learners" in order to face them intensely in inquiry, questioning and experimentation. Hence, the program could be a model for teachers regarding forms of teaching through ABI. Also another aim of treating teachers as learners was to show them how they should behave their students as learners and to make them understand how students really feel and what they do in an ABI related learning process. Such activities not only highlighted the value and joy of ABI learning but also presented an opportunity for self-reflection about their own learning dynamics. The national and international research analysis in inservice teacher education pointed out the necessity of teacher practice of the training period as a learner in an attempt to make the teachers share their own learning experiences and to make their own inferences about how learning occurs (Gunel & Tanriverdi, 2014).

After implementation of ABI related activities, teachers participated in discussions with respect to this implementation. The purpose of these discussions was to cross-question with teachers whether there is a difference between their learning and the students' learning, and to reflect upon what they carried out over the ABI-related activity as a learner. Moreover, after the implementation of this activity, it was also intended to manifest participant teachers that the process they were a part of was planned by taking the learning outcomes in the science curriculum into consideration. After these practices, another pedagogical discussion was carried out relevant to learners' conceptions and learning.

Abovementioned implementations were applied in the first day of the inservice teacher training program. In the second day, the program continued with a second ABI related activity in a different content from the previous one. After this activity second pedagogical discussion in the name of "fish bowl" with the purpose of demonstrating how the trainers made preparations for the ABI related activities was hold. Two of the trainers presented the preparations of previous parts of inservice training by negotiating with teachers. Here, the aim was to convince the participatory teachers that if they were diligent for the preparations, they could have a chance to make an authentic application of an ABI oriented activity in their classrooms.

On the other hand, what were the necessary preparations to get ready for implementing an ABI content related activity? Cooperation between trainers and the participating teachers was essential. In the third and last day, inservice training continued with the lesson preparations of teachers, which starts with the construction of a well-designed individual concept map. Because developing this concept map provides teacher what s/he knows about the content and which deficits s/he has related to content. Jonassen, Reeves, Hong, Harvey and Peters (1997) also stated that the intention to construct a concept map is revealing the perceptions of the map's author, rather than a reproduction of memorized facts. Particularly it is one of the best ways of reflecting someone's knowledge about a content and it is a kind of individual negotiation about concepts. Therefore, the concept map can be an effective tool to reflect and manage this conceptual and cognitive process.

After the finalization of concept maps, big and sub-ideas were formed by taking into account of the individual concept maps. Concept map oriented big idea(s) provides teachers to see the limits of the unit and to achieve a holistic view to the flow of the unit. Because ABI includes very open-ended processes for students. In this case students can get drowned in the subject and enter into nonsense and dubious investigations unless a teacher draws the red lines of his/her primary purposes. Thus, in the light of big idea(s) teacher will be able to keep the implementation where it belongs and prevent students' minds not to get meaninglessly confused. Also, "sub-ideas" provide teacher ABI activities in which students are lead to a common insight and if the teacher makes implementations touching with each sub-idea, students will be able to reach the big idea of the unit.

After teachers prepared their concept map and constructed big and sub-ideas of unit, some further preparations for the beginning activities followed. In these beginning activities, students were lead to ask a researchable question raising their curiosity via initial class discussion and make experimental investigations. Afterwards holding all these workshops in the university classrooms, the 3-day-inservice teacher training program ended with general evaluation of the workshops.

After the first stage of the PD program, teachers had a chance to take support from the expert trainers in their classrooms. These trainers are the people who guide the teachers during the inservice training and make research on ABI approach, professional development and science education as being professors, associate professors, graduate students and doctoral students. The researcher of this study was also one of the trainers in the inservice training. The support for the teachers after the inservice training was valuable because even the teachers saw some examples of ABI activities in the trainings they needed assistance when experiencing it.

In the literature, it was stated that changing teachers' practices is not an easy job. In order to innovate teachers' practices there were two major stages of this present PD program. First stage was inservice teacher training program. After inservice training, PD program continued with on-demand part. The second stage was "onsite ongoing professional support". Onsite ongoing professional support was given optionally when teachers decided to make changes in their teaching and make preparations for ABI implementations. The abovementioned structure and content of the PD program was summarized in the Table 2 below.

Table 2. The Content and Structure of the PD program

	Content Components		Description	Purpose
The Professional Development Program	**In-service Training Activities**	*Pedagogical Discussions*	Constructing an understanding of learning and teaching	Scaffolding teacher perceptions through learning and teaching of science to better inform and guide the development of the necessary pedagogical practices
		Hands-on Inquiry Experience	Immersing teachers in ABI activities within the selected units so that they can experience the process by themselves as learners	Development of familiarity with hands-on activities
		Curriculum Preparations	Development of unit plans and potential pathways activity	Successful implementation of ABI inquiry teaching in actual classrooms
	On-site Professional Support		On-going support in teachers' school settings by the school visit of researchers	Teacher engagement in ABI teaching; accommodation of their instructional needs; monitoring incentives
	Assessment and Measurement		Analysis of classroom videos recorded by teachers during ABI implementations in their own classroom environments	Providing feedback on teacher pedagogical development after each semester in the program

Source: Kilic, B., (2016). Investigating questioning patterns of teachers through their pedagogical progression in ABI classrooms.

Some of the teachers attending this ABI oriented inservice teacher training program and willing to make ABI implementations in her classrooms by taking onsite ongoing support. One of them was selected purposefully and she volunteered for this study. She also accepted that her implementations would be evaluated within the context of the present study.

3.1.2.3.2. Onsite Ongoing Professional Support

Participant teacher would implement ABI in her selected classroom(s). Although she attended the inservice teacher training program, she was not sure about how to apply it. What were the requirements of the preparation, what was waiting for her in the classroom and which reactions of students did she face with if she wanted to practice ABI? The teacher had many questions and hesitation since she had never applied ABI. The intention was to locate a new lens on teacher's preparations and implementations in order to monitor. Ongoing support provided by instructional coaches raised the possibility that teachers would transfer new learning into their classrooms (Cooter, 2003; Cranton & King, 2003; Loucks-Horsley & Matsumoto, 1999; Zemelman, Daniels & Hyde, 2005).

Considering that teacher needs time for training and investigating the innovative approach, one-on-one onsite ongoing professional support was planned by the researcher. These sessions were conducted by taking into account teacher's needs. Besides face-to-face communication e-mail, mobile phones and whatsapp were used to ease communication with the teacher. The researcher provided onsite supports in teacher's school settings at least once in two weeks, and ongoing supports at least once in a week and whenever teacher needed with other communication tools.

In the first meeting with the participant teacher in her school on October 22, 2014, a detailed briefing about the coming process was given to the teacher. A general time schedule was formed for preparations and in-class implementations, and also science units were decided for ABI implementations. After the teacher signed the consent form, pre-interview was conducted. In the second meeting, preparations were started.

The participant teacher was asked to choose one or two unit(s) from the first and second semester curriculum to make instruction in ABI format. Teacher had freedom to choose topic, grade and classes. She chose "Electricity In Our Life" (third unit in the seventh grade science curriculum) in the first semester and "Light" (fifth unith in the seventh grade science curriculum) in the second semester. Actually, we planned one more unit for the second semester; however, we could not arrange the time because of various factors: snow holiday, teacher's other project liabilities, students went to their hometowns before the start of school holiday. Also first two units could not be included into the schedule because of the duration of official authorization process for the research. Moreover, the teacher chose to make implementations in seventh grade and in one section (7/C). Implementation dates were given in the table below:

Table 3. ABI Implementation Units In Science Curriculum

Unit	**Semester**	**Recorded ABI lessons**	**Content of the ABI Implementation**
Electricity In Our Life	1	2	Frictional Electricity
		2	Electric Current
		2	Series-Parallel Circuit
Light	2	2	Absorption of Light
		2	Refraction of Light
		2	Lenses

The researcher attended all class periods with the teacher and observed the class by taking field notes and video records. The dates and times of all class observations were organized beforehand by the teacher and the researcher. But, the teacher gave the final decision about the days and times the researcher could come and observe her classes.

There are three phases in teacher preparations accompanied by onsite ongoing professional support:

1. Teacher-on-preparation
    - Teacher-researcher collaborative content related negotiations
    - Preparation of concept map

    - Deciding big and sub-ideas
    - Preparations of classroom activities and teacher's negotiation cycle
        - Development of possible negotiation cycle taking place during initial class discussion
        - Development of ABI activities including alternative scenarios
2. Teacher-on-action
    - Classroom implementation (Researcher is a nonparticipating observer but ready for onsite support if needed in the classroom) (The procedure is explained below in detail.)
3. Teacher-on-self reflection
    - Teacher's briefing (self-reflective judgement) after each ABI implementation
    - Semi-structured interviews at the beginning of first semester and at the end of the year
    - Informal conversations during preparations, before and after lessons.

Teacher-on-preparation

At first, teacher constructed a concept map related to the unit by herself and the researcher gave feedback on it via e-mail. Then a face-to-face meeting was arranged. In this meeting, collaborative negotiations about the content were held. In this way, she experienced how a negotiation cycle (class discussion) about the topic could be formed in the classroom with the students. Then the researcher and the teacher worked on the preparation of the concept map, talked about its logic and evaluated the concept map she made. Teacher-researcher collaborative concept maps were given in the Appendix C. After that they went through the formation of big and sub-ideas. The final decision of big and sub-ideas was left to the teacher. Teacher always had the freedom to accept or reject the suggestions posed during this one-on-one discussion sessions between the researcher and herself.

The next step in the preparations for the unit was to choose at least 3 ABI oriented activities related to big- and sub-ideas for implementations. Hand, Wallace, and Prain (2003) suggested that minimum 3 SWH activities was required to make a noticeable difference in a teacher's instructional approach and thereby have effect on students' understandings of the scientific conceptual knowledge. The teacher had a chance of experiencing 6 ABI implementations in two science units during this process. The activities were ABI oriented which promoted the negotiation of science knowledge in the classroom, and allowed for higher-level student thinking.

During each ABI oriented planning, the teacher used an ABI teacher template (given in Appendix B) in order to visualize the negotiation cycles that would happen during initial and whole class discussions. First she prepared an attention grabber question related to content and then possible questions that she can ask and/or the students pose. This prediction of questions during initial class discussion enables also taking precautions for students' irrelevant and searchless questions. Furthermore, one more possible initial class discussion was structured for each implementation as plan B. Then she decided possible ABI activities. If the teacher asked for advice in activity selection, the researcher helped her to find or choose the activities. After she fully constructed the ABI teacher template, she mailed it to the researcher and the researcher gave feedback for it by e-mail and phone calls. Furthermore, before each ABI implementation the teacher and researcher talked about the planning and the process that would take place in the classroom.

Teacher-on-action

What happened in the classroom during ABI implementations? In general ABI was applied in 3 consecutive phases: (1) initial class discussion (opening negotiation) (2) experimentation and small group discussions (3) whole class discussion. The teacher followed the below procedure in each ABI implementation. RTOP scores of the teacher represented how successful she implemented this procedure.

The teacher engaged students in a discussion about the topic by asking an open-ended and attention-grabber question. Teacher attempted to reveal students' prior understanding through initial class discussion and created negotiation environment in order to force them to think and state their ideas related to discussion, and she pushed them into the negotiation cycle. At the end of this opening negotiation, it was intended to create a conflict in students' mind. Then students as groups formed the questions that they wanted to investigate. After revising the questions from the view of whether they are researchable and suitable (for topic) questions or not, each group made experiments in order to find out an answer related to their questions. The experiments totally focused on students' purposes were decided by the students themselves and they might be changed as a result of negotiation between the students or between the students and the teacher. While students were making discussions in small groups, the teacher attended these negotiations by visiting each group and asking what they did, how they did it, what they found and what they thought about it. While she was making this, she tried to direct students to the big idea.

As students were performing their experiment, they were required to provide relevant qualitative observations and quantitative data. Each group recorded observations and data during investigation. The teacher encouraged students to negotiate their understandings about the data with their friends. The students were encouraged to make knowledge claims to answer their beginning questions which were also a statement of explanations for their data. And based on their interpretation of their findings they supported their claims with evidence. After completing this process, each group wrote their questions, claims and evidences on the blackboard. All groups explained and defended their claims with evidences in front of their friends respectively, which occured in whole-class discussion. At the end of each group's presentation the rest of the class asked the questions that they did not understand or make challenge to group members which creates a discussion environment. Moreover, some students refuted the arguments of the presenter group. The teacher also time to time attended to whole-class discussion with her questions and tried to direct students to the big idea, draw their attention to the missing parts and increase student-student interaction. After this discussion, students finished ABI reports that they started to write in the process. Students individually wrote for each implementation their questions, experiments, observations/findings, claims, evidences, reflections related to the change in their first ideas and information from other sources related to their findings in their ABI reports.

Teacher-on-self reflection

After each class session, the researcher discussed with the teacher about the implementation of ABI approach. The teacher gave briefings related to her ABI experiences. During this one-on-one debriefing session, the researcher first accompanied the teacher with questions (e.g., What was the best part of the lesson?, Did you have any difficulties, which moment did you face with this difficulty?) to make self reflective judgements and then highlighted some aspects of the implementation and pedagogical moves that needed improvement in order to promote teacher's awareness of certain behaviors, and finally made suggestions to the teacher for the proper implementations in the next weeks. At the time of the implementation period, the researcher repeated the same procedure. Moreover, this process built trust between the teacher and the researcher. All discussions between the researcher and the participant teacher were recorded audially for later analysis. Furthermore, at the end of the first semester, researcher gave a general feedback related to in-class implementations by watching the videos for better experiences in the next ABI implementations.

3.1.3. Data Collection

Data collection for this thesis study comprised a period of ten months. Within the span of these months, the researcher of this study applied qualitative methods of data collection. According to Yin (2002), there are three key principles in case study data collection: using multiple data sources of evidence, creating a case study database, and maintaining a chain of evidence. The multiple data sources used in this study were:

- Observations of six ABI implementations including classroom videos and non-participant onsite observations

- Semi-structured interviews
- Teacher's briefings and informal conversations

Table 4. Data Collection Tools and Purposes

Data Source		Data Type	Purpose	Research Question (RQ)
Observations	Classroom video	Video records	To analyze the level of teacher's ABI implementations with RTOP scale and the classroom moments in which the teachers initiated, scaffolded and maintained whole class negotiation(s) and overall classroom interactions for further implementations.	RQ1
	Non-participant onsite observations	Written (field notes)	To be able to discuss with the teacher immediately after ABI implementations related to the classroom moments in which the teacher initiated, scaffolded and maintained the negotiation(s) and overall classroom interactions.	RQ1
			To capture researcher's thoughts from being in the classroom and to help illustrate what videoing may not be able to capture.	RQ2
Semi structured interviews		Audio records and transcribed texts	To understand and capture the teacher's beliefs, perceptions, ideas about teaching, learning, ABI and the experiences of ABI (implementations and preparation process).	RQ2

Table 4 continued

Teacher's briefings and informal conversations	Audio records and transcribed texts	To capture teacher's self-reflection about her beliefs and instructional practices when she explicitely explained.	RQ1, RQ2

Observations (Classroom Videos and Non-participant Onsite Observations)

In order to interpret teacher's beliefs and pedagogical practices, observation was necessary as a primary data source. together with other data collection methods as an additional evidence. Observations included classroom videos and non-participant onsite observations. The 6 ABI implementations of the teacher from the two science units (Electricity in Our Life, and Light) were observed and recorded as videos. The videos allowed the researcher to see and hear the most of the aspects of the classroom and evaluate the lessons by using RTOP scale with other researchers. Each class period was approximately 40 minutes in length and each ABI implementation continued as two class periods. Most of the students voluntarily used 10 minutes break between two periods for ending their investigations. Since it was impossible to see all details related to teacher's practices in the videos, the researcher observed the class sessions. Furthermore, another important reason for non-participant onsite observation was to make it easier to interpret teacher's beliefs. As Pajares (1992) and Bryan (2003) stated studying teachers' beliefs was difficult, because individuals are generally incapable or even unwilling to share their beliefs and it is thought that teachers often do not explain their thoughts. These non-participant observations were recorded as field notes. Field notes included strengths and weaknesses of ABI implementations, remarkable student-teacher interactions, missed teacher opportunities, and how students and the teacher reacted in the small group and whole class discussions. Moreover, notes included reflections on the teacher's practices related to her beliefs. The field notes were hand written in a field journal and dated.

Semi-Structured Interview

Interviewing is one of the most important techniques preferred when applying case study research (Merriam, 1998). Interview enables for researcher to examine teachers' beliefs concerning teaching, learning and ABI approach. Semi-structured interview is generally used to investigate teacher beliefs in the way they define their thoughts and practices (Kagan, 1990). Interviews were oriented to understand teacher's current views of learning and the pedagogy she believed she was performing. Case study analysis should "show how it sought to use as much evidence as was available, and [the] interpretations should account for all of this evidence and leave no loose ends" (Yin, 2009, p. 160). This study includes semi-structured interviews, which were conducted at the beginning and end of the year. Each interview has 31 questions (given in Appendix D and E) which were developed to make explicit teacher's beliefs and practices before, during and at the end of the process, and focusing on the information this study searched. Each interview continued almost two hours. The researcher tried to give the teacher enough time for deeply answering the questions. they were recorded audible in order to transcribe dialogs later for coding in data analysis procedure.

Teacher's Briefings and Informal Conversations

The teacher gave briefings related to her ABI experiences immediately after the implementations. These briefings enabled to make her self-reflected judgements with the guidance of the researcher during one-on-one debriefing dialogs. Informal conversations also generally occured after the lessons and sometimes during the lesson while students working individually or in groups. These conversations concentrated on teacher's moves related to the elements of ABI implementation. Briefings and informal conversations were generally captured by audio recording or notes were taken after the conversations.

3.1.4. Data Coding and Analysis

The researcher investigated the change in science teacher's pedagogical practices and beliefs when she implemented ABI oriented science lessons in seventh grade classrooms with onsite ongoing professional support over a year. The research questions of the study are:

1- What changes occur in science teacher's pedagogical practices following implementation of ABI accompanied by onsite ongoing professional support?
2- What changes occur in science teacher's beliefs about teaching and learning following implementation of ABI accompanied by onsite ongoing professional support?

3.1.4.1. Analysis of Research Question One

The Reformed Teaching Observation Protocol (RTOP) (Piburn & Sawada, 2000) was selected to measure teachers' ABI instructions. The RTOP is an observational instrument that was designed to evaluate changes in classroom environments as regarding reform as implied by the NRC and was used to analyze videotaped science lessons. The RTOP was also modified into Turkish by Günel, Akkuş, Özer-Keskin and Keskin-Samanci (2013). The items of RTOP, which were appropriate to the teacher template of the SWH approach, were categorized into four components: student voice, teacher role, problem solving and reasoning, and questioning (Martin & Hand, 2009). Scores were calculated by using a rubric of 0 (never occured) to 4 (very descriptive) which was detailed enough to identify the participant teacher's level of ABI implementation of each criterion. The RTOP has been shown to have a high inter-rater reliability and has been factor analyzed for construct validity. Despite the fact that RTOP is an effective tool for identification of reformed based teaching, the researcher shared the same concern with Promyod (2013) related to RTOP's limitations for evaluating teacher's questioning since it contained only one item directed to questioning practices. In this study, the three items which were added by Promyod (2013) to the RTOP's questioning category were also considered and included. Abovementioned 17 RTOP categories were given in Table 5 below:

Table 5. RTOP Categories

Student Voice	- The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein. - The focus and direction of the lesson was often determined by ideas originating with students. - Students were involved in the communication of their ideas to others using a variety of means and media. - There was a high proportion of student talk and a significant amount of it occurred between and among students. - Student questions and comments often determined the focus and direction of classroom discourse.
Teacher Role	- The teacher acted as a resource person, working to support and enhance student investigations. - The metaphor "teacher as listener" was very characteristic of this classroom.
Problem Solving and Reasoning	- This lesson encouraged students to seek and value alternative modes of investigation or of problem solving. - Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures. - Students were reflective about their learning. - Intellectual rigor, constructive criticism, and the challenging of ideas were valued. - Active participation of students was encouraged and valued. - Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.
Questioning	- The teacher's questions triggered divergent modes of thinking. - Questioning to encourage student's investigation - Teacher's questioning to promote students' negotiation and multi-person conversation - Opportunity for learners to pose their own questions

In this study, participant teacher's 6 ABI implementations were videotaped. Each video continued for 90 minutes of two consecutive lessons. Videorecords of the lessons were evaluated using RTOP instrument. According to McMillan and

Schumacher (1997), the common reliability estimate applied for observational research is agreement. This means that when two or more raters observe and rank something independently, inter-rater reliability is achieved if they agree with each other with respect to rating and observations. In this study, two independent raters watched the videos and scored the participant teacher's ABI instructions by using RTOP. The raters were experienced researchers in the use of the RTOP instrument. In case of different ranking in scorings of these two independent raters, revisions of the observation notes and discussions were made until an agreement was reached. When it was needed, videos were consulted again and watched related minutes of ABI lessons to reach an agreement. Inter-rater reliability between two raters was very close to 100%.

3.1.4.2. Analysis of Research Question Two

The research on teacher change draws attention to the reality that teacher pedagogical changes in their practices cannot be acquired without a change in their perceptions and beliefs about learning and teaching (Gunel & Tanriverdi, 2014). This study attempted to describe a teacher's beliefs by analyzing what she says (professed), what she intends to do (intentions), and what she does (practices) (Clark & Peterson, 1986; Pajares, 1992; Rokeach, 1968;). Therefore, in order to examine teacher's beliefs different data sources such as observation, interview and informal conversations were used in the present study. The purpose of the use of variety of data sources was to make explicit the words that the teacher chose to describe her beliefs and her practice as related to the teaching and learning of science, in order to better understand her beliefs throughout the study. All data were recorded by audible, video or written.

All interview audiotapes were transcribed in full. Interview transcripts, audio records of briefings and informal conversations, and field notes were typed and brought together. Because of the variety of data sources constant comparative method was applied for the analysis of the second research question (Glaser & Strauss, 1967).

The constant comparative method (CCM) is a method for the data analysis in order to develop a grounded theory. Researchers use CCM to develop concepts from the data by coding and analysing at the same time (Taylor & Bogdan, 1998). According to Glaser and Strauss (1967), the advantage of this method is that the research starts with raw data, through constant comparisons a substantive theory will emerge.

Corbin and Strauss (2008) refer to the process of analyzing data as coding. Coding involves three levels of analyses: open coding, axial coding, and selective coding. In this research, first unified data were descriptively coded. In the process of open coding every passage was labelled with the most appropriate codes in the context of entire story. Then it was important to make categorizations; therefore, axial coding was used and some codes were combined with other codes and formed a pattern. In the final stage of coding, as Corbin and Strauss (2008) stated, core categories validating the similarities and differences were identified. Following themes emerged as a result of analyzing the complete data set:

- Beliefs about teaching
- Beliefs about learning
- Beliefs about ABI
- Beliefs about own ABI teaching experience
- Beliefs about obstacles to teaching and learning in ABI
- Beliefs about professional development programs
- Beliefs regarding teaching profession

At the end, an external researcher who is experienced in coding independently coded the data. After two raters disscussed about the codes they made and reached a consensus, inter-rater reliability was calculated as almost 100%.

3.1.5. Trustworthiness of the Study

Credibility, transferability, dependability and conformability are the four issues to determine the trustworthiness of a qualitative study (Lincoln & Guba, 1985).

Lincoln and Guba argued that ensuring credibility is one of most important factors in establishing trustworthiness. By having prolonged engagement during this study, trust was established and adequate understanding was gained between researcher and the participant teacher (Erlandson, Harris, Skipper & Allen, 1993; Lincoln & Guba, 1985; Merriam, 1995). Another technique for developing credibility for this study was peer debriefing (Lincoln & Guba, 1985). The researcher discussed the analysis with peer-researchers from the field of science education and the external researchers who coded the data. During the interpretation of the data in order to answer research questions, many discussions were regularly held with the advisors of this study. Triangulation is another technique to ensure credibility of the study since data were collected from multiple sources to produce greater understanding (Merriam, 1995).

In terms of transferability, Merriam (1998) and Stake (1994) expressed the importance of qualitative studies whose findings are applicable to other or broader areas. This study is a representation of presenting thick descriptions of a teacher's classroom practice and beliefs, and a professional development program to transfer the findings to other situations.

To ensure dependability of the study, transcripts of the data were coded by another experienced researcher mentioned before and videos of ABI implementations of the participant teacher were rated with RTOP by two other experienced researchers who were specialized enough in RTOP scoring. Furthermore, in order to reach consensus about RTOP scores and data coding many discussions were held.

3.1.6. Limitations of the Study

The greatest limitation of this study was that first interview was conducted after the inservice teacher training program since the participant was selected purposefully from the teachers who attended this program. Even she explained her previous beliefs honestly and clearly, inservice training could have affected some of the teacher's expressions and accordingly this might affect the data. The data addressed the teacher's previous teaching practices and beliefs about teaching and learning which were based on teacher's expressions. Observation before the inservice training could have been done and this would present us more data source; however, the training was conducted immediately after the participant was identified following the inservice teacher training program.

CHAPTER 4

RESULT

This chapter will report the findings of the data analysis procedures discussed in the previous chapter. In this section the case of a science teacher was presented and in the light of research questions how much teacher's pedagogical practices and beliefs were changed with onsite ongoing professional support given after inservice training was explained in detail. The research questions are:

1- What changes occur in science teacher's pedagogical practices following the implementation of ABI accompanied by onsite ongoing professional support?

2- What changes occur in science teacher's beliefs about teaching and learning following the implementation of ABI accompanied by onsite ongoing professional support?

As it was stated before in the method chapter of the study, this professional development program consists of two parts: in-service teacher training and ongoing onsite professional support. Second part of the program requires three stages: teacher-on-preparation, teacher-on-action and teacher-on-self reflection.

4.1. Introduction: Developing Lessons Using the ABI Approach

After inservice training the participant teacher was willing to implement ABI approach in her classrooms. She was open to innovative approaches to apply. When she applied a few things from what she saw in the inservice training program, the teacher was amazed of students' reaction:

> Everybody in the classroom incredibly attended to the lesson. Students started to be more interested when they feel they are doing something. Although I cannot apply new approach in eighth grade classes, at least I start the lesson by questioning. After attending inservice training I initiate lessons with questions. Firstly I could not wait for the answers but now I give time for it. This takes time; however, students really learn. Also because they comment on their learnings, they learn more permanently. We made negotiations and they liked arguing.

After the teacher was very pleased with these kind of small but positive changes, she decided to innovate her teaching; however, she did not find herself enough to change her pedagogical practices and not know how to implement ABI. Therefore, she requested to take onsite ongoing professional support in order to apply ABI implementations as it should be in her classrooms and volunteered for this study.
Then preparations started at full steam. The whole process was planned in detail with the teacher.

Preparations were made with teacher-researcher collaboration in several meetings before in-class implementations. During this time, with the feedbacks of the researcher, teacher formed her concept maps, big and sub-ideas related to content. Then the researcher and the teacher deeply had both conceptual and content related negotiations. Hereafter the teacher modified her preparations and brought negotiation cycle (what would happen in the classroom) into being. Throughout the year researcher and the teacher constantly kept in communication via face-to-face communication, mails, phone calls and whatsapp messages. Moreover, the researcher attended all classroom implementations as an observer. In this case, the researcher was able to record immediately teacher's reflection and make negotiation with the teacher related to ABI instruction after each classroom implementation.

Teacher came to the classroom after having a different preparation process from the previous ones as it was stated above (More detailed information about the preparation process was given in the method chapter). Big idea of the implementations was identified by the teacher; however, the activities were conducted by the students. During the whole process from the initial class discussions -through the identification of the questions by the students as groups after having small group discussions, experimentation and developing claims related to questions in groups- to the discussion of the claims and evidences as whole class, the teacher incorporated the students into the conceptual framework of the topic and the discussions parallel to the objectives of the unit. Furthermore, the teacher structured the relationship between conceptional elements of the unit through student focused questions, investigation activities, discussions, claims and evidences.

4.2. Teacher's Process Trajectory in her Pedagogical Practices

The teacher made 6 ABI implementations in her one seventh grade class over a year. In each semester she made 3 ABI implementations. Each implementation was rated with the RTOP scale from the classroom video records by the two independent experts who were also trainers in the inservice teacher training program. Experts evaluated their scores until reaching a consensus to get the final score which represents the ABI implementation level of the teacher. Furthermore, interviews were coded by two independent researchers. Then interrater reliability was calculated as 100%.

In the whole process, teacher's RTOP scores came from 0.60 to 1.82 over 4.0. After inservice training teacher's first implementation score was 0.60. With the onsite ongoing support, highest RTOP score of the teacher was rated as 1.82 in the same academic year. The teacher's RTOP scores show the improvement of ABI implementations throughout two semesters. Based on this outcome, it can be roughly said that onsite and ongoing support contributed to teacher's advancement in her ABI practices in the classroom. The teacher's process trajectory in the modified RTOP scale was evaluated below.

In the first semester, ABI was implemented in the unit of "Electricity in Our Life". The teacher wanted to apply it in seventh grade level and chose the class of section C from her three seventh grade sections. In this semester she experienced three ABI implementations. In the second semester, ABI was implemented in the unit of

"Light". Teacher made a three ABI implementations in the second semester and totally six implementations over an academic year.

In this part teacher's moves during her ABI implementations in sections C were presented together from the very first implementation to the last (sixth) one through interpretation in four categories of RTOP: student voice, teacher role, problem solving and reasoning, and questioning.

4.2.1. Student Voice

Participant science teacher's RTOP scores in each item of student voice category which show the ABI implementation level were presented in Table 6.

Table 6. Scores of Student Voice

		RTOP Scores of ABI Implementations					
		1st	**2nd**	**3rd**	**4th**	**5th**	**6th**
Student Voice	The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0.5	1.5	1.5	1.5	2	1.5
	The focus and direction of the lesson was often determined by ideas originating with students.	0.5	1	1.5	1	2	1.5
	Students were involved in the communication of their ideas to others using a variety of means and media.	0.5	1	2	2	2	1
	There was a high proportion of student talk and a significant amount of it occurred between and among students.	0.5	1	1.5	1.5	2	1
	Student questions and comments often determined the focus and direction of classroom discourse.	0.5	1.5	1.5	2	2	1
	Total/5	0.5	1.2	1.6	1.6	2	1.2

(RTOP scores are over 4.0.)

At the beginning of the first semester, student voice showed up just as answering teacher's questions. While the vast majority of the class was involved for the short answer questions, just certain students were active for the open ended questions teacher asked to move discussion further. Only the ones who raised finger to talk were given the permission. The movement towards other students to push them into initial class discussion was limited. Moreover, the teacher skipped some of the willing students. Even when she gave permission to these willing students to talk, it was observed that she did not ask follow-up questions; therefore, they could not find much opportunity to talk. The focus and the direction of the lesson was not determined by ideas originating with the students; because, the teacher picked the ideas of the students suiting her plan. Student-student interaction was almost none. Dialogs were commonly between teacher and student. Same students were generally actively partipated in the discussions. The teacher repeated the groups' presentations and asked questions to understand whether the students follow their friends or not. Also it was observed that mostly the teacher asked questions to the groups during the whole class discussion. The teacher was talking loudly, there was no any other person in the class louder than her. It cannot be exactly said for the first semester that -as it is stated in the RTOP scale as a criterion- student questions and comments often determined the focus and direction of the classroom discourse. Students could not find much opportunity to communicate their ideas to each other. On the other hand, the teacher's attempts to extend the conversation or questions to students why/what they believed increased in time.

From time to time, the questions of the students crossed the border that the teacher determinated with the big idea for the lesson without teacher's interference during the initial class discussion. The students had difficulty when they were developing their questions that they were curious about. One of the possible reasons for this situation may be that the students did not have enough question marks in their minds. It was expected that the teacher constructs contradiction in students' minds at the time of the initial class discussion. This could not exactly happen in the first semester. Sometimes the teacher could not use some opportunuties. For example, it was seen in one of the groups that the students collected two types of data and the teacher could have used this variety of data as a chance to involve the silent students into the discussion and also give students an opportunity to think on what they did. Sometimes the teacher went towards the students who had not talked. There were moves for non-participating students in order to count them into ABI; nonetheless, argumentation was squeezed between the teacher and student. The teacher did not know fully what happens in each group especially in the first implementations, since she had difficulty to follow. At the end of the first semester (in the third implementation), when the teacher started to succeed being silent during whole class discussions, the proportion of student talk increased and sometimes the students' comments determined the direction of the classroom discourse. Everybody was talking all together because they were trying to make themselves heard by the teacher. The groups sometimes had very similar research questions which shows us that the teacher could not follow what each group searched; however, there were times that she interfered in small group discussions and showed different point of views of these very similar questions to direct students make their investigations in various ways for the same research question. As time passes, student voice in the classroom increased; however, it was generally followed by much larger turns of talk by the teacher.

In the second semester especially beginning from the first implementation (teacher's fourth ABI experience) the teacher tried to encourage her students more to communicate their ideas in front of the class after group work with the presentations during the whole class discussion. Also she tried more to engage the other students by encouraging them to ask questions to the presenter from their friends and to argue about conflicting ideas. Therefore, these moves of the teacher increased the proportion of the student talk.

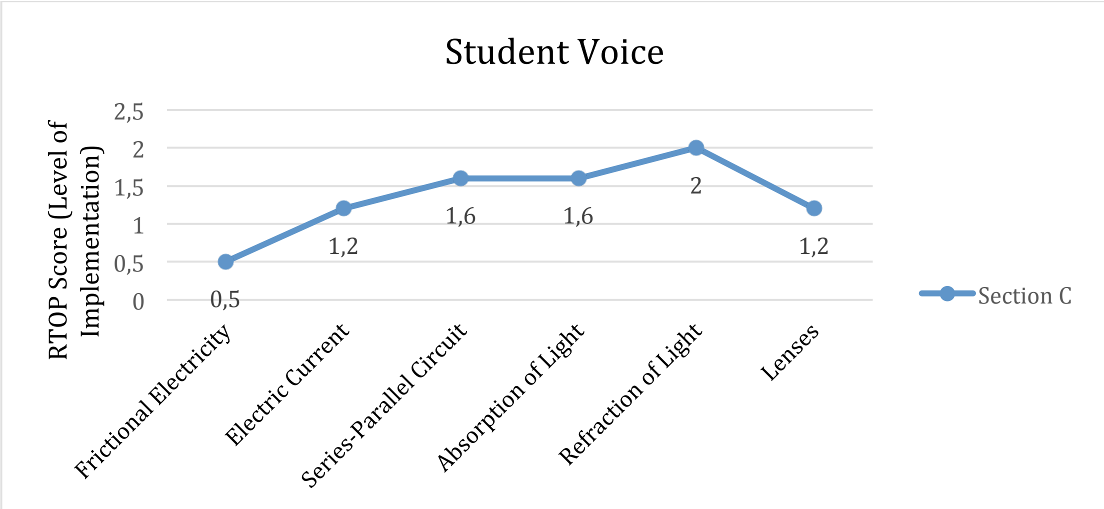


Figure 2. Teacher's Reformed-Based Practice Scores Representing Level of Implementation of the ABI in the Category of "Student Voice" throughout Two Science Units

Figure 2 reveals the participant teacher's levels of ABI implementations over two science units. As illustrated, the scores of the teacher compared from the beginning until the end of the year varied. Despite the fact that there was not a spectacular change in terms of the practice scores, this figure exposes the trend of the teacher's actions in her science classrooms across the ABI implementation phase. It can be seen that the participant teacher performed an improvement except for the last implementation throughout the observation period. This ABI practice was focused on "lenses" in the unit of "light". The reason beyond the decline in the last one can be explained with the teacher's inadequate preparation during the construction of initial class discussion (compared with the previous ones).

4.2.2. Teacher Role

Teacher's RTOP scores in each item of teacher role which show the ABI implementation level were presented in Table 7.

Table 7. Scores of Teacher Role

		RTOP Scores of ABI Implementations					
		1st	2nd	3rd	4th	5th	6th
Teacher Role	The teacher acted as a resource person, working to support and enhance student investigations.	1	1.5	1.5	2	2	2
	The metaphor "teacher as listener" was very characteristic of this classroom.	0.5	1	1.5	2	2	2
	Total/2	0.75	1.25	1.5	2	2	2

(RTOP scores are over 4.0.)

At the beginning, the teacher was the most dominating factor in the classroom. Most of the negotiation was between student and the teacher, not among students. Initial class discussion was completely teacher centered. Sometimes the students gave really nice answers that the teacher could use them to make argumentation in the classroom; nevertheless, the teacher preferred to follow through the plan and missed such good chances for argumentation. Teacher sometimes totally held the control of the process and started to tell which one to discuss next.

> Teacher: You saw in the sixth class that an object pulled pieces of paper. How does this pulling and/or pushing happen?
> Student: I made an experiment. When I brought a plastic comb near to the water flowing from tap, water came close to the comb. Is it about the charges pulling in comb and water?
> Teacher: OK then, what are the factors affecting frictional electricity?

Normally, she had to discuss the student's question; however, she passed another question as if she did not hear it. This situation also explains that the teacher moved away from the inquiry process in her mind and set her previous teaching practices to work. Moreover, the teacher did not carefully follow what happened in small groups. All moves of the teacher was based upon taking the right answer. When she heard a wrong answer, she did not discuss it most of the time and just passed on to another student. Although the teacher was trying to act as a resource person who works to support and enhance student investigations, she had difficulty leaving her routine.

Furthermore as it was stated in the RTOP scale as a criterion, the metaphor “teacher as listener” was not characteristic of this classroom at the beginning; because, she was the one in the classroom who talked the most.

Still at the beginning of the second semester, since the teacher focused on controlling the planned process related to ABI, she followed the steps in her mind without asking enough follow-up questions directed to examining thoroughly students’ answers. Sometimes she seemed to like talking more as she did in previous science unit (Electricity In Our Life) in the first semester.

In the fourth implementation, students’ questions mostly became like “say what you think and pass”. Moreover, when the teacher faced with points that were not present in her prepared teacher template, she said “We will negotiate it next week”. She had difficulty to handle unexpected moments and concepts not included in the preparation; however, she started to better handle these kind of situations as time progressed. Sometimes she pretended to be a listening teacher by playing “find what is in my mind”. As time passed, beginning from the second semester with the unit of “Light”, the teacher started to succeed keeping silent during whole class discussions in order to give students the floor and in this phase she mostly became the listener as a difference from the first semester. When students made their presentations as a group, she sit back and watched.

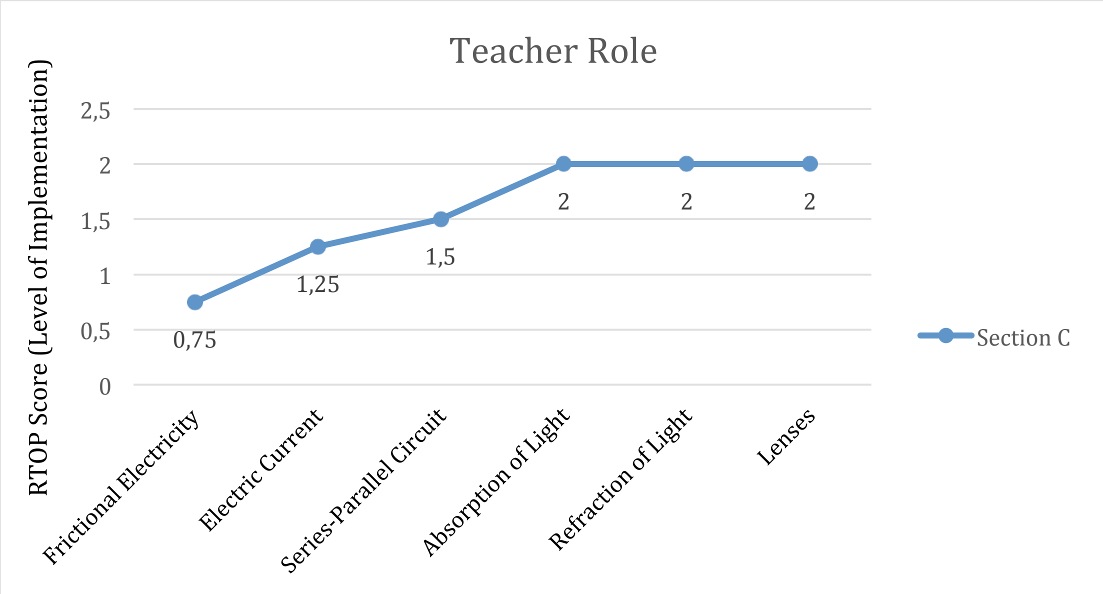


Figure 3. Teacher's Reformed-Based Practice Scores Representing Level of Implementation of the ABI in the Category of "Teacher Role" throughout Two Science Units

As it can be seen in the Figure 3, in terms of teacher role, the participant teacher performed a shift and developed her ABI implementations. The teacher reached her highest score in the fourth implementation for the first time. She tried to act as a resource person who works for supporting and enhancing student investigations, and tried to listen more than talking; however, she needs more improvement.

4.2.3. Problem Solving and Reasoning

Teacher's RTOP scores in the category of problem solving and reasoning which show the ABI implementation level were presented in the Table 8.

Table 8. Scores of Problem Solving and Reasoning

		RTOP Scores of ABI Implementations					
		1st	**2nd**	**3rd**	**4th**	**5th**	**6th**
Problem Solving and Reasoning	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0.5	1.5	1	1.5	1.5	1.5
	Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0.5	1	1	1.5	1.5	1.5
	Students were reflective about their learning.	0.5	1	1	1	2	2
	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0.5	1	1	1.5	1.5	1.5
	Active participation of students was encouraged and valued.	1	1	2	1	1.5	1.5
	Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.	0.5	1	2	1	2	2
	Total/6	0.58	1.1	1.33	1.25	1.67	1.7

(RTOP scores are over 4.0.)

At the onset of the first semester, when the students were asking questions each other the during whole class discussion in section C, it was seen that teacher did not make any moves for arguing the thoughts and reasons beyond the process. Moreover, it was observed that the teacher asked a few questions which creates contradiction; however, this negotiation atmosphere did not continue for a very long time because the teacher dominated it by going on with asking terms and the effect of this atmosphere disappeared. An example was given below:

Teacher: What does energy consist of?
Students: Friction of airscrews.
Teacher: No. Electricity originates and airscrew turns because of electricity. What does flow here?
Students: Wind / energy / wind energy / powerhouses (Answers came from different students)
Teacher: What does matter consist of?
Students: Atom
Teacher: What are the building blocks of atom?
Students: Electrons.
A student: positively and negatively charged electrons.
Teacher: Are electrons negatively charged?
Teacher: Does electiricty consist of matters?
Students: Yes / No (Answers came from different students)

Instead of creating a negotiation setting based on the answers coming from students, the teacher asked about the terms in students' answers. For example:

Teacher: What is needed to create current?
Student A: Ammeter.
Teacher: For what to measure is ammeter necessary?
Student B: If the ammeter is necessary for measuring the current, it is not necessary for creating the current.

The teacher mostly managed the process with questions and answers without making negotiation as it was seen in the example above. She asked the related terms as if they are seperate terms and has no relationship. For example, in the third implementation in section C in the first semester, after making argumentation of current and voltmeter, the teacher asked what the voltage is. This showed that the connection between the terms had not formed in teacher's mind. When variables were being argued in the class, the teacher just took the ideas of the students but did not ask any question related to the variable students had said. For instance, when factors affecting brightness of lightbulb were being discussed in the classroom again in the same implementation, the teacher approved variables that she wanted to hear by saying "super, good" but did not discuss them. For example, one of the students said as a variable "the wire in the lightbulb". Then the teacher wrote it on the blackboard and passed on to another one. Actually, the teacher could have asked how and why the wire in the lightbulb affected the brightness, and this question might have caused a discussion between students. Moreover, in this third ABI implementation, it was observed that the teacher focused on the results of the students' investigations rather than the process students experienced. In this context, the teacher did not focus on the discussion between students but stayed connected to the plan in her mind. This had arisen from the fact that the teacher was guiding students' dialogue only on the axis of the classroom management.

Especially in the first semester implementations, the students were not really encouraged to generate assumptions, alternative solution strategies, and/or different ways of interpreting evidence because the teacher's mind was so complicated and the conceptualisation related to subject was weak. Therefore, she did not know where to put what was said and with which question to continue the argumentation. Also "how?" questions were flying in the air, she could not clearly state her questions.

Since the teacher had difficulty to bring students to the big idea, students mostly moved away from the subject. At the moments that she realized this situation she asked for example "What is absorption?, how does absorption occur?". On the other hand, while students were developing their questions, it was observed that these questions were from different topics other than absorption due the fact that no contradiction in students' minds had occured in the initial class discussion. Moreover, the connection between the questions teacher asked in the discussion was weak.

Except for a few situation, student-student interaction was rarely seen especially at the beginning of the second semester. As time passed, the interaction increased. The variables coming from students were not deeply argued before they formed their questions to make investigation. In the fourth implementation of the teacher, even two or three groups at the back of the classroom were not really actively involved in the process. In addition to this, the teacher still had difficulty to pull students in the big idea.

At the beginning of the second semester the teacher asked questions based on reasoning as stated below:

> Student: There needs to be generator to form light.
> Teacher: Is there a generator inside the sun?

Even she asked this type of a question which requires reasoning in the forth implementation, she mostly proposed a kind of "find the answer in my mind" question. Based on the students' answers related to the question "What happens to the sun and the light exists?", teacher asked them without making any challenge to the answers "Does it has a relation with atom?". Students explained, teacher listened and passed. The discussion did not continue further.

The teacher sometimes typically encouraged students to remember the terms. After asking what absorption and reflection were, a student gave related examples but it was observed that the teacher asked these terms again. This situation showed that the teacher was searching for an exact description she wanted. Moreover, the subject of light had not taken its certain position in teacher's mind, and therefore it seems that initial class discussion did not reach the objective for the students. Where the subject goes, about what students wonder and ask questions were unclear.

The teacher expected from students to give bookish definitions of the terms. She focused on how students use the terms and what their meanings were rather than students' reasoning beyond the terms. This showed that the teacher's pedagogical beliefs overweight in the direction of "teaching in her old style". Also it can be seen that this situation reflected on the teacher's pedagogical practices. For example, when the teacher thought that the students' ideas were important, she mostly repeated these ideas in the classroom. She asked sometimes questions to take students to "find the answer in my mind". For example, during whole class discussion the teacher's reaction to the students' claim of "As density increases, fraction increases." seemed to bring the terms into the forefront by saying "Can we call it refractivity instead of density?". The teacher made effort to bring argumentations through class level but she did not seem to be approaching with the right pedagogical moves. She tried to include all class members in the process and asked non-participating students questions. In this situation she could have proposed questions from small group discussions to these students in the whole class discussion but she did not. The teacher started the lesson once by saying the topic of the week. This brought a picture to the students' minds and was not prefered to happen at the beginning of an ABI implementation. Since the teacher had not make the big idea clear enough in her mind in most of the time, it was observed that she lost the control of the process. It can be said that the implementation sometimes continued with discussion of the titles in the book.

Teacher's behaviors were generally in such a manner that she encouraged silent students to talk. Some of the non-participating students were actively involved after teacher moves for encouragement.

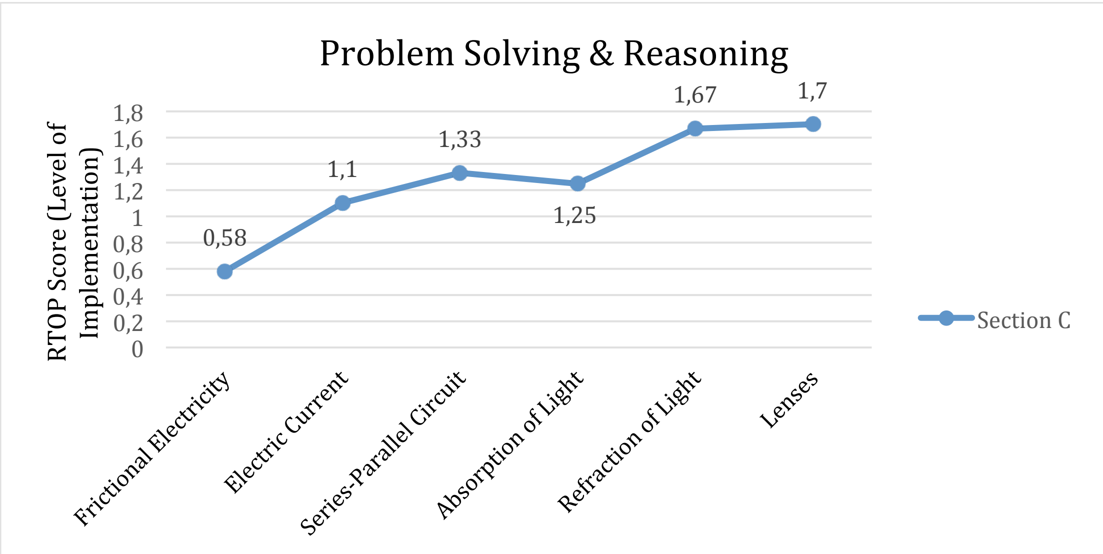


Figure 4. Teacher's Reformed-Based Practice Scores Representing ABI Implementation Level in the Category of "Problem Solving and Reasoning" throughout Two Science Units

As it can be seen from the Figure 4, teacher's RTOP scores related to problem solving and reasoning improved. A small amount of decline was seen in the fourth implementation in section C. The reasons were stated above in detail. To state briefly, not all groups were active in the fourth implementation and the teacher faced difficulty taking the students' attention to the big idea. However, she had a positive trend to improve her ABI implementations.

4.2.4. Questioning

Participant science teacher's RTOP scores in the category of questioning which show the ABI implementation level were presented in the Table 9.

Table 9. Scores of Questioning

		RTOP Scores of ABI Implementations					
		1st	**2nd**	**3rd**	**4th**	**5th**	**6th**
Questioning	The teacher's questions triggered divergent modes of thinking.	0.5	1	1	1	1.5	1.5
	The teacher asks questions that reveal the preliminary knowledge of the students.	1	1.5	1.5	2	2	1.5
	The teacher is using the questions that start and continue the negotiation process effectively.	0.5	1.5	1.5	2	2	1.5
	The teacher continues the negotiation process by asking follow-up questions.	0.5	1	1	1	1.5	1
	Total/4	0.63	1.25	1.25	1.5	1.75	1.38

(RTOP scores are over 4.0.)

In the first of six ABI implementations, the teacher had a problem of stating open-ended questions. She used short answer questions very much; on the contrary, she could also ask open ended questions like "What does come to your mind when I say electricity?" and had difficulty to keep the borders of the subject. In addition to that, the teacher was asking basic recall and lower level comprehension questions related to the content. Sometimes it was enough for the teacher to hear an answer to pass the next question during whole class discussion. The students could not mostly hear the answers from their friends, the teacher repeated them loudly. Teacher's questions merged at the point of "How do you know?" over time and this situation caused unrelated behaviours of students in the classroom. There was a plenty of "What else?" question, which was not challenging the ideas. It was seen that the students' questions were mostly related to experimental setup oriented in whole class discussion. Since students newly experinced ABI, these were expected questions; however, the teacher did not make any onset towards argumentation of ideas and reasons beyond what students investigated. In order to keep her plan, sometimes she made unconnected transitions between answers when asking follow-up questions. Therefore, it cannot be absolutely said that the teacher's questions triggered divergent modes of thinking in the unit of electricity during three ABI implementations in the first semester.

In the second semester starting from the fourth ABI application, the teacher's questions were mostly about understanding what students think when compared to teacher's previous ABI implementations. The teacher should have been patient and not answered what she asked to the students. The interaction between the teacher and students was based on conceptual remembering. Students' answers were not intended to think but to answer the teacher. The teacher asked a question but did not listen to anyone hazarding the big idea. She made as if she listened somebody. Once she took the answer she wanted to hear, she passed on immediately to another question and skiped other students who wanted to talk. Instead of following the process cognitively, the teacher posed questions to pursue the flow that she had prepared before. There was a general problem with follow-up questions. The teacher did not ask "how" questions and this prevented deeper argumentation. Even she tried to deepen students' answers by posing questions, she did not ask mostly follow-up questions. For example, in the sixth implementation, upon teacher's question of "How can I make a lens?" one of the students answered "By using a black cartoon and changing the shape of glass". Then the teacher asked "Why black?" and the student gave an answer. Although the answer was a good opportunity to create a negotiation and she made a good start for argumentation, the teacher then wanted students to tell another variable at this point. It is thought that this situation was caused by the teacher's intention to pursue the plan in her mind step by step regardless of students' various ideas.

At another time in the same lesson, based on the teacher's question "Did you think like this before?", one student said "No, I thought the opposite." and then the teacher said nothing in response. This could be used as a chance to make student-student negotiation and argumentation might take place by posing just one "why?" question. Since the teacher focused too much on the concept, she just posed questions related to them. She sometimes asked about only the relationship between two concepts: "What is the relationship between lens and light?" Instead, it would be better to ask "How does a lens show an object big and small, or close and distant?".

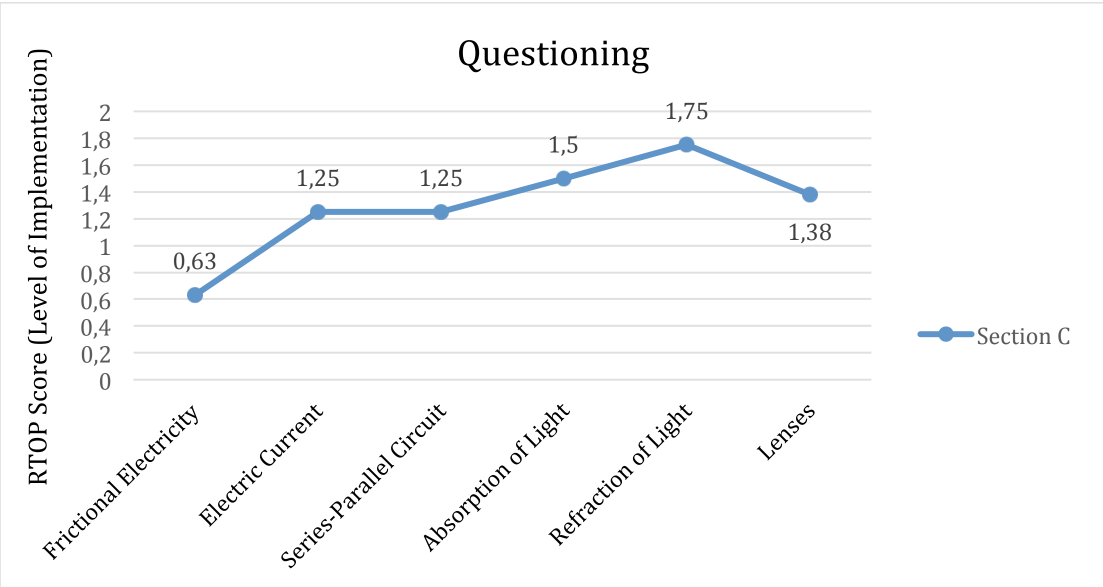


Figure 5. Teacher's Reformed-Based Practice Scores Representing ABI Implementation Level in the Category of "Questioning" throughout Two Science Units

As it can be seen from the Figure 5, teacher's RTOP scores related to questioning increased. The most dominant factor on this result was the change in teacher's questioning style. At the beginning, she had a problem of asking open-ended and thought-provoking questions, and also provided almost no opportunity for students to investigate independently or to investigate questions. As the teacher experienced ABI throughout two semesters, the amount of yes/no or factual recall questions decreased, the high-level questions increased so did the student voice. Therefore the teacher improved her ABI implementations; however, taking into account the RTOP scale from zero to four (lowest to highest) it cannot be said that a huge improvement is seen in the Figure 5, which means the teacher still needs to innovate her teaching a lot. To talk about the final RTOP score from the figure, it can be said that the teacher had better ABI implementations in previous ones; however, in the last lesson there was a big relation problem in the process of identifying initial class discussion questions. It was assumed that this situation lowered the last score from the expected one.

4.2.5. General Summary of Teacher's Pedagogical Practice

In the Figure 6, a general picture of teacher's ABI performance in each segment of RTOP scale is presented. All in all there is a tendency to have better ABI implementations. The declines are evaluated below.

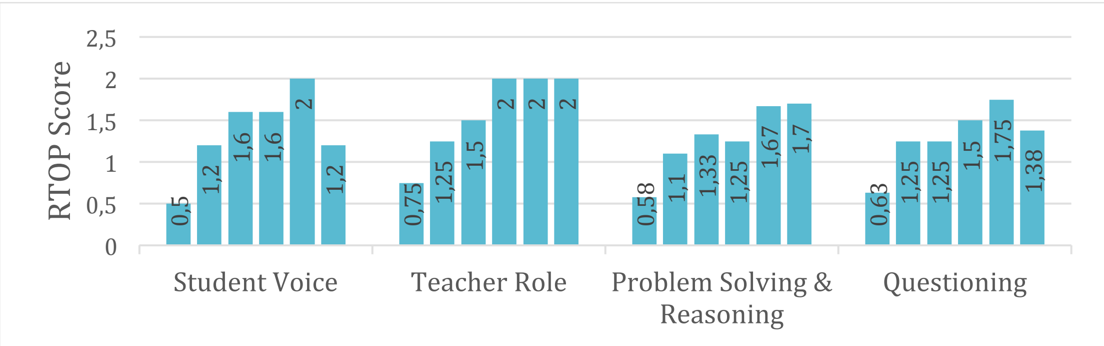


Figure 6. Teacher's Reformed-Based Practice Scores Representing Level of Implementation of the ABI in the Categories of RTOP throughout Two Science Units

Furthermore, all scores are given in the Table 10 one by one for each implementation one under the other in each RTOP category in order to represent the genaral situation in another way.

Table 10. RTOP scores by subscale (average)

RTOP category	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**
Student Voice	0.45	1.2	1.6	1.6	2	1.2
Teacher Role	0.75	1.25	1.5	2	2	2
Problem Solving and Reasoning	0.58	1.1	1.33	1.25	1.67	1.7
Questioning	0.63	1.25	1.25	1.5	1.75	1.25
TOTAL	0.60	1.2	1.3	1.47	1.82	1.47

(RTOP scores are over 4.0.)

The analyses of the data showed that the teacher moved from a traditional approach to a more student-centered approach through presenting an improvement in her ABI implementations in general. As it can be seen from the Figure 6, as time passed, the teacher as a talker was still the basic characteristic of this class; however, it should be noted that the teacher made an effort for changing her role in the class, such as providing more opportunities for students to discuss in groups and to present their ideas to the whole class. Moreover she succeeded in staying mostly silent during group presentations in the whole class discussion. Despite this big endeavor, she still could not keep herself from controlling students' investigations and presentations.

The lesson was still not completely ABI oriented, where students were unlimited in conducting their own investigations; however, the teacher provided more opportunities for students' involvement in both investigation and presentation. She mostly encouraged non-participating students to ask questions to the presenter and to argue about conflicting ideas.

Although the teacher took important steps and her good intentions to provide a classroom environment that supported student work, she mostly did not provide enough waiting time for the students to think or respond to her questions. Therefore, her questions were mostly answered by the teacher herself at the end.

In general, as measured by RTOP scores it can be said that the teacher shifted her pedagogical practices throughout the six ABI implementations in two semesters of investigation but still need to improve when the RTOP scale from 0.0 to 4.0 is considered.

4.3. The Change of Teacher's Beliefs

Since this study required the implementation of a new approach, it was important to start constructing initial interpretations of the teacher's beliefs about teaching and learning that the teacher held before implementing ABI approach. In pursuit, teacher's expressions from informal conversations, her briefings, and pre and post interview were presented in accordance with the flow of the content. In general, it can be said that the researcher's observations supported the teacher's beliefs.

From the coding of all transcribed expressions by two independent researchers, seven themes were emerged and the trajectory of teacher's beliefs were accordingly explained under these themes: beliefs about teaching, beliefs about learning, beliefs about ABI, beliefs about own ABI teaching experience, beliefs about obstacles to teaching and learning in ABI, beliefs about professional development programs and beliefs regarding teaching profession.

4.3.1. Beliefs about teaching

At the onset of the study, the participant teacher's beliefs about how she should teach science were characteristic of a teacher-centered classroom where she was the giver of knowledge. Before the professional development program she stated that she was prefering direct teaching. She also mentioned that she taught science through the use of the science textbooks. She was preparing her lesson plan by considering high stakes tests (TEOG). She was asking short answer and information based questions to her students. If they had questions, she was directly replying to these questions. She was sometimes doing activities but these were taking just a little time in the lesson. This situation can be exemplified through teacher's statement below:

> I was implementing direct teaching and also made my preparation a little bit TEOG (high-stakes tests) focused since I was generally teacher of high grade classes which enter these tests. We had textbook. For example, if the first unit was electricity in the book, I was teaching it related to the book and did not add anything from myself. In early times of my teaching, I did not look for the objectives, just narrated what appeared inside of the book. Then objectives came into play and this time I started to do some activities oriented to these objectives but the laboratory in our school did not have enough materials. Sometimes I was applying questioning which took small part of the course.

Before professional development program, experiments were done only in elective course named science applications. This course was also teacher directed. She explained what happened in this course in the following excerpt:

> I am preparing myself for the elective course by deciding the experiment. First of all, I make an introduction related to the experiment. For example, lastly we made a research about the effect of the type of spring of a dynamometer on elongation. At the beginning I gave brief information related to topic. I covered the content by questioning. We made negotiation with questions such as "What is force?", "Where do we use force?", "What kind of a matter is a spring?", "Where can be used elastomers?" etc. Then we passed directly to experiment. I put the materials in front of the students. They could not make out at first what to do with these materials. I gave a little bit clue and drew something like a chart which shows extent of elongation vs. type of spring. I said "You will try it for three times." and then they prepare an experiment sheet.

As it can be seen from this explanation, when teacher had a little bit freedom from time and curriculum, she chose to teach in this way. There was again no argumentation, no inquiry, no negotiation. Teaching was again teacher centered. She believed that she was the transmitter of knowledge. When she was asked in pre-interview what teaching is and if she believes that she teaches well, she said:

> Teaching is transmitting information in shortest way with the best method by adapting students existing knowledge to daily life. Am I thinking that I teach well? For linguistic subjects yes. If some students cannot conceptualize a subject, I help them by showing visuals. I do not know whether it is effective or not but my students take good grades from high-stakes tests. On the other side, students cannot do anything in their daily life with this learning. In my opinion, good teaching is not dictating something scientific on notebooks.

> The matter is about if students use a subject in their everyday life, what profits they have and if they use what they saw in the lesson in a practical way. This is the good teaching I believe. A teacher who knows much is not a good teacher. A teacher who can transmit his/her knowledge is a good teacher. If a child can use what s/he learned in everyday life, his/her teacher is good. Knowing much is not a measure of good teaching. The matter is transmitting.

On the contrary, at the end of the year she expressed that education should be in a way that it turns into experience other than directly transmitting information. Previously she had the opinion that if students have good grades from high-stakes tests, this meant that they had a good teacher. As time passed the teacher's ideas slowly started to change as follows:

> If children bring a good project, you can understand from the product that they have a good teacher. This means the teacher captivated students' interest which is the main concern. I believe that a good teacher is the person who reveals the hidden talent of children. I do my best to be such a teacher. I am not very good but try to be. I think real success is increasing unwilling students' motivation and including them in the lesson. Believe me I make an effort for that but do not think that is enough. In my opinion it is because of heavy workload other than teaching and large class size.

But then after inservice training as she started to apply ABI by herself before taking professional support, she realized that beginning lesson by questioning gets students' attention. The teacher thought that her job gets easier. Since students were naughty, she believed that ABI could have benefits for her classroom management during teaching. She was inspired by the video recordings in 3-day inservice training. The teacher watched a short video of a teacher who makes an ABI implementation in the classroom. The teacher in the examplary video was not making a direct teaching and the students in the classroom was very actively involved in the lesson. When the teacher saw that even the students at the back row were active, she thought that ABI could be a useful approach to change her teaching. She also recorded her teaching and then evaluated how she taught by watching videos. She believed that this makes a contribution to her teaching and also she confessed that she sometimes used video camera as a threat to silence the students.

At the onset of the study, the teacher was seeing her role as an instructor. Then she changed her belief and saw herself as a person who makes adaptation when students transfer their knowledge to daily life. At the end of the study, she was thinking that she was a learner, too just as the others in the classroom. She thinks that she learns her teaching field. She expressed herself below:

> Previously we were talking about the known things in the books but as being unaware of the reasons beyond them. I was getting information from the book and giving it to the students; however, things are changed and now the situation is different. I doubt the truth and justification of the information. My role has changed, it is not directly giving information anymore. This year has a great effect on me. Since I know ABI process better and I make better observations, I got used to my new role and started to enjoy learning. I observed that now I am more patient and tolerant. We alltogether present a product and then enjoy that product. I began to get pleasure out of my job. I liked being a teacher but now more like it. Now me and my students, we all are part of ABI process.

After she attended inservice training and started to take support for implementing ABI, she began to ask more open ended, syntesis level questions which provoke the curiosity of the students. She indicated this through her words:

> After inservice training and with your support for ABI, I saw my deficiencies and learned many things. For example, I learned to define electricity as a concept with my own words. There was nothing like this before. I was narrating what is exactly inside the book and adding nothing from myself. On the other side, when I make my preparations for the class, I think on much how to construct initial class discussion and which activities can be integrated. I changed my questioning. I was asking information based and short answer questions before and now I started to ask more synthesis level, open ended and curiosity provoking questions, and even I also sometimes do not know the answer and wonder answers.

The teacher realized the meaning of questioning. She believes that posing challenging questions is very effective during teaching.

4.3.2. Beliefs about learning

Before the participant teacher implemented ABI approach, she believed that reading and listening were some of the ways of learning, and also visuals could help learning. The teacher stated that when she explained a subject, she believed that students would learn it. According to her, students were learning through a transmission of factual information provided by the teacher. Moreover, when a student did not learn a topic although she had made a great effort for it, she did not take the responsibility of this situation since she thought that she had already done her best. The teacher carried this on parents' and the student's shoulders, and saw the reason as student's unwillingness. On the other side students did not have a chance to experience constructivist learning.

To understand the concept of learning in teacher's mind, she was asked in the pre-interview what learning is, she defined it as below:

> Learning is the accumulation of knowledge related to making my daily life easier. It is a little bit simpler than teaching I thought.

According to the teacher, learning is how much information you have in order to use in life. Also she made a comparison between teaching and learning and found that transmitting information is harder than collecting it. After giving the definition, the teacher talked about how better learning occurs and complained about how students failed to do that:

> Better learning occurs as it is used. Students cannot direct their everyday used knowledge into the class and exams and/or vice versa. They cannot transmit scientific and theoretical information learned in the class to their daily routine. Students isolate these two. They think that scientific knowledge and the life are apart from each other. This perception has to be changed.

Here the teacher talked about the students' lack of ability of internalisation and conceptualisation related to their learning. She thought that using the information from classroom and experiencing them in daily life showed the amount of learning.

On the one side, she talked about this problem and on the other side in another explanation of the teacher, she said her learning criteria which show how much students learn as the scores of high-stakes tests, numbers of correct answers in tests, performance homeworks, end of unit worksheets and the answers given her questions.

As she started to make ABI implementations, learning environment of the classroom changed gradually and so as teacher's beliefs about learning. Students' motivation increased and they started to be more active during lessons. The lessons became more student centered and the teacher realized that students learn from each other. The teacher expressed this change below:

> Actually I observed that starting the lesson by questioning got students' attention. When their motivation increased, they learn better. At first, the noise students made disturbed me. I thought that they were cheeting but then I realized that it was productive noise. It was because they discuss their questions, argue with each other, and try to reach a consensus about the question they would investigate. This process is very exhausting; however, actually a good thing.

After the participant teacher made ABI implementations, her beliefs about students' learning changed in a way that students became more curious, started to ask better questions and transfered their learning into their daily life:

> I understand whether students learned or not from the questions they ask because sometimes they pose such questions that they have to know something and build that question on it. The most important factor for learning to occur is curiosity. Students satisfy their sense of wonder by questioning. During ABI implementations, students learned how to ask question. They found out that there has to be a problem in order to produce something, which is a milestone of inquiry I believe. Students started to make connection between everyday life and the things they did in the classroom. Now they are really thinking on the reasons beyond they see. ABI provoked students' creativity, and provided them a constructivist learning environment. They also learned how to present arguments to each other. Moreover, the feedbacks coming from parents give clue about students' learning. They say "Our child came and made this, we were very surprised. They experienced that in the class. Thank you.".

From this explanation it can be easily realized that the learning criteria of the teacher totaly changed. While the teacher believed at the beginning that scores of high-stakes tests, numbers of correct answers in tests, performance homeworks, end of unit worksheets and the answers given to her questions were learning criterias, now she thinks that the questions they pose, the arguments they present and their products give more clue about students' learning.

When the teacher expressed the change in students' learning, she emphasized the differences in students' behaviors. She said that they started to try being more active during lesson rather than just considering taking high grades.

> The project homeworks are another indicator of how much students learn. Prior to the study, students were making a superficial search in Google and bringing me its print on which they added nothing from theirselves. However, now they make great effort for their homeworks and bring me really original products on which much contemplated and worked a lot. Students started to think about how to be more active in the lesson rather than how to take higher grades.

In the process of preparation and implementation of ABI with onsite ongoing support, the teacher questioned not only how students learned but also how she learned. ABI provided the teacher a chance of self-evaluation of her own learning which is stated below:

> Previously I was thinking that just reading is enough for my learning but now I am aware that it is not. I do not accept a new information anymore without questioning it. First I convince myself. Actually there is so much that we do not know. Namely, I discovered that I just know the center of a circle but do not know its circumference and this pushed me for seaching. I pondered how to reach more information from more sources during this process. Now I want to learn more about ABI and start a master program.

As it can be seen from teacher's statement, much has changed with ABI implementations. The change of her beliefs about how she learns, how students learn and the desire of learning show how much ABI implementations affects significantly the learning occured in the classroom.

4.3.3. Beliefs about ABI

The teacher thought at the beginning that ABI was very time consuming both in class and preparation before the class, it took teacher's time and was tiring. The teacher had to make more detailed, careful and student-caring preparation; therefore, she has to allocate more time and thinking to it. This situation was clarified through teacher's statement below:

> More detailed and careful process comes into question with planning. I make plan, too but this approach requires more extensive and more student focused plan. Also at the same time it is so tiresome and time-consuming program. I sit at home and think about how I should do and ask questions. It really takes teacher's time. I cannot predict that how much a teacher who works hard can implement ABI. I really do not know actually.

Regarding the teacher's concerns about classroom management, at first she had been anxiously thinking about the high extent of noise that students could make; however, she realized during ABI implementations that there was noise in the class but it was productive noise. It occured since students asked their questions, discussed their ideas and made investigations. In other words, it was because of the learning environment of ABI. Furthermore, in this context, teacher mentioned her ideas related to classroom management in general and adaptation period during ABI implementations:

> When I first met with ABI approach, I thought that classroom management would get really easier since medium level students would probably be active during lesson. However, it did not happen the way I thought. It was very hard at the beginning stages but then, as students got used to this approach and learned the process, we made it up. Actually, this was very natural. Everybody faces with difficulties when trying to be accustomed to a new situation. This was new both for me and for my students.

At the beginning the teacher thought that it could be hard to apply ABI in crowded classes; however, at the end she did not see high class size as an obstacle for the implementation. Moreover, before starting ABI she held the idea that actually implementing ABI was not very difficult if the science curriculum would be narrower. After she started to apply ABI, as time went on she saw that students gained more objectives related to topic than she expected in a short time. Many elements of a science subject could be covered in one ABI implementation thanks to intensive questioning and investigations. This was surprising for her and she changed her belief. Thereby curriculum was not an inhibiting factor for applying ABI.

Before the teacher experienced ABI, she believed that ABI's effect would be positive in general. She was thinking that the students would be more interested to the lesson and their participation to the lesson would increase. In the post interview she expressed that the students enjoyed the lesson, were curious about the content, and they learned how to ask questions and make inquiry based investigations in ABI lesson. ABI enabled students to form their questions which promotes curiosity, argumentation and inquiry. She also believed that ABI provided more permanent learning, encouraged creative thinking and made available for students to transfer their learning into their daily life. ABI changed students' attitudes towards science lesson. She explained her ideas in the following statements:

> ABI is a process in which students apply their thoughts and thinking abilities by taking students' attention rather than direct teaching. It is a kind of system that students learned fully by themselves through doing, straining, eliminating and finding, and therefore students learn more and keep this learning longer. Other approaches teach also but students cannot transfer this learning into their daily life. Maybe the students keep it for a while but then they forget it. On the other side, ABI absolutely enables students permanent learning. Moreover they enjoy it, wonder it. Children learn how to ask question, make investigation and present argument. That is the point I think. ABI is a kind of approach which enables long-lasting learning, teaches questioning and encourages creative thinking. Also it is student-centered and can be applicable in all science topics I think.

Teacher said after a few ABI implementations students started to request for looking their exam papers in order to follow what they did and why it was wrong. Furthermore, an inclusive student started to be active in the lesson and ask questions. The teacher did not talk about this inclusive student before implementing ABI; however, she mentioned about him in the final interview as if she was surprised about his attendance at the small group works and whole class discussion:

> I had a student with the name of Kutay. He was an inclusive student. An inclusive student can ask question. I think, this is a very precious thing for a teacher. His attendance is really valuable for me. A kind of perception and curiosity came into being. Even this was very important. Therefore, I think this was the most effective and most fascinating part of ABI. That is to say, questions asked by a student who normally does not care about my class. This is so good and a teacher becomes happy with this. I am happy, too.

In the post interview the teacher was asked if ABI affected students learning process positively and in which phase it was most effective. In consideration of this question, she pointed out that the students' questioning is the most prominent positive part of ABI. The whole answer given by the teacher was:

> Of course ABI affected students learning process positively and I believe forming their questions by themselves is the most effective part, because this arouses curiosity to the subject. Students think when they are asking questions whether they can prove it or not and also how they can prove it. This situation naturally promotes interest, inquiry, and searching. These reveal their creative thinking. They started to generate their own questions and I think this is the most effective part of ABI.

4.3.4. Beliefs about own ABI teaching experience

Participant teacher's beliefs about own ABI teaching experience are characterized by her beliefs about teaching, by her beliefs about learning and by her beliefs about ABI. At the beginning, she did not believe that she could do effective ABI implementations. She had some drawbacks such as, "Do we skip some topics?", "Would there be uncovered parts of the subject?", "Could we finish in time?", "Which questions should I ask?" etc. Moreover, she believed that first implementations would be difficult since students were not used to the ABI approach. The teacher talked about her experiences by comparing her first ABI implemantations with the last ones:

> In the first implementation I was so fussy and anxious about asking how to ask which questions, whether time was enough or not, if I could make connection between my questions and students' questions. Actually, I was very excited. On the contrary, I was very relaxed in the last implementation. There is a big difference between the first and the last one because both me and my students got used to the ABI approach in the progress of time. The

> process was like domino. I started to handle the questions coming from students. I learned much about science subject as a result of preparation before the class. Everything was very lovely. While I was doubtful at the beginning about whether I could handle it or not, in my last ABI implementation I said that it is OK now. I can easily apply ABI in fifth, sixth and eighth grade classes too. I do not have problem with covering all the topics, if I make my lesson plan accordingly.”.

Although she had the abovementioned drawbacks towards ABI (such as; timing, questioning and proper application of the ABI procedure), as she explained in the pre-interview she had believed that experiencing ABI would affect students’ learning positively. She was foreseeing that curiosity would direct students’ investigation and this situation could ease her job. She believed that first implementations would be hard. Immediately after her first ABI experience she said that first implementation was not as she was afraid of. Moreover, she realized that ABI was an applicable approach. She believed that ABI supported student centered cooperative learning rather than teacher centered direct teaching. That is why she thought it could be effective. On the other hand, she pointed out the main problem of ABI implemantation as the noise in the classroom.

She interpreted the change from the beginning to the end and mentioned the difficulties she faced during adaptation to a new approach. Classroom management, time arrangement, preparation before ABI implementations were really hard for her at the beginning; however, she succeeded to better handle all these in time. In this regard, teacher expressed the change in the process of ABI implementation as below:

> It was very difficult at the beginning but then we made it up. A kind of adaptation period happened to children, too. In this period, classroom management was very hard for me. After students learned when to do what, we started to finish an ABI implementation in time (weekly in 2 course hours). Previously, whole class discussions were left half finished. Sometimes I got in a quandary since I had habits coming from the past. Especially in the preparation level during formation of my concept map and big ideas, I made many mistakes. I checked up my content knowledge, searched a lot and discovered many new things. Getting used to ABI was not an easy task for me; however, it was good to experience. I complete my deficiencies in time by more experience. Nothing happens suddenly. I believe that after two or three years much better works will appear. It has not finished yet; however, we made a good start. We learned how to do, how to reveal students’ creativity which is the most important thing. Did we know it

before? No. We were teaching in a traditional way. We attached here importance to individuality. Previously we were equating them all.

Moreover, in the post interview the teacher talked about the things that were surprising for her during ABI experiences. She found out the reason beyond why some of the students were not active during lesson. The teacher realized that provoking their interest was the key point to make them join to the class. Related explanation of the teacher was given below:

> During ABI experiences we understood that in fact lazy students do not participate in the lesson because they are not interested in lesson not because of they do not know the subject. When I make ABI applications, I saw that hardworking students were not smarter than the others. I believe the ones sitting at the back of the class can make much better things. We succeed in provoking their interest. These children came to me and said they want to attend the science festival. Previously, the ones I mentioned had nothing to do with these kind of festivals or so. They said to me that they could make a project. I think this is very important. Developing self-confidence is a really hard job and they gained self-confidence.

The teacher thought that the ones who wants to implement ABI would meet with difficulties (e.g., adaptation, preparation) at first. She said that they would have difficulty but after that when they saw their own improvement, they enjoyed it. She said it happened to her in this way. Her openness to change allowed her to make ABI implementations, but it was not an easy process although she was willing. At the beginning she was murmuring like “Oh God!” and finding it very difficult to prepare but then it became pleasure for her. The teacher expressed that now she tells ABI wherever she goes:

> When I go to seminars, I always narrate what we did: “At first, adaptation and preparation are very difficult and take time, but after approximately applying it two or three times, it is on the track. First semester is the adaptation period.”

In addition, she justifies her foreseeing. As she said in the pre-interview she believed that she could not make effective implementations in the earlier stages. In the post-interview the teacher did not think that she experienced effective ABI implementations in the first ones and called this as adaptation period. She gradually managed the time better and during implementations she observed her own deficiencies, took feedbacks from the researcher, wondered reasons beyond the things she never questioned before, learned how to ask question and liked searching more. She said that she became a learner just like her students and found this more enjoyable and better than being a traditional teacher. As time went on, she spent less time for ABI preparations. She believed that if she would continue to apply ABI for a while, even less time could be spent. She also pointed out the importance of planning before the ABI implemantation in the class. She belived that effective planning provided better implementations, effective teaching and learning together with students. She stated that time to time she left her plan, she could not exactly sticked to it because of the different questions of the students caused by their curiosity; nevertheless, she succeed in staying in the borders of the subject with the help of the concept map and big ideas she prepared before.

After ABI implementations, the teacher was asked in which points she had deficiencies and wanted to improve herself. The teacher believed that she needs to improve herself in all parts of ABI (initial class discussion, small group discussions and investigations, and whole class discussion). She believed that she needs to be more patient, keep silent, give the floor to students and let each student to talk. As she stated that she should ask better questions and manage the time effectively. Furthermore, she thought that she needs to follow students' questions and investigations more carefully. She answered this question as below:

> Actually, at every stage I had deficits. For example, initial class discussion is not really an easy process. Putting together all the questions during negotiation, making connections between questions, providing each student to state his/her idea and recognizing each of them equal time, being able to hear each of them, stepping back and keeping silent etc were not easy tasks. During initial class discussion now I try to ask more nested questions rather than more detailed ones. While I could not estimate which questions students could ask previously, now I started to forecast them slowly. Because you also search the topic, namely you study it, too. Therefore, you can guess what you can face with. In small group discussions, I can be more patient because sometimes I gave some directions to students. I started to minimize my directions. Now I just started to answer, if they ask me something and try not to interfere, if there is no need for it. I cannot say that I do something completely OK in each phase; however, I evaluate and think

> on them and say that I can ask better questions, more curiosity provoking questions and let each student talk. I did not give word to each of them because of time issue, but I know that this is not a good thing. Since I can manage time better lately, I can give the floor to more students. I work on all of my deficiencies to improve and I believe I will handle them in time.

The teacher told that from one implementation to another one as she experienced ABI, she accomplished one more thing in each time. Despite all of her deficiencies she believed that non-participating students joined the classroom activities and also she saw this as a profit. ABI caused noise in the classroom but she defended it as a kind of productive noise which was caused by competition between students. During argumentation they tried to convince each other on their ideas. She believed that when she asked good questions, attention of the students increased and they also posed better questions. Even some of the students did not go out during breaks and continued their investigations.

At the beginning she did not believe that she could do effective ABI implementations, had some hesitations and faced with some difficulties; however, at the end she was confident that she could apply ABI effectively. On the other hand, she was aware of her deficiencies related to her ABI implementations.

4.3.5. Beliefs about obstacles to teaching and learning in ABI

The participant teacher believed that there were some factors affecting teaching and learning negatively. These factors were seen as obstacles to better ABI implementations. The teacher's related beliefs towards this issue mostly did not change during whole year. Since the curriculum was already very intense, the teacher had difficulty to finish teaching all subjects on time. In respect of covering all the curriculum, the teacher felt pressure not only from the Ministry of Education but also from the school director and parents. The students had to enter high-stakes tests and there was a great expectation from teacher to help them in terms of taking high grades. The teacher believed that the education system should be changed for better learning and teaching. Her statement below presented an explanation of the situation:

> I think that better learnings occur as you use it. Unfortunately our education system does not evaluate how much you use and internalize knowledge, but how much information you have. I wish the science curriculum could be more different than that. Even small changes made in the curriculum such as new activities related to daily life drew students' attentions and enabled them to bring better science projects.

At beginning of the year, the teacher talked about crowded classes as an obstacle for teaching and learning. She had approximately 36 students in each of her classes. She thought that if class size would be lower, ABI can be applicable; however, at the end of the year she did not see the high number of students as an important barrier for ABI. She believed that the most important obstacle to better learning and teaching, and applying innovative approaches was the curiculum. Both in pre- and post-interview she adressed intensity of the curriculum as an obstacle in front of teaching and learning. Teacher's ideas about the curriculum in the pre-interview were given below:

> We have psychological pressure about the curriculum. I think that the reason that teacher cannot ask good questions is the intensity of the curriculum. Inquiry based questions are good questions but a teacher cannot ask qood questions and spare much time for it because of timing. There is much to teach and the teacher has limited time. Objectives of a unit have many sub-ideas and this needs time. Therefore, our education program is not suitable to have ABI implementations. If at least the curricula would be narrower, it could be applicable and teacher can do much more better things in lessons.

Another factor the teacher believed as an obstacle was the parents of the students. She thought that they affected their children's learning. She explained it as below:

> Family factor is very important. They prefer that their children find something from the internet, write it and bring to school as homework. Actually, parents block students' creativity. Our school laboratory has lack of materials. When I want children to bring some materials for experiments, families suddenly give reaction because of financial reasons. The level of income in our school region is low. Moreoever, when I give students a research work, parents ask whether they get a score in return of that homework. We cannot change the perception related to grades. Parents say to their children "If the teacher does not give a grade for it, making this will not be useful for you.". Therefore, the students have a concern of grade.

> They evaluate learning in this way. I say again, parents inhibit students' creativity. Furthermore, in the second semester of ABI (spring semester) the students wanted to make more ABI implementations, they wanted to do investigations about planets; however, they went with their families to hometowns before the end of academic year. Most of the students did not come to school in the last couple of weeks. If it was up to students, I believe they would have come.

In the post interview she stated that with one ABI implementation she could cover many objectives than she thought before and she believed that she did not face any problem catching up with the curriculum. Although she thought there was not a big problem with covering all the science content, she again thought that curriculum should be narrowed:

> Alongside narrowing curriculum, our education policy should be changed radically. The Ministry should expect from teachers other than teaching and waste their energy. Now there is constructivist learning in the program but there is no infrastructure for it. You see our lack of materials in the laboratory. Moreover, when I teach the "Human and the Environment", I want to be able to take students to a botanical garden not to stay in the class. Actually this is already possible in our system but there are so many procedures for it.

In general, teacher's beliefs about obstacles to teaching and learning were mostly based on the Turkish education system and parents' attitude toward students' learning.

4.3.6. Beliefs about professional development programs

Even the participant teacher was not asked any questions about professional development programs both in pre- and post interviews, she addressed it in the last interview. She stated her displeasure about mostly done inservice trainings in which teachers are just listeners and she characterized these programs as traditional. Her explanation about how a professional development program should be is presented below:

> Professional development programs should have periodicity rather than being one-time study. In this way, the interest of the teachers can be kept

> alive. Also they should be practical and speciality based. At the present time knowledge is reachable from everywhere, I can find them anywhere if they will just narrate me something in training. I am interested in application oriented information. Moreover, programs can be enjoyable. The environment is important.

Furthermore, the teacher talked about this present professional development related to ABI. She expressed below how she realized her deficiencies and improved herself in this professional development process:

> I learned so many things from these trainings. I was doing direct teaching before. Especially after attending this inservice training I learned a lot. Also by doing ABI implementations with given onsite ongoing support I found out my deficiencies. For example, I learned constructing the definition of electricity with my own words. I was telling directly what the book required and I was not adding anything from myself.

This program directed the teacher to self-monitoring. For example, she started to use video recording in order to watch herself and improve her teaching. Moreover, the feedback of the researcher provided her with an opportunity to revise what she did. The onsite ongoing support helped teacher learn how to construct a concept map.

> I started video recordings in lessons after I attended the inservice teacher training. We watched a video of a teacher and evaluated her teaching. I was inspired from that. Your comments guided me (in the second stage of professional development program) when I was preparing concept map. I was thinking about how I should teach during preparation but it was a wrong move. Your feedback helped me to learn how to construct a concept map.

After ABI experience, more wish for making research come into existence. Now the teacher wants to join these kind of programs and the European Union projects.

4.3.7. Beliefs regarding teaching profession

The participant teacher's beliefs about teaching profession has changed during this process. In the post interview, she explicitly used the expressions "The work I have done became more enjoyable", "I started to find pleasure in my job." and "I like my job more." This change is actually a result of the shift in beliefs about teaching and beliefs about learning. She expressed the change in the role of teacher as below:

> There was no product before but now there is. It is nice to have a product. My role was “evaluating” before and now it is different. I am a part of the process, too.

Moreover the teacher is not satisfied with teachers’ attitude towards their profession after the adoption process of ABI approach:

> I hope that all the teachers will make these ABI implementations. I see many teachers in inservice trainings who do not want to teach and prepare an extra activity, and escape from the workload. There is a great reluctance and they always complain. I was thunderstruck. Almost nobody is solution oriented. They are so tired of the workload. On the one part, I can say that they are right because there is pressure from MoNE. The Ministry makes teachers responsible for very unnecessary things and their energy is wasted for no reason. The education policy should be changed. I can understand them; they have children at home and do not spare much time. However, raising generations is not an easy job. Therefore, everybody should not be a teacher in this case. Sacrifice has to be the most important thing. Conscientious part of this job is really important. Teachers have to be forced to do something anymore. There must be teachers who want to do good things. The teacher should be innovative. I believe that I am really so. I always think about what to search from where and how to be more helpful for the students.

The teacher thought that good constructed professional development programs make changes in teachers, provoke their research willingness and show the way of enjoying their teaching profession.

4.3.8. Summary of the Teacher’s Beliefs

At the end of the study, the participant teacher’s beliefs about teaching in the context of both her teaching style and her role in the classroom changed. She shifted her teaching from teacher-centered to student-centered and her role from content deliverer to collaborator or mentor. As her role shifted, her questioning patterns changed to allow more divergent modes of thinking.

Her beliefs about how learning occurs and how learning is assessed have changed.

At the onset of the study she believed that better teaching and learning may occur in the context of ABI. She mentioned the importance of student participation during her implementations. ABI promoted creative thinking and encouraged students to participate actively teaching and learning process and make investigations. The teacher believed that as student participation increased, students learned much more, better and more permanently and also they gained self-confidence.

At the end of the study, she expressed that ABI was student-centered and suitable to implement in all science subjects and crowded classes. She stated that she still had deficiencies but would improve herself in time. The teacher believed that after two or three years much better products would be revealed, therefore, she was confident that she could apply effective ABI implementation in the future.

According to the participant teacher, Turkish teachers also face with the pressure from parents and students in respect of the educational goals. In her estimation, the major goal of the students at the middle school level in the Turkish educational system is to be able to enter a good high school. Because of this widespread objective the teachers are unable to avoid the pressures associated with the parents who expect their children to take high grades from lessons.

In addition to the concerns associated with curriculum, the teacher had also some hesitations towards ABI. She mentioned her concerns about the materials and the curriculum to be covered. At the onset of the study, she said that her class had lack of materials for investigations; however, at the end of the study she did not think that this is a big obstacle to students' learning. Furthermore, she touched upon the students' problem of transmitting learnings into daily life and believed that with the experience of ABI approach the students could be able to overcome this problem. Although there were some obstacles in front of teaching, learning and a new approach, she realized that ABI did not need perfect conditions related to number of students, materials and curriculum. Then she attempted to transfer her positive attitude about ABI to her colleagues. When she had a chance to meet with other teachers in different trainings she also advised and tried to convince them to implement ABI. The teacher believed that change is not easy and sudden, and also difficult for a teacher, but it is worth that and they should continually try to improve.

In general, she was satisfied with the changes in her students and liked her job much more. The teacher further expressed her satisfaction after being introduced to and trying to implement this new approach in her classrooms. Furthermore, she stressed that she would continue to improve her teaching.

CHAPTER 5

DISCUSSION

The research questions examined in this study were focused on changes occur in a middle school science teacher's pedagogical practices and beliefs about teaching and learning during a year of the implementation of ABI accompanied by a year of onsite ongoing professional support. In this chapter, findings are discussed and located in the existing body of literature. Then limitations and implications for professional development programs and future research are presented.

5.1. Discussion of the Findings

First of all, it should be remembered that the participant of this study did not experienced ABI before this research and also she was volunteered for the study after the 3-day ABI oriented inservice teacher training (first step of the professional development program); therefore, her readiness was high. Willingness of a teacher for engaging with a new teaching approach is an important factor during the implementation process (Ghaith & Yaghi, 1997). The participant teacher made six ABI implementations throughout one year. During this process onsite ongoing professional support was given to the participant and it was expected to occur some changes in teacher's pedagogical practices and her beliefs about teaching and learning. Just as a basic overall outcome it can be said that ABI approach helped to change teacher's pedagogical practices and beliefs about teaching and learning in a positive way with the help of onsite ongoing support. According to Wood (2013) teachers cannot be appropriately prepared without the determined training that comes through ongoing professional development.

The participant teacher shifted her pedagogical practice from traditional teacher centered teaching to a more student-centered approach. As the teacher's RTOP scores shows, she presents an improvement in her ABI implementations in time. These findings are in line with the related literature (e.g., Gunel, 2006; Kıngır, 2011; Nam et al., 2010) which shows that teachers generally make higher level of ABI implementations in time. On the other side, there are also studies that show the non-shifting pattern of the teachers (e.g., Gunel, 2006; Promyod, 2013). In this process, the teacher in this study made an effort for changing her role in the class, such as providing more opportunities for students to ask questions, discuss in groups and present their ideas to the whole class. Furthermore, she started to succeed mostly to keep silent during group presentations in the whole class discussions towards the end of the year.

Despite her big endeavor, she still was not able to desist from controlling students' investigations and presentations. Teacher's highest RTOP score is 1.82 out of 4.00; therefore, it cannot be talked about a perfect shift in teacher's practices. However, the teacher provided more opportunities for students' involvement in both investigation and presentation. Teacher's use of questioning is an important factor that affected her pedagogical practice, because questioning involves all necessary elements of ABI classrooms (Piburn et al., 2000). Questioning increases student talk (Gunel et al., 2007; Martin & Hand, 2009), starts and guides the classroom negotiation (Gunel et al., 2007; Kawalkar & Vijapurkar, 2013), implements scientific argument (Martin & Hand, 2009); improves reasoning and justification for explanations (Benus, Yarker & Hand, 2010). She changed her questioning style by decreasing direct recall short answer questions and by increasing open-ended, thought provoking questions. Furthermore, the teacher mostly encouraged non-participating students to ask questions and to argue about conflicting ideas. Encouraging students increased student voice. One of the surprising result of ABI for the teacher is that an inclusive student started to be active in the lesson and ask questions. This is one of the significant moments of the present study. The teacher tried to provide a learning environment that really include all the members of the classroom no matter which deficit they have. Moreover, as the teacher stated in the final interview, passive students who were normally not interested in science lesson started to be active and even sometimes they became the prominents of their groups. Students' role is shifted from passive receivers to active learners in the science inquiry classroom (Anderson, 2002). Because students need to have an active role in discussions for argumentation to take place in science classrooms (Jiménez-Aleixandre & Erduran, 2008). It is obvious that the improvement in participant teacher's pedagogical practices related to ABI approach is not satisfactory. How longer she need onsite ongoing support to make much more better ABI implementations is unclear. However, according to literature it is certain that at least 6 months more this teacher needs to make effort in order to be observed significant shifts in her pedagogical practices (Gunel & Tanriverdi, 2014; Martin & Hand, 2009). Gunel and Tanriverdi (2014) explained that the changes in teaching practices remain stable after the 18 months of a longitudinal training time.

Teachers' lack of pedagogical strategies to support students' argumentation is a major barrier for the implementation of argumentation in school science (Driver et al., 2000). Onsite ongoing professional support helped the teacher to improve her teaching and ABI implementations. The possibility of teachers' transfering new learning into their classrooms raised with ongoing support provided by instructional coaches (Cooter, 2003; Cranton & King, 2003; Loucks-Horsley & Matsumoto, 1999; Zemelman et al., 2005). Teacher-researcher collaborative negotiations, preparations before lessons and teacher's self-reflection accompanied by researcher's reflections enabled better ABI implementations. Feedbacks, before and after lesson conversations, support during preparations for in-class implementations were continued the whole year during six ABI implementations of teacher. For the sustainability of motivation and ability of the teacher, long-term training of inservice teachers and onsite ongoing support is very important. PD programs which require systematic follow-up and ongoing support are strongly recommended in the reform movements (Danielson, 2006; DuFour & Eaker, 1998; Feiman-Nemser, 2001; Gunel & Tanriverdi, 2014; Kent and Lingman, 2000; Killion, 2000; Lewis, 1997). Bryan (2012) stated that mentoring and coaching relationship possitively affects the revision and readjustment of science teachers' beliefs and practices. The participant teacher also stressed how much the onsite ongoing support positively affected her implementations. As it is suggested in the literature, professional development should provide trained peer-observers at the time of implementations in order to get feedback with respect to what progressed well and what were the lost opportunities during the lessons (Borko, 2004, p. 6). In the present study teacher's both pedagogical practice and beliefs were investigated as elements that can affect learning in the classroom. Yager (2005) stated that efficient PD programs should be long term and aim at many complex values such as; pedagogy, beliefs, and perceptions that affect teacher classroom practices.

It is also worth to be mention why the teacher could not do better ABI implementations. First of all, not all the things in the schedule were applied as they were expected. For example, more feedbacks were intended to be given during onsite ongoing support; however, since teacher devoted much time to form ABI teacher template than expected, there was time for just one feedback mostly. If at least two feedbacks for each teacher template requiring negotiation cycle were given, better ABI implementations could take place in the classroom and the teacher could ask better questions, and more follow-up questions. Second, more and more detailed feedback could be given during evaluation and self-reflection of implementation after lesson. Third, the adaptation to a new approach and to classroom dynamics during new approach application takes time. This study did not comprise a short time but also not a very long time. It is seen that participant teacher needs time longer than an academic year. Martin and Hand (2009) have shown that shifting teaching practice to include scientific argumentation takes time (at least 18 months). It is found that an extended period of professional development helped to adapt classroom practice toward the use of argument (Simon, Erduran, & Osborne, 2006).

Over a year of ABI implementations, the teacher's beliefs about teaching and learning shifted. In general, there is a change in teacher's beliefs to a more student-focused pedagogy over the professional development period. Since the given support to the teacher in this research was both onsite and ongoing, the change in teacher's beliefs was followed more precisely. At the onset of the study, the teacher’s beliefs about teaching were characteristic of a teacher-centered classroom. She shifted her definition of role of teacher from the transmitter of knowledge to a person who increases unwilling children’s motivation to science by captivating their interest, who reveals the hidden talent inside of the students by allowing them more opportunities to formulate questions and investigate freely, and who guides students when they transfer their knowledge into their daily life. She described her role at the end of the study as a facilitator. As her role shifted, her questioning patterns changed to which allow more divergent thinking. Teacher’s beliefs about learning are also changed in this process. She was thinking at the onset of the study that students learn through a transmission of factual information, but then the teacher shifted her beliefs about learning to a more ABI approach focused learning in which students ask questions, negotiate them with their friends, investigate their questions and present their claims in a process promoting critical thinking.

In this study the teacher stated her beliefs about teaching, learning, ABI, her own ABI teaching experience, obstacles to teaching, and professional development programs; however, the main focus of the interview questions was teaching and learning. Martin (2008) discussed teacher’s beliefs about both teaching and learning and supports the claim that teacher’s core belief was related to how students learn. Similarly in the present study, the teacher’s belief about learning is the central belief which is the reference point of other beliefs. Because the idea of how students learn better shapes the teacher’s teaching and provides a positive attitude towards the ABI approach when the teachers statements considered.

This present study is consistent with Rokeach’s (1968) idea. According to Rokeach (1968), the most central beliefs are the ones that most intertwined with other beliefs and connected in many ways to other beliefs, values and attitudes. Furthermore, he proposed that the entire belief system is affected by the change of a central belief. Teacher understanding related to how learning occurs help them to reorganize beliefs about both teacher’s and students’s role in the classrooms, which thereby affect the way they teach (Levitt, 2001; Luft, 2001; Richardson, 1996). In the present study, a change in beliefs about learning (core belief) shapes the teacher's beliefs about teaching (peripheral belief). Therefore, she modified her teaching by looking at how she herself learnes and her students learn.

At the beginning of the study, the teacher was thinking that the students learn through a transmission of factual information provided by the teacher. She changed her teaching since she saw that this way of teaching was useless in learning. The shift is from a traditional learning to one which is more constructivist. This finding is in line with the proposal that if a teacher is dissatisfied with his/her beliefs, shifts in beliefs exist by means of a conversion or a gestalt shift (Feldman, 1997; Nespor, 1987; Pajares, 1992). During the 3-day inservice training program the teacher realized that students do not learn when she directly narrates science and ABI approach can be a guiding spirit to help her in the classroom; therefore, she shifted her beliefs. Because inservice teacher training caused dissatisfaction in the teacher's beliefs. This finding supports Martin's (2008) suggestion that a critical event causes change in beliefs or practice. If there is no dissonance in teacher's previously held beliefs, the change would not occur.

As in Martin's study, this dissonance was caused by the professional development meetings held before the change in beliefs and practice. During the inservice training, teachers were treated as if they were students in order to focus on how students learn. At that time the teacher felt dissatisfaction and shifted her beliefs about learning and was convinced to apply what she saw in the trainings to her classroom. Here as a key finding of this study it can be said that the teacher's beliefs shifted before her practice. As her practice changed, her beliefs and practice continued to shift. This situation shows that there is a bi-directional relationship between beliefs and practice (Martin, 2008; Haney et al., 2002; Cobb et al., 1990) which confirms Thompson's (1992) theoretical model that there is a dialectic relationship between beliefs and practice. As she got surprised what the students did and how they enthusiastically engaged in the lesson, she became more motivated and confirmed her beliefs and continued to improve her practice. This is a kind of cyclic in which beliefs and practice continually shifted by turns. This is an example of the dialectic relationship between beliefs and practice interpreted by Thompson (1992). On the contrary, in the related literature there are also studies proposing little or no relationship between beliefs and practice (Simmons et al., 1999; Wilcox-Herzog, 2002; Hoyles, 1992; Bauersfield, 1988), or a unidirectional relationship from practice to beliefs (Guskey, 1986; Schoenfeld, 1992; Ruthven, 1987).

The teacher was thinking that there was obstacles (such as lack of material, curriculum, high-stakes testing, time etc.) affecting her ABI implementations. During the process the teacher's beliefs about obstacles to teaching and learning in ABI have changed. Curriculum, the pressure from MoNE in relation to curriculum, high-stake tests, the pressure from parents and school director related to these tests, large class size, lack of materials for investigation and sparing much time for preparation of ABI were the obstacles the teacher saw. In time she changed her mind in which ABI does not need perfect conditions for proper implementations and appropriate learning environment. At the end of the year although the teacher thought that with the present curriculum ABI is possible, she still insisted that curriculum was an obstacle to better ABI implementations. Furthermore she still believed that pressure from parents related to high-stake tests was an obstacle to teaching and learning in ABI. Similarly in the literature, teachers are generally concerned about the lack of materials and the curriculum to be covered (Gallagher & Tobin, 1987). Related to inquiry teaching, teachers stated the lack of materials (Anderson & Helms, 2001; Blumenfeld et al., 1994), covering the mandated curriculum and preparation for state-mandated tests as obstacles (Ladewski et al., 1994; Schneider et al., 2005). Independently of ABI, the lack of administrative support, large class sizes, and the lack of planning time are presented by the teachers as obstacles during the implementation of instructional methodologies (Hootstein, 1999). Promyod (2013) stated that the major obstacle to implementing and developing argument-based learning is a general need of support for an argument-based learning environment in the science classroom. In the present study, this main obstacle was eliminated by providing the participant science teacher onsite ongoing professional support.

Even though it was not a part of the research questions, this study also attempted to analyze beliefs-practice match. As with the implementation of ABI teacher's beliefs about teaching and learning shifted, changes in her teaching practice was observed. As teacher's beliefs shifted, she also changed her definitions about teaching and learning. RTOP data reveals that the teacher demonstrated change in her beliefs about pedagogical theory related to ABI approach and transmited her beliefs into her ABI practice in the classrooms. She expressed her deficiencies in her ABI implementations exactly as they are in her practice. On the other hand, teacher's beliefs and practice do not perfectly fit each other. When RTOP scores and teacher statements from the interviews are taken into account, it can be certainly said that teacher's RTOP scores do not directly represent her beliefs about her ABI implementations. The one who listen the audio record of the interview absolutely think that she has higher RTOP scores (for example, as if she has a score of 3.0 or 3.5 out of 4.0) but she has not in reality (a score of 1.60 or 1.80 and so on). It can be easily said that she is very enthusiastic about implementing ABI and has high level of self-efficacy; however, there is a gap between her beliefs and RTOP scores related to her ABI implementations although both have a positive trajectory.

On the one hand since both beliefs and practice were in tendency to ABI approach, it cannot be said that there is an inconsistency between belief and practice. On the other hand there is no perfect match between the teacher's beliefs and practice. This issue of consistency in belief and practice is complicated in the literature. There are studies found the inconsistency (Kang & Wallace, 2005; Luft, 2001; Murray & MacDonald, 1997; Simmons et al., 1999) and there are studies found the consistency between beliefs and practice (Boulton-Lewis et al., 2001; Haney et al., 2002; Luft, Roehrig & Patterson, 2003; Martin, 2008; Richardson et al., 1991; Yerrick et al., 1997). Perhaps this present study can be located within the literature that supports the idea that teachers who hold both old and new ideas about teaching; their learning and actions mix at the same time and change depending on the situation and personal factors

(Bryan, 2003; Hancock & Gallard, 2004; Marx et al., 1997).

To sum up, although there is not an incredible shift in ABI implementations by looking the teacher's RTOP scores, teacher's determined big endeavour to make ABI present in the classroom was a great change for students when it is compared with the teacher's old traditional teaching. Moreover, this teacher is very decisive not to go back to her previous teaching style since her beliefs about teaching and learning shifted. Also she is confident about her beliefs about ABI's effectiveness on students' learning and her teaching. Even just this output can make this present study valuable. The teacher stated at the end that the change is not easy and sudden but it is worth this difficulty and she should continually try to improve herself in this way.

5.2. Implications of the Study

The result of this study presents a number of implications. In this study it was investigated that the changes occur in science teacher's pedagogical practices, and her beliefs about teaching and learning during a year of the implementation of ABI accompanied by onsite ongoing professional support. The main effect provided by ABI which comprehend all necessary elements for the following implications of this study.

Focusing on after inservice trainings' support which is called in this study onsite ongoing support is very important for the teacher to deal with obstacles and make sustainable changes in the pedagogical practice. Teachers need this kind of support during shifting their beliefs and practices at the time of applying an innovative approach in the classroom. The support given whenever the teacher needs makes the process easier, shows the way of handling the problems faced with and helps to better understand the process. As much as possible reflections and feedbacks are very effective in this process. It is also stated in the literature that in order to promote the change in teachers' beliefs and practices professional development programs, academic workshops and long-term collaborative inservice programs are important

(Richardson et al., 2001). The suggested duration for the PD programs is at least 18 months to for teachers to make noticable shift in practice and start to understand the chacteristics of the new teaching and learning approach (Blumenfeld et al., 1994; Huberman & Miles, 1984; Martin & Hand, 2009;).The partipant teacher proposed that good constructed professional development programs provoke teachers research willingness and show them the way of enjoying their teaching profession. In addition, teachers need time to experience a new approach; because, especially at the beginning they may have questions or hesitation whether they can successfully make the implementations or not. During this process, teachers should be given onsite ongoing support to improve their related skills and to eliminate their concerns. Moreover there are studies that suggest teachers enough time for practicing (e.g., Richardson, 1990; van Driel et al., 2001). This stresses the importance of long-term sustained professional development.

Considering teacher's beliefs about learning as her central beliefs, two main implications can be mentioned. First, focusing on the beliefs about learning rather than beliefs about teaching promotes teachers more prepared for the innovations in science education. Second, focusing on learning in professional development programs can promote teachers to rethink on their beliefs about learning and teaching (Martin, 2008). This happens through discussion about beliefs and being treated as if they were students during these programs. In this regard, PD programs should allow participants to experience the innovative approach from the view of students, to discuss with respect to this implementation by examining the role of language in learning science and the pedagogical issues related to implementation of the new approach. Teacher role in increasing student voice, teacher's problem solving and reasoning skills, and teacher's questioning style can also be discussed during programs by revealing their beliefs about teaching and learning. Moreover PD programs should include assisting participants both in workshops during inservice trainings and after training by supplying onsite ongoing support. In order to accompany and help them in this new journey.

This study conducted in Turkish educational context, where reform movements are tried to be carried out in recent years. One of the purpose of this study to fill the gap in the related literature on the shift of teachers' pedagogical practice and beliefs about teaching and learning in the context of ABI by providing onsite ongoing support with particular emphasis on the Turkish educational context.

5.2.1. Implications for Future Research

There are several implications for future research:

- There can be studies in which teachers are supported by professional developers/coaches/mentors during the implementation process of innovative approach.
- Studies requiring longitudinal professional development programs are advised.
- A similar study can be applied in a larger context by extending the number of participant teacher and student, applying to other subjects and grade levels.
- ABI can be applied by the teachers working in the same school in the same time interval. Peer teachers can motivate and trigger each other rather than being alone in the implementation process.
- Numerous semi-structured interviews (pre, mid, after) can be conducted to deeply express the shift in beliefs and practice.
- Future studies should encourage teachers during implementation process in order to eliminate their concerns about obstacles related to ABI such as curriculum, time management, crowded class etc.
- It can be focused on understanding the relationship between beliefs and practice and how closely they are aligned to each other since this is a complicated issue.

REFERENCES

Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education*, 82(4), 417-436.

Ajzen, I., & Fishbein, M. (1980). Understanding attitudes and predicting social behavior. Englewood Cliffs, NJ: Prentice-Hall.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In Action control (pp. 11-39). *Springer*, Berlin, Heidelberg.

Ajzen, I. (2005). Attitudes, personality, and behavior. McGraw-Hill Education (UK).

ACARA (Australian Curriculum, Assessment and Reporting Authority). (2009). Curriculum design paper. Retrieved 16 June 2009, from http://www.acara.edu.au/ verve/_resources/Curriculum_Design_Paper_.pdf

Akkus, R., Gunel, M., & Hand, B. (2007). Comparing an Inquiry‐based Approach known as the science writing heuristic to traditional science teaching practices: Are there differences? *International Journal of Science Education, 29,* 1745-1765.

Anderson, R. D., & Helms, J. V. (2001). The ideal of standards and the reality of schools: Needed research. *Journal of Research in Science Teaching*, 38(1), 3-16.

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education*. 13 (1), 1 - 12.

Alhamami, M. (2018). Beliefs about and intention to learn a foreign language in face-to-face and online settings. *Computer Assisted Language Learning*, 31(1-2), 90-113.

Argyris, C., & Schon, D. (1974). Theory in practice: Increasing professional effectiveness. San Francisco, CA: Jossey-Bass.

Arora, A. G., Kean, E., & Anthony, J. L. (2000). An interpretive study of a teacher's evolving practice of elementary school science. *Journal of Science Teacher Education*, 11(2), 155-172.

Aymen Peker, E., Apaydın, Z., & Taş, E. (2012). Isı yalıtımını argümantasyonla anlama: ilköğretim 6. sınıf öğrencileri ile durum çalışması. *Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 4(8), 79-100.

Banilower, E. R., Heck, D. J., & Weiss, I. R. (2007). Can professional development make the vision of the standards a reality? The impact of the national science foundation's local systemic change through teacher enhancement initiative. Journal of Research in Science Teaching: *The Official Journal of the National Association for Research in Science Teaching*, 44(3), 375-395.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, 191-215.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bauersfeld, H. (1988). Interaction, construction, and knowledge: Alternative perspectives for mathematics education. In D. Grouws, T. Cooney & D. Jones (Eds.), *Perspectives on research on mathematics education* (27- 46). Reston, VA: National Council of Teachers of Mathematics.

Benus, M. J., Yarker, M. B., & Hand, B. (2010). An analysis of whole-class discourse patterns after a group presents their scientific claim and evidence. In Poster presented at the Science Education Research Symposium, Iowa City, IA.

Benus, M. J. (2011). *The teacher's role in the establishment of whole-class dialogue in a fifth grade science classroom using argument-based inquiry.* (Unpublished doctoral dissertation). University of Iowa, United States.

Berland, L. K., & Reiser, B. J. (2009). Making sense of argumentation and explanation. *Science Education*, 93(1), 26-55.

Bliss, J. (2008). Commonsense reasoning about the physical world. *Studies in ScienceEducation*, 44(2), 123-155.

Blumenfeld, P. C., Krajcik, J. S., Marx, R. W., & Soloway, E. (1994). Lessons learned: How collaboration helped middle grade science teachers learn project-based instruction. *The Elementary School Journal*, 94(5), 539-551.

Blumenfeld, P. C., Marx, R. W., Patrick, H., Krajcik, J., & Soloway, E. (1997). Teaching for understanding. In *International handbook of teachers and teaching* (pp. 819-878). Springer, Dordrecht.

Borger, L. L. (2012). *Embedding argumentation discourse within elementary inquiry teaching: implications for professional development*. ProQuest LLC. 789 East Eisenhower Parkway, PO Box 1346, Ann Arbor, MI 48106.

Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educational Researcher*, 33(8), 3–15.

Borko, H. & Putman, R. T. (1995). Expanding a teacher’s knowledge base: A cognitive psychological perspective on professional development. In T. R. Guskey& M. Huberman (Eds.), *Professional development in education: New paradigms and practices.* (pp. 35-65). New York: Teachers College Press.

Boulter, C. J., & Gilbert, J. K. (1995). Argument and science education. In P. S. M. Costello & S. Mitchell (Eds.), *Competing and consensual voices: The theory and practice of argumentation.* Clevedon, UK: Multilingual Matters.

Boulton-Lewis, G. M., Smith, D. J. H., McCrindle, A. R., Burnett, P. C., & Campbell, K. J. (2001). Secondary teachers' conceptions of teaching and learning. *Learning and instruction*, 11(1), 35-51.

Bowyer, J., Ponzio, R., & Lundholm, G. (1987). Staff development and science teaching: An investigation of selected delivery variables. *Journal of Research in Science Teaching*, 24(9), 807-819.

Brickhouse, N. W. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Teacher Education*, 41(3), 53-62.

Bricker, L. A., & Bell, P. (2008). Conceptualizations of argumentation from science studies and the learning sciences and their implications for the practices of science education. *Science Education, 92,* 473-498.

Bryan, L. A. (2003). Nestedness of beliefs: Examining a prospective elementary teacher's belief system about science teaching and learning. *Journal of research in science teaching,* 40(9), 835-868.

Bryan, L. A. (2012). Research on science teacher beliefs. In *Second international handbook of science education* (pp. 477-495). Springer, Dordrecht.

Burke, K. A., Greenbowe, T. J., & Hand, B. M. (2006). Implementing the science writing heuristic in the chemistry laboratory. *Journal of Chemical Education*, 83(7), 1032.

Burke, K. A., Hand, B., Poock, J., & Greenbowe, T. (2005). Using the science writing Heuristic. *Journal of College Science Teaching*, 35(1), 36.

Bybee, R. W. (1993). Reforming Science Education. Social Perspectives & Personal Reflections. Teachers College Press, 1234 Amsterdam Avenue, New York, NY 10027 (Hardcover: ISBN-0-8077-3261-3; paperback: ISBN-0-8077-3260-5).

Cavagnetto, A., Norton-Meier, L., & Hand, B. (2006). Effects of teacher level of implementation of the science writing heuristic on student achievement and cognitive engagement in grade five science classrooms. In *Annual Meeting* *of the Natioal Association of Research in Science Teaching, San Francisco, CA.*

Cavagnetto, A. R. (2010). Argument to Foster Scientific Literacy A Review of Argument Interventions in K–12 Science Contexts. *Review of Educational Research*, *80*(3), 336-371.

Cavagnetto, A., & Hand, B. (2012). The importance of embedding argument within science classrooms. In *Perspectives on scientific argumentation* (pp. 39-53). Springer, Dordrecht.

Cavagnetto, A., Hand, B. M., & Norton ‐ Meier, L. (2010). The nature of elementary student science discourse in the context of the science writing heuristic approach. *International Journal of Science Education*, 32(4), 427-449.

Cetin, P. S., Metin, D., Capkinoglu, E., & Leblebicioglu, G. (2016). Seeking the Trace of Argumentation in Turkish Science Curriculum. *Science Education International,* 27(4), 570-591.

Chen, Y. C., Hand, B., & Park, S. (2016). Examining elementary students' development of oral and written argumentation practices through argument-based inquiry. *Science & Education*, 25(3-4), 277-320.

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education,* 86, 175-218.

Chin, C., & Osborne, J. (2010). Supporting argumentation through students' questions: Case studies in science classrooms. *The Journal of the Learning Sciences*, *19*, 230–284.

Choi, A. (2008). *A study of student written argument using the science writing heuristic approach in inquiry-based freshman general chemistry laboratory classes.* (Unpublished doctoral dissertation). Iowa State University, Ames.

Clark, C. M., & Peterson, P. (1986). l.(1986). Teachers' thought processes. *Handbook of Research On Teaching*, 255-296.

Clark, D. B., & Sampson, V. D. (2007). Personally-seeded discussions to scaffold online argumentation. *International Journal of Science Education*, 29(3), 253-277.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational psychologist*, 31(3-4), 175-190.

Cobb, P., Wood, T., & Yackel, E. (1990). Chapter 9: Classrooms as learning environments for teachers and researchers. *Journal for research in Mathematics Education*. Monograph, 4, 125-210.

Cooter, R. (2003). Teacher "capacity-building" helps urban children succeed in reading. *The Reading Teacher*, 57(2), 198-208.

Corbin, J., & Strauss, A. (2008). Basics of qualitative research: Techniques and procedures for developing grounded theory.

Cox, P. L., French, L. C., & Loucks-Horsley, S. (1987). *Getting the principal off the hotseat: Configuring leadership and support for school improvement*. Regional Laboratory for Educational Improvement of the Northeast and Islands.

Crabtree, B. F., & Miller, W. L. (Eds.). (1999). Doing qualitative research. Sage publications.

Cranton, P., & King, K. (2003). Transformative learning as a professional development goal. New Directions for Adult and Continuing Education, 98, 31-37.

Crawford, B. A. (2000). Embracing the essence of inquiry: New roles for science teachers. Journal of Research in Science Teaching: *The Official Journal of the National Association for Research in Science Teaching*, 37(9), 916-937.

Crawford, B. A. (2007). Learning to teach science as inquiry in the rough and tumble of practice. *Journal of Research in Science Education*, 44(4), 586-612.

Creswell, J. W. (1998). Qualitative inquiry and research design: Choosing among five traditions.

Creswell, J. W. (2007). Qualitative inquiry and research design: Choosing among five traditions (2nd Ed.). Thousand Oaks, CA: Sage Publications, Inc.

Cronin ‐ Jones, L., & Shaw, E. L. (1992). The influence of methods instruction on the beliefs of preservice elementary and secondary science teachers: Preliminary comparative analyses. *School Science and Mathematics*, 92(1), 14-22.

Czerniak, C. M., & Lumpe, A. T. (1996). Relationship between teacher beliefs and science education reform. *Journal of science teacher education*, 7(4), 247-266.

Cakir, B. Z. O. (2011). *The influence of argumentation based instruction on sixth grade students' attitudes toward science, conceptual understandings of physical and chemical change topic and argumentativeness.* (Unpublished master's thesis). METU, Ankara, Turkey.

Danielson, C. (2006). *Teacher leadership that strengthens professional practice*. ASCD.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. Phi delta kappan, 76(8), 597-604.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8*(1), 1-44.

Dawson, V., & Venville, G. J. (2009). High‐school Students' Informal Reasoning and Argumentation about Biotechnology: An indicator of scientific literacy?. *International Journal of Science Education*, 31(11), 1421-1445.

Deboer, G. E. (2006). Historical perspectives on inquiry teaching in schools. In *Scientific inquiry and nature of science* (pp. 17-35). Springer, Dordrecht.

Deford, D. E. (1985). Validating the construct of theoretical orientation in reading instruction. *Reading Research Quarterly*, 351-367.

Deneroff, V. (2013). Professional development in person: Identity and the construction of teaching within a high school science department. *Cultural Studies of Science Education*.

Dewey, J. (1933). How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process Vol. 8.

Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational researcher*, 23(7), 5-12.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84, 287-312.

DuFour, R., & Eaker, R. (1998). *Professional learning communities at work.* Bloomington, IN: The Solution Tree.

DuFour, R., Eaker, R., & DuFour, R. (2005). *On common ground.* Bloomington, IN: National Educational Service.

Duit, R., & Treagust, D. F. (2003). Conceptual change: A powerful framework for improving science teaching and learning. *International journal of science education*, *25*(6), 671-688.

Duruk, U., Akgün, A., Dogan, C., & Gülsuyu, F. (2017). Examining the Learning Outcomes Included in the Turkish Science Curriculum in Terms of Science

Process Skills: A Document Analysis with Standards-Based Assessment. *International Journal Of Environmental and Science Education,* 12(2), 117-142.

Duschl, R. (1990). *Restructuring science education: The importance of theories and their development.* New York: Teachers College Press.

Duschl, R. A. (2007). Quality argumentation and epistemic criteria. In S. Erduran, & M. P. Jiménez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp.159-175). Dordrecht, The Netherlands: Springer.

Duschl, R. A. (2008). Quality argumentation and epistemic criteria. In S. Erduran & M. P. Jimenez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 159–175). Dordrecht, The Netherlands: Springer.

Duschl, R., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education*, 38, 39–72.

Eemeren, F. H. van, & Grootendorst, R. (2004). *A systematic theory of argumentation: The pragma-dialectical approach.* New York: Cambridge University Press.

Erduran, S., & Jiménez-Aleixandre, M.P. (2007). Argumentation in science education: An overview. In S. Erduran & M.P. Jiménez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 3–27). Dordrecht: Springer.

Erduran, S., & Jiménez-Aleixandre, M. P. (2008). Argumentation in science education. *Perspectives from classroom-Based Research. Dordrecht: Springer*.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education, 88,* 915-933.

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods*. Sage.

Ernest, P. (1991). *The philosophy of mathematics education*. London: The Falmer Press.

Easton, L.B., (2004). *Powerful designs for professional leaming.Oxford,* OH: National Staff Development Council.

Fang, Z. (1996). A review of research on teacher beliefs and practices. *Educational* *research*, *38*(1), 47-65.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *The Teachers College Record*, *103*(6), 1013-1055.

Feldman,A. (1997).Varietiesofwisdominthepracticeof teachers. *Teaching and Teacher Education, 13,* 757- 773.

Feldman, A. (2002). Multiple perspectives for the study of teaching: Knowledge, reason, understanding, and being. *Journal of Research in Science Teaching*, *39*, 1032-1055.

Fenstermacher, G. D. (1979). Educational accountability: Features of the concept. *Theory into Practice*, *18*(5), 330-335.

Fischler, H. (1994). Concerning the difference between intention and action: Teachers' conceptions and actions in physics teaching. *Teachers' minds and actions: Research on teachers' thinking and practice*, 165-180.

Franke, M., Carpenter, T., Fennema, E., Ansell, E., & Behrend, J. (1998). Academic Degrees. *Education*, *14*(1), 67-80.

Fullan, M. 2001. *The new meaning of educational change*, New York: Teachers College Press.

Gallagher, J. J. & & Tobin, K. (1987). Teacher management and student engagement in high school science. *Science Education*, 471, 535-555.

Garet, M. S., & Porter, A. C., & Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Geban, Ö., Ertepınar, H., Yılmaz, G., Altın, A., & Şahbaz, F. (1994). The effect of the computer based education on students' science course achievements and science interest. In *1th National Science Education Congress, İzmir, Turkey*.

Geertz, C. (1973). *The Interpretation of Cultures: Selected Essays*. New York: Basic Books.

Gess-Newsome, J. (1999). Pedagogical content knowledge: An introduction and orientation. In *Examining pedagogical content knowledge* (pp. 3-17). Springer, Dordrecht.

Ghaith, G., & Yaghi, H. (1997). Relationships among experience, teacher efficacy, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher education*, *13*(4), 451-458.

Gillies, R. M., Nichols, K., Burgh, G., & Haynes, M. (2012). The effects of two strategic and meta-cognitive questioning approaches on children's explanatory behaviour, problem-solving, and learning during cooperative, inquiry-based science. *International Journal of Educational Research*, *53*, 93-106.

Glaser, B., & Strauss, A. (1967). Grounded theory: The discovery of grounded theory. *Sociology the journal of the British sociological association*, *12*, 27-49.

Goodenough, W. (1963). *Cooperation in change.* New York: Russell Sage Foundation.

Gott, R., & Duggan, S. (2007). A framework for practical work in science and scientific literacy through argumentation. *Research in Science & Technological Education*, *25*(3), 271-291.

Grandy, R., & Duschl, R. A. (2007). Reconsidering the character and role of inquiry in school science: Analysis of a conference. *Science & Education*, 16(2), 141-166.

Greenbowe, T. J., Poock, J. R., Burke, K. A., & Hand, B. M. (2007). Using the science writing heuristic in the general chemistry laboratory to improve students' academic performance. *Journal of Chemical Education*, *84*(8), 1371.

Gunel, M. (2006). *Investigating the impact of teachers' implementation practices on academic achievement in science during a long-term professional development program on the Science Writing Heuristic*. (Unpublished doctoral dissertation). Iowa State University.

Gunel, M., Kingir, S., & Geban, Ö. (2012). Analyses of Argumentation and Questioning Patterns in Argument-based Inquiry Classrooms. *Egitim ve Bilim*, *37*(164), 316.

Gunel, M., & Tanriverdi, K. (2014). In-service teacher training from international and national perspectives: the retention and loss of institutional and academic memories. *Education and Science, 39*(175), 73-94.

Gunel, M., (2017) Introduction. In *More Voices from the Classroom* (pp. 13-16). SensePublishers, Rotterdam.

Günel, M., Memis, E. K., & Büyükkasap, E. (2010). Effects of the science writing Heuristic approach on primary school students' science achievement and attitude Toward science course. *Egitim ve Bilim*, *35*(155), 49.

Guskey, T. R. (1985). Staff development and teacher change. *Educational leadership*, *42*(7), 57-60.

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational researcher*, *15*(5), 5-12.

Guskey, T. R. (1989). Attitude and perceptual change in teachers. *International journal of educational research*, *13*(4), 439-453.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and teaching*, *8*(3), 381-391.

Hancock, E. S., & Gallard, A. J. (2004). Preservice science teachers' beliefs about teaching and learning: The influence of K-12 field experiences. *Journal of Science Teacher Education*, *15*(4), 281-291.

Hand, B. (1996). Diagnosis of teachers' knowledge bases and teaching roles when implementing constructivist teaching/learning approaches. In D. F. Treagust, R. Duit, & B. J. Fraser (Eds.). *Improving teaching and learning in science and mathematics* (pp. 212-221). New York, NY: Teachers College Press, Columbia University.

Hand, B., & Treagust, D. F. (1997). Monitoring teachers' referents for classroom practice using metaphors. *International Journal of Science Education*, *19*(2), 183-192.

Hand, B., Wallace, C., & Prain, V. (2003). Teacher issues in using a science writing heuristic to promote science literacy in secondary science. In *European Science Education Research Association Conference, Noordwijkerhout, The Netherlands*.

Hand, B., & Keys, C. W. (1999). Inquiry investigation. *The Science Teacher*, 66(4), 27.

Hand, B. (2008). Introducing the science writing heuristic approach. In B. Hand (Ed.), *Science inquiry, argument and language: A case for the science writing heuristic*. Rotterdam, The Netherlands: Sense Publishers.

Hand, B., Norton-Meier, L., Staker, J., & Bintz, J. (2009). *Negotiating science: The critical role of argument in student inquiry.* Heinemann: Portsmouth, NH.

Hand, B., & Norton-Meier, L. (Eds.). (2011). *Voices from the Classroom*. Springer Science & Business Media.

Hand, B., Norton-Meier, L., & Jang, J. Y. (Eds.). (2017). *More voices from the* *classroom: International teachers' experience with argument-based inquiry.* Springer.

Haney, J. J., Czerniak, C. M., & Lumpe, A. T. (1996). Teacher beliefs and intentions regarding the implementation of science education reform strands. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *33*(9), 971-993.

Haney, J. J., Lumpe, A. T., Czerniak, C. M., & Egan, V. (2002). From beliefs to actions: The beliefs and actions of teachers implementing change. *Journal of Science Teacher Education*, *13*(3), 171-187.

Hohenshell, L. M., & Hand, B. (2006). Writing‐to‐learn Strategies in Secondary School Cell Biology: A mixed method study. *International Journal of Science Education*, *28*(2-3), 261-289.

Hootstein, E. W. (1999). Differentiation of instructional methodologies in social studies at the secondary level. *Journal of Social Studies Research*, *23*(1), 11.

Hoyles, C. (1992). Mathematics teaching and mathematics teachers: A meta-case study. *For the learning of mathematics*, *12*(3), 32-44.

Huberman, M. & Miles, M. B. (1984) *Innovation Up Close: how school improvement works* (New York, Plenum).

James, R., & Hall, G. (1981). A study of the concerns of science teachers regarding an implementation of ISCS. *Journal of Research in Science Teaching, 18*, 479-487.

Jiménez-Aleixandre, M.P., Rodriguez, A., & Duschl, R. (2000). "Doing the lesson" or "doing science": Argument in high school genetics. *Science Education*, 84(6), 757–792.

Jonassen, D. H., Reeves, T. C., Hong, N., Harvey, D., & Peters, K. (1997). Concept mapping as cognitive learning and assessment tools. *Journal of interactive learning research*, 8(3), 289.

Jones, M. G., & Carter, G. (2007). Science teacher attitudes and beliefs. *Handbook of research on science education*, 1067-1104.

Kagan, D. M. (1990). Ways of evaluating teacher cognition: Inferences concerning the goldilocks principle. *Review of Educational Research*, 60(3), 419-469.

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational psychologist*, *27*(1), 65-90.

Kamil, M. L., & Pearson, P. D. (1979). Theory and Practice in Teaching

Reading. *New York University Education Quarterly*, *10*(2), 10-16.

Kane, R., Sandretto, S., & Heath, C. (2002). Telling half the story: A critical review of research on the teaching beliefs and practices of university academics. *Review of educational research*, *72*(2), 177-228.

Kang, N. H., & Wallace, C. S. (2005). Secondary science teachers' use of laboratory activities: Linking epistemological beliefs, goals, and practices. *Science education*, *89*(1), 140-165.

Kawalkar, A., & Vijapurkar, J. (2013). Scaffolding Science Talk: The role of teachers' questions in the inquiry classroom. *International Journal of Science Education*, *35*(12), 2004-2027.

Kazempour, M. (2009). Impact of inquiry-based professional development on core conceptions and teaching practices: A case study. *Science Educator*, *18*(2), 56-68.

Kelly, G. J., Drucker, S., & Chen, K. (1998). Students' reasoning about electricity: Combining performance assessment with argumentation analysis. *International Journal of Science Education,* 20, 849-871.

Kelly, G. J., & Takao, A. (2002). Epistemic levels in argument: An analysis of university oceanography students' use of evidence in writing. *Science Education,* 86(3), 314–342.

Kent, K., & Lingman, C. (2000). California's Course.*Journal of Staff Development*, *21*(3), 31.

Keys, C. W., Hand, B., Prain, V., & Collins, S. (1999). Using the science writing heuristic as a tool for learning from laboratory investigations in secondary science. *Journal of Research in Science Teaching*, 36(10), 1065 – 1084.

Kılıç, B. (2016). *Investigating questioning patterns of teachers through their pedagogical progression in argument-based inquiry classrooms.* (Unpublished master's thesis). METU, Ankara, Turkey.

Kıngır, S. (2011). *Using the science writing heuristic approach to promote student understanding in chemical changes and mixtures.* (Unpublished doctoral dissertation METU, Ankara, Turkey

Killion, J. (2000). Online staff development: Promise or peril? *NASSP bulletin*, *84*(618), 38-46.

Knight, P. (2002). A Systematic Approach to Professional Development: Learning as Practice. *Teaching and Teacher Education, 18*(3), 229-241.

Knowles, M.S., Holton, E.F., & Swanson, R.A. (2000). The Adult Learner. The definitive classic. In *adult education and human resource development.* Burlington, MA: Elsevier.

Schneider, R. M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform‐based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *42*(3), 283-312.

Kubitsky, B., & Fishman, B. (2007, April). *A design for using long-term face-to-face workshops to support systemic reform.* Chicago, IL: Presented at the American Educational Research Association.

Kuhn, D. (1991). *The skills of argument.* Cambridge, UK: Cambridge University Press.

Kuhn, D. (1992). Science as argument: Implications for teaching and learning scientific thinking. *Science Education, 77*, 319–337.

Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education, 11,* 319-337.

Kuhn, D., Black, J., Keselman, A., & Kaplan, D. (2000). The development of cognitive skills to support inquiry learning. *Cognition and Instruction*, *18*(4), 495-523.

Kuhn, D. (2005). *Education for thinking.* Cambridge, MA: Harvard University Press.

Kuhn, L., & Reiser, B. J. (2006). Structuring activities to foster argumentative discourse. Paper presented at the American Educational Research Association, San Francisco, CA.

Ladewski, B. G., Krajcik, J. S., & Harvey, C. L. (1994). A middle grade science teacher's emerging understanding of project-based instruction. *The Elementary School Journal*, *94*(5), 499-515.

Lather, P. (1992). Critical frames in educational research: Feminist and post-structural perspectives. *Theory into Practice*, *31*(2), 87-99.

Lawson, A. E. (2002). Sound and faulty arguments generated by preservice biology teachers when testing hypotheses involving unobservable entities. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *39*(3), 237-252.

Lawson, A. E. (2003). The nature and development of hypothetico-predictiv argumentation with implications for science teaching. *International Journal of Science Education, 25*(11), 1387-1408.

Lead States, N. G. S. S. (2013). Next generation science standards: For states, by states.

Levitt, K. (2001). An Analysis of Elementary Teachers' Beliefs Regarding-the Teaching and Learning of Science. *Science Education, 86,* 1-22.

Lew, L. (2001). Development of constructivist's behaviors among four new science teachers prepared at the University of Iowa. *Unpublished doctoral dissertation, University of Iowa, Iowa City.*

Lewis, A. C. (1997). A new consensus emerges on the characteristics of good professional development. *The Harvard Education Letter, 13,* 30-34.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry* (Vol. 75). Sage.

Loucks-Horsley, S. (1995). Professional Development and the Learner Centered School. *Theory Into Practice*, 34(4), 265-271.

Loucks-Horsley, S., & Matsumoto, C. (1999). Research on professional development for teachers of mathematics and science: The state of the scene. *School Science & Mathematics*, 99, 258-271.

Loucks-Horsley, S., Harding, C. K., Arbuckle, M. A., Murray, L. B., Dubea, C. & Williams, M. K. (1987) *Continuing to Learn: a guidebook for teacher development* (Andover, MA, Regional Laboratory for Educational Improvement of the Northeast & Islands).

Loucks-Horsley, S., Stiles, K., & Hewson, P. (1996). Principles of Effective Professional Development for Mathematics and Science Education: A Synthesis of Standards. *National Institute for Science Education, 1*(1), 1-5.

Loucks-Horsley, S., Hewson, P., Love, N. & Stiles, K. E. (1998) *Designing Professional Development for Teachers of Science and Mathematics* (Thousand Oaks, CA, Corwin).

Loucks-Horsley, S., Stiles, K.E., Mundry, S., Love, N., Hewson, P.W. (2010). *Designing Professional Development For Teachers Of Science And Mathematics*. (3rd Ed.) Thousand Oaks, CA: Corwin.

Luft, J. (1999). Teachers' salient beliefs about a problem- solving demonstration classroom in-service program. *Journal of Research in Science Teaching, 36,* 141-158.

Luft, J. A. (2001). Changing inquiry practices and beliefs: The impact of an inquiry-based professional development programme on beginning and experienced secondary science teachers. *International Journal of Science Education, 23*(5), 517-534.

Luft, J. A., Roehrig, G. H., & Patterson, N. C. (2003). Contrasting landscapes: A comparison of the impact of different induction programs on beginning secondary science teachers' practices, beliefs, and experiences. *Journal of Research in Science Teaching*, *40*(1), 77-97.

Luft, J. A., & Roehrig, G. H. (2007). Capturing science teachers' epistemological beliefs: The development of the teacher beliefs interview. *Electronic Journal of Science Education*, *11*(2).

MacIsaac, D., & Falconer, K. (2002). Reforming physics instruction via RTOP. *The Physics Teacher,* 40, 479-485.

Marsh, D. (2002). Membrane water-penetration profiles from spin labels. *European Biophysics Journal*, *31*(7), 559-562.

Martin, A. B. (2008). A case study of an experienced teacher's beliefs and practice during implementation of an inquiry-based approach in her elementary scienceclassroom. *Dissertation Abstracts International Section A*, 70, 519.

Martin, A. M., & Hand, B. (2009). Factors affecting the implementation of argument in the elementary science classroom. A longitudinal case study. *Research in Science Education*, 39(1), 17-38.

Martin, R., Sexton, C., Wagner, K., & Gerlovich, J. (1997). Teaching science for all children. (2nd ed.) Boston: Allyn & Bacon.

Marx, R. W., Blumenfeld, P. C., Krajcik, J., & Soloway, E. (1997). Enacting project-based science. *The Elementary School Journal*, 97(4), 341-358.

Mangano, N., & Allen, J. (1986). Teachers' beliefs about language arts and their effect on student beliefs and instruction. In *National Reading Conference Yearbook*. National Reading Conference.

Maloney, J., & Simon, S. (2006). Mapping children's discussions of evidence in science to assess collaboration and argumentation. *International Journal of Science Education*, *28*(15), 1817-1841.

Merriam, S. B., & Simpson, E. L. (1995). *A guide to research for educators and trainers of adults*. Krieger Publishing Co., PO Box 9542, Melbourne, FL 32902-9542.

Meriam, S., & Brokett, R. (1997). The profession and practice of adult education. *San Franscisco: Jessey Bass*, *7*.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.

McLeod, D. B., & McLeod, S. H. (2002). Synthesis – beliefs and mathematics education: Implications for learning, teaching and research. In G. C. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education* (pp. 115–123). Dordrecht, The Netherlands: Kluwer.

McMillan, J. H., & Schumacher, S. (1997). Research in education: A conceptual approach. *New York: Long*.

McNeill, K. L., & Pimentel, D. S. (2010). Scientific discourse in three urban classrooms: The role of the teacher in engaging high school students in argumentation. *Science Education*, *94*(2), 203-229.

MoNE. (2005). Milli eğitim bakanlığı talim terbiye kurulu başkanlığı, ilköğretim fen ve teknoloji dersi (6, 7 ve 8. Sınıflar) Öğretim Programı. Ankara.

Millar, R., & Osborne, J. (1998). Beyond 2000: Science education for the future (the report of a seminar series funded by the Nuffield Foundation). *London: King's College London, School of Education*.

Siegel, H. (1995). Why should educators care about argumentation? *Informal Logic, 17*(2), 159-176.

Mohammad, E. G. (2007). Using the science writing heuristic approach as a tool for assessing and promoting students' conceptual understanding and perceptions in the general chemistry laboratory.

MoNE. (2013). Milli eğitim bakanlığı talim terbiye kurulu başkanlığı, İlköğretim kurulları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. Sınıflar) öğretim programı. Ankara.

MoNE. (2018). Milli eğitim bakanlığı talim terbiye kurulu başkanlığı, İlköğretim kurulları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. Sınıflar) öğretim programı. Ankara.

Murray, K., & Macdonald, R. (1997). The disjunction between lecturers' conceptions of teaching and their claimed educational practice. *Higher Education*, *33*(3), 331-349.

Munby, H., Cunningham, M., & Lock, C. (2000). School science culture: A case study of barriers to developing professional knowledge. *Science Education*, *84*(2), 193-211.

Nam, J., Choi, A., & Hand, B. (2010). Implementation of the science writing heuristic (SWH) approach in 8th grade science classrooms. *International Journal of Science and Mathematics Education, 9,* 1111-1133.

National Research Council. (1996). National science education standards. National Academies Press.

National Research Council. (2000). Inquiry and the national science education standards: A guide for teaching and learning. National Academies Press.

National Research Council (2000). *Inquiry and the National Science Education Standards*. Washington, D.C.: National Academy Press.

Nisbett, R. E., & Ross, L. (1980). Human inference: Strategies and shortcomings of social judgment.

National Council of Teachers of Mathematics. (2006). Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence. National.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8*. National Academies Press.

National Staff Development Council (US). (2001). *National Staff Development Council's Standards for Staff Development*. National Staff Development Council.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, *19*(4), 317-328.

Newton, P. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education, 21*(5), 553-576.

Newton, P., Driver. R., & Osborne, J. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education*, 21(5), 553- 576.

Norris, S., & Phillips, L. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87, 224-240.

Nussbaum, E. M., Sinatra, G. M., & Poliquin, A. (2008). Role of epistemic beliefs and scientific argumentation in science learning. *International Journal of Science Education*, *30*(15), 1977-1999.

OECD, Development. Economic Analysis, & Statistics Division. (2003). *OECD Science, Technology and Industry Scoreboard 2003*. Canongate US.

O'Connor, R., & Korr, W. S. (1996). A model for school social work facilitation of teacher self-efficacy and empowerment. *Social Work in Education*, 18(1), 45-51.

Omar, S. H. (2004). Inservice teachers' implementation of the science writing heuristic as a tool for professional growth.

Omar, S., Gunel, M., & Hand, B. (2004). The impact of teacher implementation on student performance when using the Science Writing Heuristic. In *annual conference of the Association for the Education of Teachers in Science, Nashville, Tennessee, USA*.

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, 41(10), 994-1020.

Osborne, J., & Wellington, J. (2001). Language & Literacy in Teaching Science. Buchingham: Open University Press.

Ozdem, Y., Ertepinar, H., Cakiroglu, J., & Erduran, S. (2013). The nature of pre-service science teachers' argumentation in inquiry-oriented laboratory context. *International Journal of Science Education*, 35(15), 2559-2586.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307–332.

Penuel, W.R., Riel, M., Krause, A., & Frank, K. (2009). Analyzing teacher's professional interactions in a school as social capital: A social network approach. *Teachers College Record*,1,111-124.

Peterson, P. L., Fennema, E., Carpenter, T. P., & Loef, M. (1989). Teacher's pedagogical content beliefs in mathematics. *Cognition and instruction*, 6(1), 1-40.

Piburn, M., & Sawada, D. (2000). Reformed Teaching Observation Protocol (RTOP) Reference Manual. Technical Report.

Pinney, B. R. J. (2014). *Characterizing the changes in teaching practice during first semester implementation of an argument-based inquiry approach in a middle school science classroom.* (Unpublished doctoral dissertation). University of Iowa, United States.

Promyod, N. (2013). *Investigating the shifts in Thai teachers' views of learning and pedagogical practices while adopting an argument-based inquiry approach*. (Unpublished doctoral dissertation). University of Iowa, United States.

Porter, A. C., Garet, M. S., Desimone, L. M., & Birman, B. F. (2003). Providing effective professional development: Lessons from the Eisenhower program. *Science Educator*, 12(1), 23.

Posner, G., Strike, K., Hewson, P., & Gertoz, W. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education,* 66, 211-227.

Prain, V., & Hand, B. (1996). Writing for learning in secondary science: Rethinking practices. *Teaching and Teacher Education*, 12(6), 609-626.

Prawat, R. S. (1992). Teachers' beliefs about teaching and learning: A constructivist perspective. *American Journal of Education*, 100(3), 354-395.

Putnam, R.T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teachers learning? *Educational Researcher*, 29(1), 4-15.

Radford, D. L. (1998). Transferring theory into practice: A model for professional development for science education reform. *Journal of Research in Science Teaching*, 35(1), 73-88.

Robottom, I. M., & Hart, E. P. (1993). *Research in environmental education: Engaging the debate*. Deakin University.

Richardson, L. (1990). *Writing strategies: Reaching diverse audiences* (Vol. 21). Sage.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In Sikula, J. {Ed.), *Handbook of research on teacher education* (pp. 102-119). New York: Macmillan.

Richardson, I. (2001). Software process matrix: a small company SPI model. *Software Process: Improvement and Practice*, *6*(3), 157-165.

Richardson, V., & Placier, P. (2001). Teacher change. *Handbook of research on teaching*, *4*, 905-947.

Richardson, V., Anders, P., Tidwell, D., & Lloyd, C. (1991). The relationship between teachers' beliefs and practices in reading comprehension instruction. *American educational research journal*, *28*(3), 559-586.

Richmond, G., & Striley, J. (1996). Making meaning in classrooms: Social processes in small group discourse and scientific knowledge building. *Journal of Research in Science Teaching,* 33(8), 839-858.

Ritchie, S., & Tobin, K. (2001). Actions and discourses for transformative understanding in a middle school science class. *International Journal of Science Education, 23,* 283- 299.

Roth, K.J., Druker, S.L., Garnier, H., Lemmens, M., Chen, C., Kawanaka, T., Rasmussen, D., Trubacova, S., Warvi, D., Okamoto, Y., Gonzales, P., Stigler, J., & Gallimore, R. (2006). Teaching science in five countries: Results from the TIMSS 1999 video study. Washington, DC: National Center for Education Statistics.

Rokeach, M. (1968). Beliefs, attitudes and values: A theory of organization and change.

Roehrig, G. H., & Luft, J. A. (2004). Constraints experienced by beginning secondary science teachers in implementing scientific inquiry lessons. *International Journal of Science Education*, *26*(1), 3-24.

Ruthven, K. (1987). Ability stereotyping in mathematics. *Educational Studies in Mathematics, 18,* 243-253.

Ruiz‐Primo, M. A., Li, M., Tsai, S. P., & Schneider, J. (2010). Testing one premise of scientific inquiry in science classrooms: Examining students' scientific explanations and student learning. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(5), 583-608.

Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *41*(5), 513-536.

Sampson, V., & Clark, D. (2009). The impact of collaboration on the outcomes of scientific argumentation. *Science education*, *93*(3), 448-484.

Sampson, V., Grooms, J., Walker, J. P. (2011). Argument-Driven Inquiry as a way to help students learn how to participate in scientific argumentation and craft written arguments: An exploratory study. *Science Education, 95*(2), 217-257.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education*, *89*(4), 634-656.

Schmocker, M.(2006). Results now: How we can achieve unprecedented improvements in teaching and learning. Alexander, VA: Association for Supervision and Curriculum Development.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. *Handbook Of Research On Mathematics Teaching And Learning*, 334370.

Schneider, R. M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform‐based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching: The Official*

Journal of the National Association for Research in Science Teaching, *42*(3), 283-312.

Siegel, H. (1995). Why should educators care about argumentation? Informal Logic, 17(2),159–176.

Simmon, P.E., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D., et al., (1999). Beginning teachers: Beliefs and classroom actions. Journal of Research in Science Education, 36(8), 930-954.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation; reearch and development in the science classroom. *International Journal of Science Education*, 28(2-3), 235-260.

Skamp, K., & Mueller, A. (2001). A longitudinal study of the influence of primary and secondary school, university and practicum on student teachers' images of effective primary science practice. *International Journal of Science Education,* 23, 227-245.

Smith, T. M., Desimone, L. M., Zeidner, T. L., Dunn, A. C., Bhatt, M., & Rumyantseva, N. L. (2007). Inquiry-oriented instruction in science: Who teaches that way? *Educational Evaluation and Policy Analysis*, 29(3), 169-199.

Sparks, D., & Hirsh, S. (2007). A national plan for improving professional development. Oxford, OH: National Staff Development Council.

Sparks, D., & Hirsh, S. (1996). A new vision for staff development. Oxford, OH: National Staff Development Council.

Stake, R. E. (1994). Case studies. InN. K. Denzin & YS Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 236-247).

Stake, R. E. (1995). *The art of case study research*. Sage.

Stipek, D. J., & Byler, P. (1997). Early childhood education teachers: Do they practice what they preach?. *Early Childhood Research Quarterly*, *12*(3), 305-325.

Soysal, Y. (2017). *Exploration of the relations between the teacher's discursive roles and the students' cognitive contributions to the classroom discourse.* (Unpublished doctoral dissertation). ODTÜ, Ankara, Turkey.

Supovitz, J. A., & Turner, H. M. (2000). The Effects of Professional Development on Science Teaching Practices and Classroom Culture. *Journal of Research in Science Teaching,* 37(9), 963-980.

Schweingruber, H. A., Duschl, R. A., & Shouse, A. W. (Eds.). (2007). Taking science to school: learning and teaching science in grades K-8. National Academies Press.

Taylor, S. J., & Bogdan, R. (1998). Introduction to qualitative methods: A guide and resource.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research.

Tobin, K., Tippins, D. J., Gallard, A. J. (1993). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 45-93). New York: Macmillan.

Tobin, K., & LaMaster, S. U. (1995). Relationships between metaphors, beliefs, and actions in a context of science curriculum change. *Journal of Research in Science Teaching*, 32(3), 225-242.

Tobin, K., & McRobbie, C. J. (1996). Cultural myths as constraints to the enacted science curriculum. *Science education*, 80(2), 223-241.

Tucel, S. T. (2016). *Exploring the effects of science writing heuristic (SWH) approach on the eight grade students' achievement, metacognition and epistemological beliefs* (Unpublished master's thesis). ODTÜ, Ankara, Turkey.

Wallace, C. S., Hand, B. B., & Prain, V. (2004). Writing and learning in the science classroom (Vol. 23). Springer Science & Business Media.

Wallace, C. S., & Kang, N. H. (2004). An investigation of experienced secondary science teachers' beliefs about inquiry: An examination of competing belief sets. Journal of research in science teaching, 41(9), 936-960.

Weiss, I. R., Banilower, E. R., McMahon, K. C., & Smith, P. S. (2001). The 2000 national survey of science and mathematics education. Chapel Hill, NC: Horizon Research.

Wetzel, D. R. (2001). A model for pedagogical and curricula transformation with technology. Paper presented at the National Educational Computing Conferences, "Building on the Future", Chicago, IL, July 25-27th.

Wilcox-Herzog, A. (2002). Is there a link between teachers' beliefs and behaviors?. *Early Education and Development*, 13(1), 81-106.

Williams, M. E. (2007). Teacher change during a professional development program for implementation of the Science Writing Heuristic approach.

Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practice knowledge. *Journal of Research in Science Teaching*, 38(2), 137-158.

Van Veen, K., Sleegers, P., & Van de Ven, P. H. (2005). One teacher's identity, emotions, and commitment to change: A case study into the cognitive–affective processes of a secondary school teacher in the context of reforms. *Teaching and Teacher Education*, 21(8), 917-934.

Von Aufschnaiter, C., Erduran, S., Osborne, J., & Simon, S. (2008). Arguing to learn and learning to argue: Case studies of how students' argumentation relates to their scientific knowledge. Journal of Research in Science Teaching: The Official Journal of the *National Association for Research in Science Teaching,* 45(1), 101-131.

Vygotsky, L. S. (1987). Imagination and its development in childhood. *The collected works of LS Vygotsky,* 1, 339-350.

Yager, R. E. (2005). Accomplishing the visions for professional development of teachers advocated in the National Science Education Standards. *Journal of Science Teacher Education, 16(2), 95-102.*

Yerrick, R. K., Park, H., & Nugent, J. (1997). Struggling to promote deeply rooted change: The "filtering effect" of teachers' beliefs on understanding transformational views of teaching science. *Science Education,* 81, 137-159.

Yeşildağ-Hasançebi, F., & Günel, M. (2013). Effects of argumentation based inquiry approach on disadvantaged students' science achivement. *Elementary Education Online*, 12(4), 1056-1073.

Yeşildağ-Hasançebi, F., & Kıngır, S. (2012). Overview of obstacles in the implementation of the argumentation based science inquiry approach and pedagogical suggestions. *Mevlana International Journal of Education,* 2(3), 79-94.

Yin, R. K. (2002). Applications of Case Study Research Second Edition (Applied Social Research Methods Series Volume 34).

Yin, R. K. (2009). Case study research: Design and methods 4th ed. In *United States: Library of Congress Cataloguing-in-Publication Data* (Vol. 2).

Zemelman, S., Daniels, H., & Hyde, A. (2005). Best practice: Today's standards for teaching & learning in America's schools. *Education Review//Reseñas Educativas*.

Zohar, A. (1999). Teachers' metacognitive knowledge and the instruction of higher order thinking. *Teaching and Teacher Education*, 15(4), 413-429.

Zohar, A. (2007). Science teacher education and professional development in argumentation. In S. Erduran & M. P. Jimenez-Aleixandre (Eds.), *Argumentation in science education* (pp. 245-268). Springer, Dordrecht.

APPENDICIES

APPENDIX-A RTOP / ÖĞRETMEN GÖZLEM FORMU

		Hiç Gözlenmedi				Duruma Çok Uygun
Öğrenci Sesi	**-Öğretim** yöntemleri ve etkinlikler öğrencilerin ön bilgilerini ve bunların içindeki önyargıları yansıtıyor.	0	1	2	3	4
	-Dersin odağı ve yönü öğrencilerden gelen fikirler dâhilinde belirleniyor.	0	1	2	3	4
	-Öğrenciler çeşitli sunum yolları (modlar) ile kendi düşüncelerini arkadaşları ile paylaşıyor.	0	1	2	3	4
	-Yüksek oranda öğrenci konuşması var ve bunun büyük bir bölümü öğrenciler arasında.	0	1	2	3	4
	-Öğrenci soruları ve yorumları genellikle sınıf söylemlerinin odağını ve yönünü belirliyor.	0	1	2	3	4
	GENEL (Toplam/5)					/5=
Öğretmenin Rolü	**-Öğretmen,** öğrenci araştırmalarını desteklemek ve geliştirmek için çaba harcayan kaynak kişi olarak hareket ediyor.	0	1	2	3	4
	-Bu sınıf için 'öğretmen dinleyici' dir benzetmesi çok uygun	0	1	2	3	4
	GENEL (Toplam/2)					/2=
Muhakeme ve Bilimsel Süreç Becerileri	**-Bu ders** öğrencileri alternatif araştırma ve problem çözme modelleri bulmaları ve farklı düşüncelere değer vermeleri için teşvik ediyor.	0	1	2	3	4
	-Öğrenciler, eleştirel değerlendirmenin hakim olduğu düşündürücü etkinliklere aktif olarak katılıyor.	0	1	2	3	4
	-Öğrenciler kendi öğrenme süreçleri hakkında yansıtıcı düşünüyor.	0	1	2	3	4
	-Eleştirel ve sorgulayıcı fikirlere değer veriliyor.	0	1	2	3	4
	-Öğrencilerin aktif katılımı teşvik ediliyor ve önemseniyor.	0	1	2	3	4
	-Öğrenciler varsayım kurmaları, alternatif çözüm stratejileri bulmaları ve delilleri farklı yollarla yorumlamaları için teşvik ediliyor.	0	1	2	3	4
	GENEL (Toplam/6)					/6=
Soru Sorma	**-Öğretmenin** soruları öğrencilerin alternatif düşünme yolları üretmelerini sağlıyor.	0	1	2	3	4
	-Öğretmen öğrencilerin ön bilgilerini ortaya çıkaran sorular soruyor.	0	1	2	3	4
	-Öğretmen müzakere sürecini başlatan ve devam ettiren soruları etkili bir şekilde kullanıyor.	0	1	2	3	4
	-Öğretmen takip soruları sorarak müzakere sürecini devam ettiriyor.	0	1	2	3	4
	GENEL (Toplam/4)					/4=

1RTOP SCORE (TOPLAM/17) =

APPENDIX-B ABI TEACHER TEMPLATE/DERSE GİRİŞ VE MÜZAKERELER ÖĞRETMEN FORMU

<table>
<tr><td>Ünite bilgileri:</td><td colspan="2">IŞIK</td></tr>
<tr><td>Büyük Düşünce*:</td><td colspan="2">Işık bir enerji türüdür.</td></tr>
<tr><td>Alt Düşünceler*:</td><td colspan="2">1. Işık madde ile etkileşimi sonucunda soğurulur. Soğurulan madde ısınır
2. Işık enerjisi maddenin sıcaklığında artışa sebep olur
3. Işık saydam bir ortamdan başka saydam ortama geçerken doğrultu değiştirir.
4. Merceklerle ışık kontrollü şekilde kullanılır</td></tr>
<tr><td colspan="3">Derse Giriş Etkinliğinin Tasarlanması</td></tr>
<tr><td>Alt düşünce(ler) ve ilgili kazanımların eşleştirilmesi:</td><td>Seçilmiş ünite kazanımları:
* Işığın saydam bir ortamdan başka bir saydam ortama geçerken doğrultu değiştirdiğini keşfeder.
* Işık demetlerinin az kırıcı (az yoğun) saydam bir ortamdan çok kırıcı (çok yoğun) saydam bir ortama geçerken normale yaklaştığı, çok kırıcı (çok yoğun) saydam bir ortamdan az kırıcı (az yoğun) saydam bir ortama geçerken ise normalden uzaklaştığı sonucunu çıkarır.
* Işığın hem kırıldığı hem de yansıdığı durumlara örnekler verir.
* Çeşitli ortamlarda kırılma olayını açıklamak için basit ışın diyagramları çizer.
* İki ortam arasında doğrultu değiştiren ışık demetlerini gözlemleyerek ortamların yoğunluklarını karşılaştırır.
* Işığın her zaman çok kırıcı (çok yoğun) ortamdan az kırıcı (az yoğun) ortama geçemediğini deneyerek keşfeder.
* Işığın kırılmasıyla açıklanabilecek olaylara örnekler verir.</td><td>Eşleşen ve kapsayıcı alt düşünce(ler):
*ışık saydam bir ortamdan başka saydam ortama geçerken doğrultu değiştirir.</td></tr>
<tr><td>Başlangıç müzakeresinin kısaca tanıtılması:</td><td colspan="2">Işığın soğurulduğu ve yansıdığını geçen derste öğrenmiş olan öğrencilere, ışık her ortamdan geçer mi sorusu sorularak derse başlanır. Öğrenciler saydam ortamlardan geçeceğini , saydam olmayan ortamlardan ise ışığın geçmeyeceğini vurgular. Öğrencilerin cevabı üzerine her saydam ortam aynı özelliği taşır mı sorusu sorulur,</td></tr>
</table>

	öğrencilerden gelen hayır cevabına neden sorusu yöneltilir. Öğrencilerden yoğunluklarının farklı olduğu, katı, sıvı , gaz halinde oldukları moleküller arası boşlukların farklı oldukları gibi muhtemel cevaplar gelebilir.** Bunun akabinde ışık hızının her yerde sabit olup olmadığı sorulur. Öğrencilerden evet veya hayır cevabı gelebilir. Evet ve hayır cevaplarını kanıtlayıcı örnekler sorulur. Ardından ışık hızının neden sabit kalmadığı arttığı mı yoksa azaldığı mı sorulur? Işığın boşlukta 300 bin km/h olduğu, maddesel ortamda hızının azalacağı, ortamdan ortama değişeceği, yoğunluk arttıkça hızının azalacağı gibi cevaplar gelebilir. Bir ortamdan başka bir ortama geçerken neden hızının değiştiği, ışığın başına ne geliyor da hızının değiştiği sorulur. Kırılma cevabı buradan gelebilir. Ve ışığın kırılmasının ne demek olduğu, nasıl gerçekleştiği sorulabilir. ** Işığın doğrusal yolla yayıldığını bilen öğrenciler doğrultu değiştirdiğini vurgulayabilir. Kırıcılık her ortamda aynı mıdır sorusu yöneltilir (kırıcılığın yoğunlukla aynı kavram olmadığı belirtilir). İçi su dolu bardağa belli bir açı ile konulan kalemin doğrultusunun aynı olup olmadığı sorulur. Öğrenciler hava ile su gibi ortamların farklı ortamlar olduğunu söyleyebilir. Bunun üzerine "farklı olan ortamlara konulan kalemin doğrultu değiştirip değiştirmediği durumların olup olmadığı" sorulabilir. Evet/hayır cevapları alındıktan sonra ışığın kırılmasını etkileyen faktörlerin ne olduğu sorulup başlangıç müzakeresi tamamlanır. Öğrenciler, ışığın kırılmasının; maddenin cinsine, yoğunluğuna, maddenin hallerine, parlak veya pürüzlü olmasına bağlı olarak değişebileceğini söyleyebilirler.
Alternatif başlangıç müzakeresi:	** Işığın kaynaktan çıktıktan sonra yayılırken nasıl bir yol izlediği sorulur. Doğrusal/dağınık/kaynağa göre değişir/düzgün gibi cevaplar gelebilir. Işığın geçtiği ortamın davranışında/doğrultusunda nasıl bir etkisi olduğu sorulur. Herhangi bir etkisi olmaz veya yön/doğrultu değiştirir diyebilirler. Neden ortam farklılaştıkça ışığın davranışının/doğrultusunun değiştiği sorulur.
Varsa araştırılması istenilen değişkenler:	ışığın kırılmasını etkileyen faktörler: maddenin cinsi, yoğunluğu, maddenin halleri, parlak veya pürüzlü olması
Olası öğrenci araştırmaları 1:	Saydam olan ortamların katı, sıvı, gaz hallerinin ışığın kırılmasına etkisi • Buz • Su

<table>
<tr><td></td><td>Hava
Zeytinyağı
Kolonya
Beherglas
Kalem
Pipet
Lazer kalemi
Burada öğrenciler maddenin hallerinin ışığın kırılmasına etkisini inceleyeceğinden aynı maddenin farklı fazları (katı, sıvı, gaz) üzerinde çalışabilir.</td></tr>
<tr><td>Olası öğrenci araştırmaları 2:</td><td>Saydam olan ortamların yoğunluğunun (kırıcılıklarının) ışığın kırılmasına etkisi
Zeytinyağı
Su
Cam
Lazer kalemi
Fener
İçinde su, zeytinyağı ve boş olan beherlere lazer kalemi tutularak hangi ortamın ışığı ne kadar kırdığına bakılabilir.</td></tr>
<tr><td>Olası öğrenci araştırmaları 3:</td><td>Saydam olan ortamların cinsinin ışığın hızına etkisi.
Su
Zeytinyağı
Cam
Hava
Beherglas
Lazer kalemi
Örneğin içinde su, kolonya, zeytinyağı olan beherlere iki aynı cisim koyularak kırılmaya bakılabilir. Aynı cimi karşılaştırma yapmak için boş bir behere de koyulabilir. Burada öğrenciler aslında maddenin yoğunluğu ile maddenin cinsinin doğrudan ilişkili olduğu sonucuna varabilir.</td></tr>
<tr><td>Olası öğrenci araştırmaları 4:</td><td>Madde miktarının kırıcılığa etkisi.

Yarı ve tam dolu beherlere koydukları kalemlerin kırılmasına madde miktarının herhangi bir etkisinin olup olmadığını da inceleyebilirler.</td></tr>
<tr><td>Kullanılacak malzemeler</td><td>Su, zeytinyağı, kolonya, beherglas, lazer kalem, pipet.

Öğrenciler araştırmaları esnasında dilediği uygun materyali kullanmakta serbesttir.</td></tr>
<tr><td>Öğretmen notları</td><td>Öğrenciler kolaylıkla bu değişkenleri inceleyemeyebilirler.</td></tr>
</table>

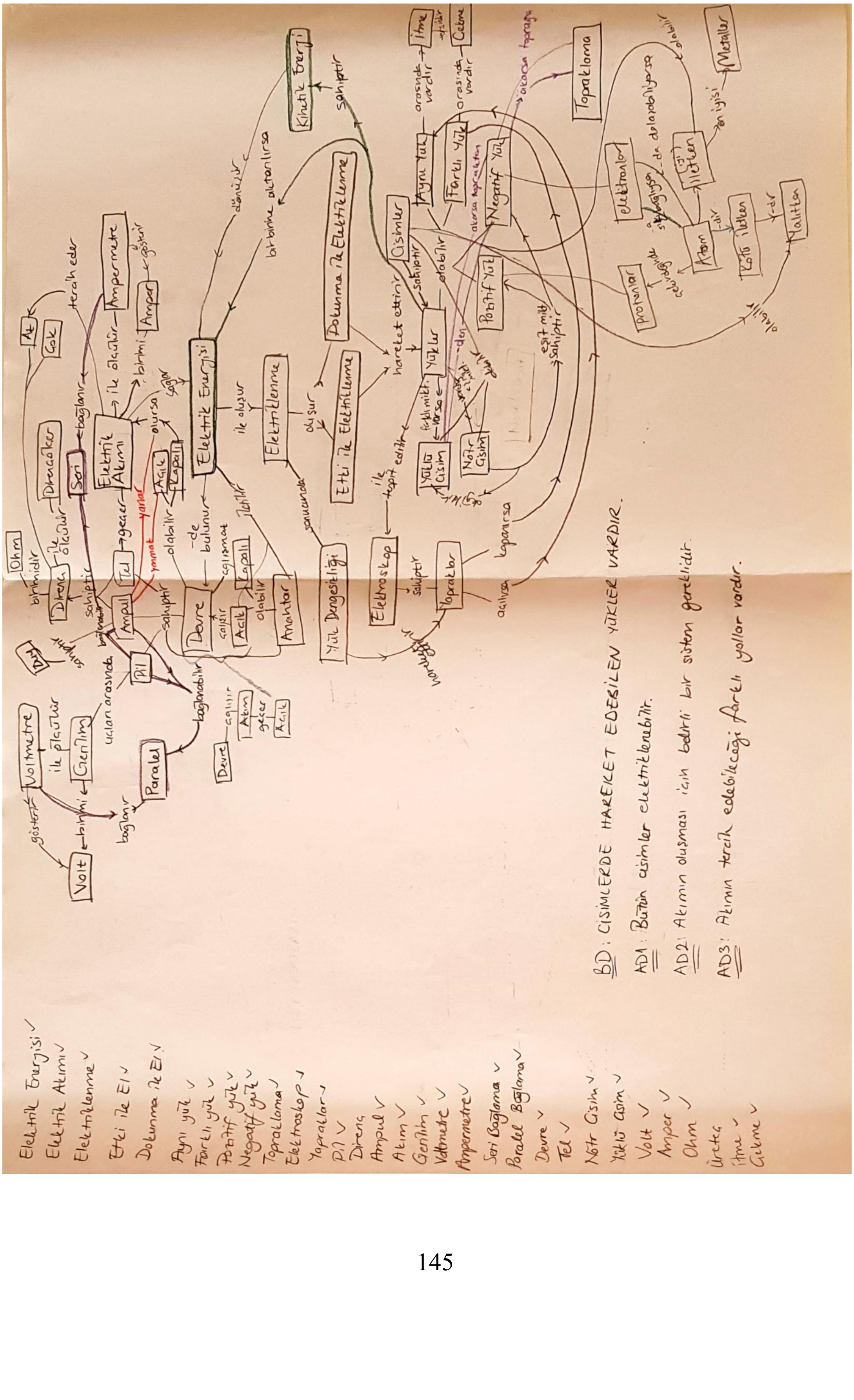
	Dolayısıyla özellikle gruplar sorularını yapılandırırken ve deneyleri tasarlayıp, verilerini toplarken yeterince iyi takip etmek gerekiyor.

*Yukarıda belirtilen tüm üniteyi kapsayan büyük düşünce ve onun bileşenleri olan alt düşünceler ünite süresince öğretmenin yapacağı giriş etkinliklerini belirlemesinde yardımcı olacaktır.

**Alternatif başlangıç müzakeresinin entegre edilebileceği yerler

The ABI teacher template adapted from Cavagnetto, A., Hand, B. M., and Norton-Meier, L. (2010); Cavagnetto, A., and Hand, B. M., (2012); Hand, B., and Keys, C. (1999); Hand, B., and Prain, V. (2006); Hand, B. (2008).

APPENDIX-C CONCEPT MAPS




Işık
Işın
Optik
Madde
Enerji
Kırılma
Yansıma
Mercekler
Prizma
Ayna
Foton
Renk
Created By Paint X

APPENDIX-D PRE INTERVIEW QUESTIONS

A. Past Teaching Experiences

1) What are the preparations you make for the lesson?

    -Do you review your time, objectives and the materials?

2) How do you decide what to teach? What are the things that help you giving this decision? (Experiences, curriculum, course book, achievement levels of the students etc.)
3) What are your criteria when choosing the methods you use for teaching?
4) How do you start your lesson?
5) How do you manage your time?
6) How do you evaluate the teaching method that you choose?
7) How do you check how much students learn when you are teaching?
8) How do you understand whether the students learn the objectives that you teach or not?
9) How do you evaluate your teaching method?

B. Learning, Teaching, Pedagogy

10) What does learning mean to you?
11) What is teaching?
12) How do you see your role in the classroom?
13) How is a good teacher should be? What are the features of a good teacher?

    -How much of these features do you have?

14) Do you think you have the control over what you teach in the classroom? How?
15) What are the essentials of an effective learning environment?
16) How do you learn? Could you please give an example?
17) How do you understand as a teacher that your students learn?
18) How do you think that students learn best?
19) How does your classroom seen when you motivate your students to learn and when you think that a learning environment occured in the classroom?

20) How can a good question be asked? How do you ask your questions?
21) Do you think that you do not have enough content knowledge?

C. Perceptions and Expectations for ABI (Implementations)

22) What is the purpose of concept map?
23) What is big idea? What is the purpose of the big idea?
24) What do you think will be the impact of the preparations you made before the class (constructing concept map, forming big and sub-ideas, planning entry activities and negotiation cycle) on the ABI implementations?
25) What do you think about ABI?
26) Do you believe that you can effectively make ABI implementations?
27) Do you think that ABI is a suitable approach for students? How?
28) How do you think the implementations will affect students' learning process? (Do you think that ABI implementation will affect students' learning process positively?)
29) How do you think that ABI implementations affect classroom management?
30) Do you think that ABI implementations are appropriate for your teaching understanding? In which way?
31) Do you think that these implementations are performable in the existing education system? (exam system, administration, time, content of the curriculum, intensity of the curriculum, parents etc.)

APPENDIX-E POST INTERVIEW QUESTIONS

A. Perceptions for ABI (Implementations)

1) What is the big idea?
2) Are there any benefits of defining big ideas in terms of your implementations? How?
3) Do you check your content knowledge at the time of defining big ideas?
4) What is argument-based inquiry?
5) How was the effect of your preparations on ABI implementations? What is the point of the preparations were the most effective?
6) Are there any maneuvers that you have planned in your preparations, but you cannot implement in the classroom? What? Why could not you apply it? Could you give an example?
7) What is the most effective part of ABI implementations on students' learning processes?
8) Do you think that you made effective ABI implementations? What are the essential points that make these implementations effective?
9) What is the point that you think you did best during your ABI implementations?
10) What are the problems you faced with during implementations? What was the reason of the problem? At which point do you think that you were weak?
11) How did you handle classroom management issue during implementations?
12) Did your ideas change related to classroom management in this process?
13) How did you manage your time during ABI implementations?
14) What has changed in your practices during the process?
15) Do you think that ABI is a suitable approach for students? How?
16) Do you think that you can make an ideal ABI implementation in science? Why?
17) Have you ever get any feedback related to implementations from students, school, parents and your colleagues? If yes, what kind of feedback did you get?

18) Do you think that these implementations are performable in the existing education system?
19) What differences you observed from your students after ABI implementations?

B. Learning, Teaching, Pedagogy

20) Did these ABI implementations change your beliefs about learning? What does learning mean to you?
21) Could you please tell a learning experience of yourself? Why did you define this process as learning?
22) As a teacher how do you understand that your students learn?
23) Is there a difference between students' learning and your learning when you think of inservice trainings?
24) At which point learning and teaching intersect?
25) What is your role in the process of learning and teaching? What is teaching?
26) Is there any difference in your role between past and present? Did you have any difficulties during this role change?
27) Did you feel that you do not have enough content knowledge during ABI implementations?
28) What are your pedagogically strong points?
29) Do you think your students better learned with ABI approach compared to previous lessons?
30) What is the importance of student-student interaction?
31) What is the role of questioning?

APPENDIX-F TURKISH SUMMARY / TÜRKÇE ÖZET

Türk Milli Eğitim Bakanlığının fen eğitimindeki hedefi fen okuryazarı bireyler yetiştirmektir (MoNE, 2013). Bakanlık 2004, 2013 ve son olarak 2018 yıllarında fen bilimleri dersi öğretim programında büyük değişikler yapmıştır. Fen okuryazarlığı vizyonu altında fen bilimleri dersi öğretim programı yenilikçi öğretim stratejileri açısından önemli bir rol oynamaktadır. Fen okuryazarı bir birey bilimsel bilginin niteliğini kaynağına ve üretilmesi için kullanılan yöntemlere bakarak değerlendirebilmelidir. Ayrıca fen okuryazarlığı kanıtlara dayanarak argüman üretme ve değerlendirme ile bu argümanlardan uygun sonuçların çıkarılmasını ifade eder (NRC, 1996). Bilimsel bilginin niteliğinin değerlendirilebilmesi için argüman üretme ve değerlendirme yeterliğinin geliştirilmesi veya artırılmasına ihtiyaç vardır. Araştırmacılar bu hedeflere nasıl ulaşılacağını tartışarak öğrencilerin bilimsel araştırmalara aktif olarak katılım sağlamaları gerektiği sonucuna varmışlardır (Wallace et al., 2004). Aslında mesele bir atasözünde de ifade edildiği gibi balık vermek değil balık tutmayı öğretmektir.

Fen okuryazarı bireylerin araştırıp sorgulayan, etkili karar veren, problem çözen, kendine güvenen, iş birliğine açık, etkili iletişim kuran ve hayat boyu öğrenmeye açık olmasını beklenmektedir (MEB, 2013). Bu bağlamda Argümantasyon Tabanlı Bilim Öğrenme (ATBÖ) yaklaşımı öğrencilerin arkadaşları ve öğretmenleri ile güçlü etkileşim halinde bulunarak kavramsal anlayışlarını ve görüşlerini savunabilme kabiliyetlerini geliştirmektedir. Ayrıca bu süreç öğrencilerin eleştirel düşünme becerilerini ve bilgi birikimlerine katkı sağlamaktadır (Hand, 2008). Araştırmacılar genellikle ATBÖ'yü öğrencilerin argümanlar aracılığıyla öğrencinin bir araştırma sorgulama sürecinden geçmesini sağlamak için uygulamaktadırlar (Akkus et al., 2007; Gunel, 2006; Hand & Keys, 1999; Prain & Hand, 1996). ATBÖ, öğrencilerin soru-iddia-delil çerçevesinde araştırma sorgulama etkinlikleri yapmasıdır (Hand & Norton-Meier, 2011).

Burada önemle vurgulanması gereken bu tür bir yaklaşımın öğretmenlerin öğrenme ve öğretmeye yönelik kabullerinin bilgiyi aktarandan öğrenmenin bilişsel perspektiflerini anlama ve uygulama yönünde değişmesini sağlamayı gerekli kılmaktadır. Bu değişim, ATBÖ yaklaşımını benimseme sürecinde bütün öğretmenlerin deneyimlediği bir durumdur (Hand, Norton-Meier & Jang, 2017). Bu noktada öğretmenlerin bu yeni yaklaşımı sınıfta uygulama sürecinde gerekli değişiklikleri yapabilmesi için desteğe ihtiyacı vardır. Bu çalışma kapsamında bir fen bilimleri dersi öğretmenine ATBÖ ile ilgili katıldığı üç günlük hizmet içi eğitimin ardından hem iş başında hem de sürekli olarak destek sağlanmıştır. Fen eğitimindeki bu yenilikçi yaklaşım öğretmenlerin sınıf içi pratiklerinde önemli değişiklikler yapmalarını gerektirmektedir. Öğretmenlerin pedagojik pratiklerini değiştirmesi ise kolay bir süreç değildir. Öğretmenler uygulamalarını değiştirirken yeni beceriler, bilgiler ve inançlar geliştirir. Bu değişiklik bir profesyonel gelişim programı kapsamında meydana gelir. Bu programlar öğretmenlerin inançlarını ve sınıf içi pratiklerini etkileyebilecek niteliktedir (Pajares, 1992).

Bybee (1993) öğretmenlerin inançlarının ve öğretimlerinin, eğitimde değişimin ve nihayetinde başarılı bir eğitim sürecinin temel öğeleri olduğunu vurgulamıştır. Öğretmenlerin inançları bu noktada önemli rol oynamaktadır.

İnanç, üzerinde uzlaşı sağlanmış bir tanıma sahip değildir. Pajares (1992) tutumlar, yargılar, görüşler, ideolojiler, algılar, anlayışlar, kavramsal sistemler, önyargılar, eğilimler, örtük teoriler, açık teoriler, kişisel teoriler, iç zihinsel süreçler, eylem teorileri, uygulama ilkeleri, pratik ilkeler, perspektifler, anlama repertuarı ve sosyal stratejiyi inanç olarak tanımlamaktadır. Ayrıca, Pajares inançların mutlaka kişilerin sözlerinden veya eylemlerinden anlaşılması gerektiğini belirtmiştir. Rokeach (1968) inancı merkezi (çekirdek) inançlar ve çevresel (ikincil) inançlar olarak sınıflandırmış ve ayrıca merkezi inançların çevresel inançlarla bağlantılı ve değişmeye dirençli yapısına dikkat çekmiştir.

Her bir bireyin inanç sistemi karmaşık olduğu için (Boulton-Lewis, Smith, McCrindle, Burnett, & Campbell, 2001; Bryan, 2003; Crawford, 2007; Peterson, Fennema, Carpenter, & Loef, 1989; Wallace & Kang, 2004), öğretmenlerin inançlarıyla öğretimleri arasındaki ilişkiyi tanımlamanın tek bir yolu yoktur. Öğretmenlerin inançlarının sınıf içi öğretimlerinde temsil edildiğini iddia eden çalışmalar bulunduğu gibi (Borko & Putman, 1995; van Driel, Beijaard, & Verloop, 2001; Yerrick, Park, & Nugent, 1997) zaman zaman öğretmenlerin öğretimlerinin inançlarını şekillendirdiğini işaret eden çalışmalar da mevcuttur (Simmon et al., 1999; Anderson, 2002). Öğretmenlerin inançları ve uygulamaları arasında karşılıklı bir ilişki bulunmakla birlikte bu ilişkinin sırası her zaman doğrusal değildir (Marx, Blumenfeld, Krajcik, & Soloway, 1997). Öğretmenler bazen çeşitli nedenlerle inançlarını sınıf uygulamalarından farklı olarak değiştirebilir (Tobin, Tippins, & Gallard, 1993; Wetzel, 2001; Prawat, 1992). Bu çalışma öğretmenin inançlarıyla öğretim pratikleri arasındaki ilişkiyi tanımlama girişiminde bulunmuştur.

Bu çalışmanın amacı, bir ortaokul fen bilimleri dersi öğretmeninin argümantasyon tabanlı bilim öğrenme (ATBÖ) yaklaşımını sınıfında uygulama sürecinde işbaşında ve sürekli destek alarak pedagojik pratikleri ile inançlarının nasıl değiştiğini incelemektir. Bu çalışma, bilhassa ATBÖ yaklaşımının özelliklerine odaklanılarak hazırlanmış bir profesyonel mesleki gelişim programı kapsamında yapılmıştır. Bu program iki aşamadan oluşmaktadır: (1) hizmet içi öğretmen eğitimi, (2) işbaşı-sürekli profesyonel destek. Sistematik takip ve devamlı destek sağlayan mesleki gelişim programları reform çalışmalarında şiddetle önerilmektedir (Danielson, 2006; DuFour & Eaker, 1998; Feiman-Nemser, 2001; Gunel & Tanriverdi, 2014; Kent and Lingman, 2000; Killion, 2000; Lewis, 1997). Dolayısıyla bu çalışma kapsamında işbaşında ve sürekli olarak yerinde sağlanan desteğin öğretmenin pedagojik pratiklerine ve öğrenme ile öğretmeye yönelik inançlarına etkisi incelenmiştir.

Çalışmaya yön veren araştırma soruları şu şekildedir:

1- İşbaşında-sürekli destek eşliğinde ATBÖ uygulamaları yapan bir fen bilimleri öğretmeninin pedagojik pratiklerinde ne gibi değişiklikler meydana gelir?

2- İşbaşında-sürekli destek eşliğinde ATBÖ uygulamaları yapan bir fen bilimleri öğretmeninin öğrenmeye ve öğretmeye yönelik inançlarında ne gibi değişiklikler meydana gelir?

Türkiye'de son yıllarda fen bilimleri öğretim programında düzenlemeler yapılmış ve programda ATBÖ'ye vurgu yapılmıştır (MoNE, 2018). Fen bilimleri programında belirtilen bütün beceriler (bilimsel süreç becerileri; yaşam becerileri: analitik düşünme, karar verme, yaratıcı düşünme, girişimcilik, iletişim, takım çalışması; mühendislik ve tasarım becerileri: yenilikçi düşünme) ATBÖ yaklaşımında tecrübe edilmektedir. Fen bilimleri programının ana amacı fen okuryazarı bireyler yetiştirmektir (MoNE, 2018) ve fen sınıflarında argümantasyon fen okuryazarlığını teşvik etmektedir (Erduran & Jimenez-Aleixandre, 2007). Programdaki bu hedef, fen öğretimi içeriğinde argümantasyona dayalı girişimlerde istikrarlı bir artışa sebep olmuştur (Cavagnetto, 2010). Öte yandan fen eğitimi literatüründe bir eğitim hedefi ve öğretim yaklaşımı olarak argümantasyonun etkililiğine ilişkin çokça çalışma bulunmasına rağmen (Duschl & Grandy, 2007; Osborne, Erduran, & Simon, 2004) fen sınıflarında argümantasyon nadiren gözlenmektedir (Driver, Newton & Osborne, 2000). Öğretmenlerin sınıflarında bu tür yenilikçi yaklaşımları uygulaması için cesarete ve desteğe ihtiyaçları vardır. Bu bakış açısından hareketle bu çalışma öğretmen gelişimine, mesleki gelişim projelerine, öğretmen pedagojisinin iyileştirilmesine ve öğretim programı geliştirilmesine önemli bir katkı sağlayabilir.

Fen bilimleri öğretmenlerinin ders hazırlığı ve bu hazırlıkları özellikle ATBÖ perspektifinden sınıfa yansıtmasına ilişkin az sayıda çalışma mevcuttur. Sparks ve Hirsh (2007) öğretmenlerin büyük çoğunluğunun katıldığı mesleki gelişim programlarının yüksek kalitede olmadığını ileri sürmektedir. Öğretmen mesleki gelişim programlarının çoğu genellikle tek seferlik atölye çalışmaları olup takip desteği sağlamamaktadır. Dolayısıyla bu programlar gerekli değişikliklerin sağlanması açısından başarısız olmaktadır (Schmocker, 2006; Sparks & Hirsh, 1996). Bu bağlamda bu çalışma bir ortaokul fen bilimleri öğretmenine ATBÖ odaklı üç günlük bir hizmet içi eğitimin ardından bir eğitim öğretim yılındaki iki fen bilimleri ünitesinde sürekli ve işbaşı destek fırsatı sunmuştur. Bu destek pek çok çalışmada olduğu gibi bir paket programın parçası olmayıp, öğretmene ihtiyaçları doğrultusunda ATBÖ uygulamalarının hazırlık, uygulama ve değerlendirme süreçlerinde yerinde ve devamlı olarak destek sağlanmıştır. Bu çalışmanın sonuçları, araştırmacıların özellikle öğretmenlerin tamamen ATBÖ yaklaşımına dahil edildiği etkin mesleki gelişim programları geliştirmesinde faydalı olabilir.

Alanyazında sınırlı sayıda çalışma öğretmen inançlarını durum çalışması ile araştırdığı görülmektedir. Çalışmaların çoğu daha büyük örneklemi ve nicel yaklaşımı tercih etmiştir (Martin, 2008). Bu çalışmanın güçlü yanı tek bir öğretmene nitel araştırmayla odaklanması ve bu öğretmenin ATBÖ uygulamaları süresince pedagojik pratikleri ile öğrenme ile öğretmeye ilişkin inançlarının derinlemesine incelenmesidir. Bu çalışma, öğretmen eğitimi programlarını öğretmenlerin öğrenme ve öğretmeye ilişkin inançlarının önemi hakkında bilgilendirme potansiyeline sahiptir.

Alanyazında uygulama ile inançlar arasındaki ilişki ve bu ilişkinin hangi yönde olduğuna dair bir karışıklık bulunmaktadır. Bir yanda inançların uygulamayı etkilediğine dair çalışmalar bulunurken, diğer yanda uygulamanın inançları etkilediğiyle ilgili bazı araştırmalar bulunmaktadır. Bunların dışında bu ilişkinin iki yönlü veya belirsiz olduğunu işaret eden çalışmalar da mevcuttur. Bu çalışma alandaki bu karışıklığı gidermek adına, uygulama ve inançlar arasındaki ilişkiye dair daha açık bir resim ortaya koyulmaya çalışılmıştır.

Bu çalışmanın araştırma sorularını cevaplandırmak için nitel araştırma yöntemlerinden durum çalışmasına başvurulmuştur. Durum çalışması, sınırlı bir sistemin derinlemesine betimlenmesi ve incelenmesidir (Merriam, 1998).

Çalışmaya 2014-2015 eğitim öğretim yılı başında düzenlenen 3 günlük hizmet içi öğretmen eğitimine katılan 48 fen bilimleri öğretmeninden dördü seçilerek ilk dönem başlanmış olup, öğretmenlerden üçü süreç içinde çeşitli sebeplerle ikinci dönem çalışmaya devam edememiştir. Kalan bir öğretmenle eğitim yılı tamamlanmıştır. Dolayısıyla bu çalışmada bir ortaokul fen bilimleri dersi öğretmeni katılımcı olarak anlatılmıştır. Katılımcının seçiminde öğretmenin hizmet içi eğitimde deneyimlediği ATBÖ uygulamalarını kendi sınıfında uygulamak istemesi ve okulunun araştırmacı için ulaşılabilir olması etkili olmuştur. Öğretmen ATBÖ uygulama sürecinde sürekli ve yerinde destek almayı kabul ederek bu çalışmaya gönüllülük esasına dayalı olarak dahil olmuştur. Çalışmanın başında öğretmenin feni nasıl öğreteceğine dair inançları bilgiyi aktaran konumunda olan öğretmen merkezli bir yaklaşım yönünde olduğu görülmektedir. Öğretmen genellikle sınıfta düz anlatım yapmakta, öğrenciler kendisine soru sorduğunda derhal yanıtlamakta ve ders hazırlığını TEOG sınavını göz önünde bulundurarak yapmaktaydı. Öte yandan yenilikçi yaklaşımlara açık olan bu öğretmen, üç günlük ATBÖ odaklı hizmet içi eğitimde kendisine öğrenciymiş gibi davranıldığı, atölye çalışmalarında öğrencilerin düz anlatımla öğrenmediğini, soru-cevapla, tartışarak ve araştırarak öğrendiğini fark etmiş, öğrenme ve öğretmeye yönelik inançlarında bir değişim başlamış ve sınıfında ATBÖ uygulamaları yapmaya karar vermiştir. Ancak bu süreci nasıl yöneteceği konusunda çekinceleri bulunan öğretmene ders öncesinde ve sonrasında ATBÖ uygulamalarına yönelik destek verilmiştir.

Çalışmada bahsi geçen mesleki gelişim programının amacı, öğretmenlerin fen sınıflarında ATBÖ'ye yönelik anlayışlarını ve uygulama becerilerini geliştirmektir. Mesleki gelişim programı iki aşamadan oluşmaktadır. Birincisi üç günlük (yaklaşık 24 saat) hizmet içi eğitim, ikincisi ise sürekli ve işbaşında profesyonel destektir. Araştırmacı da hizmet içi programda görev almış eğitimcilerden biridir ve öğretmenle atölye çalışmaları esnasında tanışmış ve öğretmenin ileri dönük istediğine dair bilgi sahibi olmuştur. Verilen destek 2014-2015 eğitim öğretim yılında devam etmiş ve bu süreçte öğretmenin seçtiği iki fen bilimleri ünitesi (Yaşamımızdaki Elektrik, Işık) toplam 6 ATBÖ uygulaması (Sürtünme ile Elektriklnme, Elektrik Akımı, Serive Paralel Devreler, Işığın Soğurulması, Yansıma, Mercekler) ile öğretmenin seçtiği 36 mevcutlu 7/C sınıfında yapılmıştır. Destek derse hazırlık aşamasında, ders esnasında ve ders sonrası değerlendirme esnasında sağlanmıştır. Öğretmenle iletişim yüz yüze, telefon görüşmesi, email ve kısa mesaj yoluyla sürekli olarak sağlanmıştır.

Hazırlık aşamasında öğretmenle araştırmacı konuya ilişkin tartışma yürütmüş öğretmen kavram haritaları yapılandırmış üniteye yönelik büyük ve alt düşüncelerini belirlemiştir. Ayrıca, öğretmenin derse nasıl giriş yapacağı, tartışmaya yön verecek soruların neler olabileceğini, öğrencilerin olası araştırma sorularını ve ATBÖ etkinliklerini öğretmen şablonu üzerinde planlanmıştır. Ders esnasında araştırmacı, sınıfta gözlemci olarak bulunmuş, süreci öğretmen yürütmüştür. ATBÖ uygulamaları üç temel aşamadan oluşmaktadır: (1) Öğretmenin dikkat çekici açık uçla sorularla başlattığı ve öğrencileri akıl yürütmeye teşvik ederek çelişki durumu oluşturmaya çalıştığı derse giriş tartışması, (2) öğrencilerin cevabını merak ettiği araştırma sorularını belirledikleri küçük grup tartışmaları ve araştırmalarını/deneylerini yapmaları (soru-iddia-delil oluşturma süreci), (3) Öğrencilerin soru-iddia-delillerini arkadaşlarıyla paylaştığı ve yorumladığı büyük grup tartışması. Ders sonrasında öğretmen ile ATBÖ deneyimine yönelik değerlendirmelerde bulunulmuş, araştırmacının öğretmene sorular yönelterek özdüşünümsel değerlendirmelerde bulunması sağlanmaya çalışılmıştır.

Bu süreçte öğretmenin inançlarının ve pedagojik pratiklerinin yorumlanabilmesi için 6 ATBÖ uygulaması yapılmıştır. Uygulamalar hem araştırmacı tarafından dahil olunmadan gözlenerek alan notları alınmış, hem de alanında uzman bağımsız araştırmacıların RTOP ölçeğini kullanarak daha sonra değerlendirmede bulunabilmesi için video kaydına alınmıştır. Bir diğer veri kaynağı ise sürekli yerinde destek sağlanmadan önce ve 6 ATBÖ uygulamasının sona ermesinin ardından yıl sonunda yapılan yarı yapılandırılmış ön ve son mülakatlardır. Her biri 31 sorudan oluşan mülakatlar araştırmacıya öğretmenin öğrenme, öğretme ve ATBÖ'ye ilişkin inançlarını inceleme imkanı sağlamıştır. Mülakatlar ses kaydına alınmıştır. Başka bir veri kaynağı ise öğretmenin ders sonrası uygulamalarına ilişkin özel olarak yaptığı özdüşünümsel bilgilendirmeler (Briefing) ve süreç ile ATBÖ'ye dair bütün resmi olmayan konuşmalar/sohbetlerdir (informal conversations). Bunlar da ses kaydına alınmış ve görüşmelerden sonra alan notu tutulmuştur.

Bu çalışmada iki tür veri analizi yapılmıştır. Birinci araştırma sorusu için videolar iki bağımsız uzman araştırmacı tarafından Reform Tabanlı Eğitim Gözlem Protokolü (RTOP) kullanılarak öğretmenin ATBÖ uygulamaları puanlanarak pedagojik uygulama düzeyine ilişkin çıkarımda bulunulmuştur. RTOP 0 (hiç gözlenmedi) ila 4 (duruma çok uygun) arasında bir puanlama sistemine sahip olup dört alt başlığa sahiptir: öğrenci sesi, öğretmenin rolü, muhakeme ve bilimsel süreç becerileri, soru sorma. İkinci araştırma sorusu için sürekli karşılaştırma yöntemiyle analiz yapılmıştır. Öncelikle ses kayıtlarının tamamı (öğretmenin mülakatlarda, verdiği briefinglerde ve resmi olmayan konuşmalarda ifade ettiği her şey) yazılarak alan notlarıyla bir araya getirilmiştir. Araştırmacı açık kodlamayla başlayıp çeşitli kategoriler oluşturduktan sonra eksensel kodlamayla birleştirme yoluna gitmiş ve en son seçici kodlamayla çekirdek kategoriler belirlenmiştir:

- Öğretmeye ilişkin inançlar
- Öğrenmeye ilişkin inançlar
- ATBÖ deneyimine ilişkin inançlar
- ATBÖ'de öğrenme ve öğretmeye ilişkin engellere dair inançlar
- Mesleki gelişim programlarına ilişkin inançlar
- Öğretmenlik mesleğine ilişkin inançlar

Bu kategoriler üzerinden başka bir deneyimli araştırmacı da veriyi kodlamış puanlayıcılar arası güvenirlik neredeyse %100 çıkmıştır.

Veri toplama ve analiz süreçlerinin güvenilir ve geçerli bir şekilde yürütülebilmesi için belli başlı yöntemler izlenmiştir. Çalışmanın güvenirliğinin sağlanması için çalışma esnasında araştırmacı ile katılımcı öğretmen arasında güven tesis edilmiş ve anlayış kazanılmıştır. Güvenirliği artırmak için fen alanından uzmanlardan düzenli olarak geri bildirim sağlanmıştır. Buna ek olarak anlayışı artırmak için farklı kaynaklardan veri toplanarak güvenirlik emniyete alınmak istenmiştir. Verilerin başka deneyimli araştırmacılar tarafından kodlanması ve RTOP ölçeğiyle puanlanması da güvenirliği temin eden unsurlardandır. Puan ve kodlamalarda uzlaşı sağlanana dek veri üzerinde çokça müzakere edilmiştir. Transfer edilebilirlik ölçütünün sağlanması için bir öğretmenin sınıf uygulamaları, inançları ve bir mesleki gelişim programı hakkında detaylı bilgi verilerek, bulguların başka durumlarda da başvurulabilir olması sağlanmıştır.

Bu çalışmanın sınırlılığı, ön mülakatın öğretmen hizmet içi eğitim programından sonra yapılmış olmasıdır. Her ne kadar öğretmen geçmişe dair görüşlerini bütün samimiyetiyle açıklasa da bu durum öğretmenin ifadelerini ve dolayısıyla da veriyi etkilemiş olabilir.

Öğretmenin her bir dönemde üçer olmak üzere sürekli-işbaşı destek eşliğinde toplam olarak 6 ATBÖ uygulaması yaptığı süreç boyunca RTOP puanları 4 puan üzerinden 0.60'tan başlayarak en fazla 1.82'ye çıkmıştır. Genel olarak öğretmen geleneksel yaklaşımdan daha öğrenci merkezli bir yaklaşıma doğru kayarak ATBÖ uygulamalarında gelişme sağlamıştır. Zaman ilerledikçe konuşan öğretmen sınıfın temel özelliklerinden biri olmayı sürdürse de öğretmenin rolünü değiştirmek için gösterdiği gayret önemlidir. Öğretmen öğrencilere giriş tartışmasında ve küçük gruplarda tartışmalarında ve de büyük grup tartışmasında görüşlerini ifade etmeleri için daha fazla fırsat sunmaktadır. 0'dan 4'e kadar olan RTOP skalasında öğretmenin en fazla 1.82 puan aldığı göz önünde bulundurulduğunda dersin tamamen ATBÖ odaklı olduğu söylenemese de öğretmen öğrencilerin merak ettikleri soruları araştırma ve soru-iddia-delillerini sunmada daha fazla olanak sağlamaktadır. Öğretmen derse katılmayan öğrencileri genellikle soru sormaları ve çelişkili görüşlere argüman sunmaları konusunda cesaretlendirmektedir.

Öğretmen soru sorma tarzını büyük ölçüde değiştirmiştir. Başlangıçta açık uçlu ve düşündürücü sorular sormakta zorlanırken süreç içerisinde kısa cevaplı ve sadece hatırlamaya yönelik sorularını azaltarak daha üst düzey sorular sormaya başlamıştır. Bu da sınıftaki öğrenci sesinin artmasını sağlamıştır. Öğretmen, önemli adımlar atmasına ve öğrenci çalışmasını destekleyen bir öğrenme ortamı sunma niyetine rağmen hala öğrencilerin düşünmesi ve soruları yanıtlaması için yeterli zamanı tanıyamamaktadır.

Çalışmanın sonunda katılımcı öğretmenin öğretmeye ilişkin inançları öğretim şekli ve sınıftaki rolü bağlamında değişiklik göstermiştir. Öğretimini öğretmen merkezliden öğrenci merkezliye değiştiren katılımcı, rolünü de içerik aktaran kişiden kılavuza dönüştürmüştür. Öğretmenin rolü değiştikçe soru kalıpları da daha farklı düşünme biçimlerine müsaade eden şekilde değişiklik göstermiştir.

Öğretmenin öğrenmenin nasıl olduğu ve nasıl ölçüldüğü ile ilgili inançları da değişmiştir. Çalışmanın başında ATBÖ ile daha iyi öğretme ve öğrenmelerin olabileceğine inanan öğretmen, ATBÖ uygulamalarının öğrencilerde yaratıcı düşünceyi tetiklediğinden ve öğrencileri öğrenme-öğretme sürecine etkin katılım konusunda cesaretlendirdiğinden bahsetmiştir. Ayrıca, öğrenci katılımı arttıkça öğrencilerin daha iyi ve kalıcı şekilde öğrendiklerine ve özgüven kazandıklarına inandığını ifade etmiştir.

Çalışmanın sonunda katılımcı öğretmen ATBÖ'nün öğrenci merkezli olduğunu, bütün fen konularında ve kalabalık sınıflarda uygulanmaya uygun olduğunu belirtmiştir. Öğretmen hala ATBÖ uygulamalarında bazı eksiklikleri olduğunu, ancak zamanla bu konularda gelişme kaydedeceğini belirtti. İki veya üç sene sonra çok daha iyi ürünlerin ortaya çıkacağına inanan öğretmen, gelecekte etkin ATBÖ uygulamaları yapacağını inanmaktadır.

Öğretim programıyla ilgili kaygıların yanı sıra öğretmenin başlangıçta ATBÖ ile ilgili çekinceleri vardı. Buna ilişkin olarak öğretmen, materyallerden ve yetiştirilmesi gereken öğretim programından bahsetti. Çalışmanın başında sınıfının araştırmalar için yeterli materyale sahip olmadığını söyleyen öğretmen sona gelindiğinde bu durumun öğrencilerin öğrenmesinde büyük bir engel olmadığını ifade etti. Ayrıca öğrencilerin öğrendiklerini günlük yaşama aktaramadıklarından bahsetti ve ATBÖ yaklaşımını deneyimleyerek öğrencilerin bu sorunu aşabileceklerine inandığını söyledi. Öğretmen, öğrenme ve yeni bir yaklaşımın önünde bazı engeller olmasına rağmen aslında ATBÖ'nün öğrenci mevcudu, materyaller ve öğretim programına ilişkin mükemmel koşullara ihtiyacı olmadığını fark etmiştir.

Öğretmen daha sonra ATBÖ'ye karşı olan bu olumlu yaklaşımını meslektaşlarına aktarmak istemiştir. Başka hizmet içi eğitimlerde çeşitli öğretmenlerle bir araya gelme fırsatı bulan katılımcı, onları ATBÖ'yü uygulamaları konusunda ikna etmeye çalıştığını belirtmiştir. Öğretmen değişimin kolay ve aniden olmadığına aynı zamanda bir öğretmen için zor olduğuna inanan öğretmen ancak aynı zamanda buna değdiğine ve sürekli olarak geliştirmek için uğraşmaları gerektiğini düşünüyordu. Ayrıca, mesleki gelişim programlarının tek seferlik eğitimlerden ziyade belli zaman aralıklarıyla yapılarak öğretmendeki ilginin canlı tutulması gerektiğine inanıyordu. Bu program, öğretmenin kendini gözlemlemesini ve değerlendirmesini fırsat sağlamış ve bu nedenle öğretmen eksikliklerinin farkına varmıştır. Ayrıca, öğretmen devamlı olarak verilen desteğin hazırlık aşamasında kendini etkili bir şekilde yönlendirdiğini ifade etmiştir.

Genel olarak, öğretmen öğrencilerindeki değişimden memnun kaldığını ve mesleğini daha fazla sever hale geldiğini ifade etmiştir. ATBÖ ile tanıştıktan ve sınıfında uygulama girişimlerinde bulunduktan sonraki memnuniyetini ifade eden öğretmen, öğretimini geliştirmeye devam edeceğine vurgu yapmıştır. İyi yapılandırılmış mesleki gelişim programlarının öğretmenlerin araştırma isteklerini artıracağını ve öğretmenlik mesleğinden zevk almanın yolunu göstereceğini düşünmektedir.

Bu çalışma kapsamında öğretmenin ATBÖ uygulamaları zaman içerisinde ilerleme kaydetmiştir. Bu bulgu, öğretmenlerin zaman geçtikçe genellikle daha üst düzey ATBÖ uygulamaları yaptığını gösteren önceki çalışmaların bulgularıyla bağdaşmaktadır (Gunel, 2006; Kıngır, 2011; Nam, Choi & Hand, 2010). Öte yandan öğretmenin yeni yaklaşıma adaptasyon sağlaması vakit almaktadır. Bu çalışmada öğretmenin bir yıldan daha fazla zamana ihtiyacı olduğu görülmüştür. Çalışmalar bilimsel argümantasyonun olduğu öğretim uygulamalarının değişmesi için en az 18 aya gerek duyulduğunu göstermiştir (Martin & Hand, 2009; Tanriverdi & Gunel, 2012) .

Soru sorma, ATBÖ'nün önemli bir parçasıdır ve bütün gerekli elementleri bünyesinde barındırmaktadır. Bu çalışmada öğretmen soru sorma tarzında değişikliğe gitmiştir. Soru sorma sınıfta öğrenci sesini artırmakta, sınıf tartışmasını başlatarak tartışmaya yön vermekte ve akıl yürütme ile açıklamaları ispat ederek savunmayı geliştirir. İlgili literatür de bu bulguyu desteklemektedir (Benus, Yarker, & Hand, 2010; Gunel, Kingir, & Geban, 2007; Martin & Hand, 2009; Kawalkar & Vijapurkar, 2013; Piburn et al., 2000).

Öğretmen genellikle derse katılmayan öğrencileri soru sorması ve çelişkili görüşler hakkında tartışması konusunda cesaretlendirmiştir. Normalde fen dersine ilgili olmayan pasif öğrenciler hatta kaynaştırma öğrencileri bile derse etkin katılmaya ve bazen gruplarının önde gelenleri olmaya başlamışlardır. Yapılan çalışmalarda araştırma sorgulama uygulamalarının olduğu fen sınıflarında öğrenci rolünün pasif alıcıdan aktif öğrenene doğru değiştiği görülmüştür (Anderson, 2002; Jiménez-Aleixandre & Erduran, 2008).

Alanyazında sistematik takip ve sürekli destek sağlanan mesleki gelişim programları reform çalışmalarında şiddetle tavsiye edilmiştir (Danielson, 2006; DuFour & Eaker, 1998; Feiman-Nemser, 2001; Gunel & Tanriverdi, 2014; Kent and Lingman, 2000; Killion, 2000; Lewis, 1997). Bu çalışma kapsamında öğretmen-araştırmacı arasındaki iş birlikçi müzakereler, ders öncesi hazırlıklar, öğretmenin araştırmacı eşliğinde uygulamalara yönelik öz değerlendirmede bulunması daha iyi ATBÖ uygulamaları yapılmasını sağlamıştır. Literatürde de verilen destek fen öğretmenlerinin inanç ve uygulamalarını yeniden gözden geçirmesi ve düzenlemesini olumlu yönde etkilemektedir. Katılımcı öğretmen de sürekli olarak ve yerinde verilen desteğin uygulamalarını pozitif yönde etkilediğine vurgu yapmıştır.

Martin (2008) öğretmenlerin öğrenme ve öğretmeye ilişkin inançlarını tartışmış ve öğretmenlerin çekirdek inançlarını öğrencilerin nasıl öğrendiğinin oluşturduğu iddiasını desteklemiştir. Benzer şekilde bu çalışmada da öğretmenin öğrenmeye ilişkin inançları diğer inançlarının referans noktası olan çekirdek inancını oluşturmaktadır. Çünkü öğrencilerin nasıl daha iyi öğrendiği, öğretmenin öğretim uygulamalarını daha iyi şekillendirmiş ve ATBÖ yaklaşımına karşı olumlu bir tutum geliştirmesini sağlamıştır.

Öğretmenin katıldığı hizmet içi öğretmen eğitimi, öğretmenin doğrudan anlatımla öğrencilerinin aslında fen öğrenmediğini fark ettiğinde inançlarında memnuniyetsizliğe neden olmuş ve inancını değiştirmesini sağlamıştır. Bu bulgu, Martin'in (2008) kritik bir olay inanç veya uygulamalarda değişikliğe yol açar önerisini desteklemektedir. Ayrıca, katılımcı öğretmenin öğrenme ve öğretmeye ilişkin inançları ATBÖ uygulaması yapmadan önce değişmiştir. Öğretmenin uygulamaları süreç içerisinde değişiklik gösterdikçe, inançları ve uygulamalarındaki değişim de devam etmiştir. Bu durum inanç ile uygulama arasında karşılıklı iki yönlü bir ilişki olduğunu (Martin, 2008; Haney et al., 2002; Cobb et al., 1990) doğrulayan Thompson'ın inanç ve uygulama arasında diyalektik bir ilişki olduğunu ifade eden teorik modelini desteklemektedir. Öte yandan öğretmenin inançları ile uygulamaları mükemmel bir uyum içerisinde değildir. İkisi de pozitif yönlü bir eğilim izlemesine rağmen öğretmenin inançları ile RTOP puanları arasında açıklık vardır. Literatürde de inanç ile uygulama arasındaki uyuma ilişkin olarak bir karmaşa hakimdir. Bu açıdan bu çalışma, alan yazında öğretmenlerin öğretme ve öğrenmelerine ilişkin hem eski hem de yeni görüşlere sahip olduğu ve duruma ve kişisel etkenlere göre değişen karışık eylemlerde bulunduğu görüşünü desteklemektedir (Bryan, 2003; Hancock & Gallard, 2004; Marx, Blumenfeld, Krajcik, & Soloway, 1997).

Çalışma esnasında öğretmenin belirttiği engeller olan öğretim programı, bakanlık ve ebeveyn baskısı, sonuçları öğrenci için büyük anlam ifade eden sınavlar (TEOG) ve materyal eksikliği benzer şekilde literatürde de engel olarak görülmüştür (Gallagher

& Tobin, 1987; Schneider, Krajcik, & Blumenfeld, 2005; Ladewski, Krajcik, & Harvey, 1994; Hootstein, 1999). Promyod (2013) argümantasyon tabanlı öğrenmelerin geliştirilmesinin önündeki en büyük engel olarak genel bir destek eksikliğine işaret etmiştir. Bu çalışma kapsamında katılımcı öğretmene devamlı olarak ve yerinde destek sağlanarak bu engel ortadan kaldırılmaya çalışılmıştır.

Öğretmenlere katıldıkları hizmet içi eğitimin ardından engellerle baş edebilmesi ve pedagojik uygulamalarında sürdürülebilir değişiklikleri yapabilmeleri açısından destek verilmesi oldukça önemlidir.

Öğretmenlerin öğrenmeye ilişkin inançlarının çekirdek inançları olduğu göz önünde bulundurulduğunda şu iki çıkarıma ulaşılabilir:

1) Öğretmeye yönelik inançlardan ziyade öğrenmeye yönelik inançlara odaklanmak öğretmenleri fen eğitiminde yeniliklere daha iyi hazırlamaktadır.
2) Mesleki gelişim programlarında öğrenmeye odaklanmak öğretmenlerin öğrenme ve öğretme üzerinde etraflıca düşünmeye teşvik etmektedir.

Bu çalışmada bir ortaokul fen bilimleri öğretmeninin bir yıl boyunca yaptığı ATBÖ uygulamaları süresince pedagojik uygulamaları ve öğretme ile öğrenmeye ilişkin inançlarındaki değişim incelenmiştir. Bu bağlamda öğretmene bir yıl içinde uyguladığı iki fen bilimleri ünitesinde ihtiyaçları dikkate alınarak bire bir işbaşında sürekli profesyonel destek sağlanmıştır. İlerleyen çalışmalarda daha uzun süre, daha fazla sayıda öğretmene, farklı sınıf düzeylerinde destek verilebilir. Benzer çalışma aynı zaman aralığında aynı okulda çalışan öğretmenlere uygulanarak meslektaşların birbirine motivasyon sağlaması mümkün kılınabilir. Daha fazla sayıda yarı yapılandırılmış görüşmeler yapılarak öğretmenlerin inançları ve uygulamaları arasındaki ilişkiyi anlamlandırmaya odaklanılabilir.

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