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Teacher Beliefs toward Using Alternative Teaching Approaches in Science and Mathematics Classes Related to Experience in Teaching

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The purpose of this study was to examine the relationships among Turkish classroom, science and mathematics teachers' beliefs toward using inquiry-based approaches, traditional teaching approaches, and technology in their mathematics and science classrooms; their efficacy beliefs in teaching those subjects; and years of experience in teaching in consideration of curriculum movements. The analysis was based on 258 teachers who had been working in elementary schools in Ankara, Turkey. The Teacher Beliefs toward Instructional Approaches Questionnaire-Revised Scale was used as a measuring instrument. Conducting descriptive statistics, it was found that the teachers had strong beliefs in using inquiry-based instructional approach. The results of two-way MANOVA showed no statistical difference between teachers' beliefs regarding alternative teaching approaches with respect to their branches. Similarly, no significant difference was reported on their beliefs regarding traditional and technology-enhanced instructional approaches in terms of years of experience in teaching. On the other hand, the teachers with an experience of more than 16 years had significantly more favorable beliefs on using inquiry-based instructional approaches than the teachers with an experience of 6-10 years. The results of path analysis revealed that teachers' experience in teaching had a significant and positive relation to their beliefs in using traditional teaching approaches and their teaching efficacy, but negative relation to their beliefs in using technology-enhanced teaching approaches. No significant relationship between these teachers' experiences and their beliefs in using inquiry based approaches was reported. It was also shown that beliefs in using inquiry-based approaches were positively associated with beliefs in using technology-enhanced approaches.

Keywords: teaching experience, inquiry-based approaches, teaching efficacy belief, technology-enhanced teaching

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INTRODUCTION

Until the recent reform movements in science education, science teaching primarily required setting objectives for students to memorize facts found in textbooks and to verify known phenomena through performing some experiments (College Entrance Examination Board [CEEB], 1990). The theory and mathematical models were given to students, and then teachers moved to textbook exercises. Later, real-life applications of the topic were explained (Seymour & Hewitt, 1997). Students were motivated to learn these topics since they were informed that the topics were important in the curriculum or in their future career. However, the failure to connect the content of the courses to real life applications led students to lose their interest in science (Kardash & Wallace, 2001; Seymour & Hewitt, 1997). Opposed to the failure of this approach for science teaching, *Science for All Americans* proposed the primary goal of science teaching as educating "a scientifically literate person who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individuals and social purposes" (American Association for the Advancement of Science [AAAS], 1989, p. 4). This vision of science education has also attracted attention in policy documents. For instance, The National Committee on Science Education Standards and Assessment (NCSESA, 1993) set some principles which emphasize the pedagogical shift from teacher-centered to student-centered instructional paradigm by engaging students in scientific inquiry applications.

Inquiry-based and technology-enhanced learning environments

Inquiry-based learning grounded in constructivism means a transition from traditional teaching styles to more active mode of learning and teaching. In inquiry-based instruction, learners are active participants in their learning process by asking questions, discussing ideas, reflecting on observations, investigating of events and teachers are facilitators of students' learning (NRC, 1999; Prince & Felder, 2007; Von Secker & Lissitz, 1999)). In general sense inquiry is defined as:

> A student-centered pedagogy that uses purposeful, extended investigations set in the context of real-life problems as both a means for increasing student capacities and as a feedback loop for increasing teachers' insights into student thought processes (Supovitz, Mayer & Kahle, 2000, p. 332).

In such classrooms, students are presented with a challenge (such as "authentic" question to be answered, an observation or data set to be interpreted, or a hypothesis to be tested), and they accomplish the desired learning outcome in the process of responding to that challenge (Prince & Felder, 2007, p. 14). In order to solve the given task, students plan and conduct their own investigations, use suitable tools and techniques to collect data, think logically and critically about relationships, construct and analyze alternative explanations and solutions, and finally, communicate on findings in terms of scientific arguments (Johnson, 2006). State differently, in these environments students could find solutions to authentic problems by asking questions, gathering and analyzing data, making conclusions and presenting their findings (Engeln et al., 2013, Krajcik et al, 1998, Puntambekar, Stylianou, Goldstein, 2007). In that way, learners construct their own solutions; learn through inquiry rather than obtaining information automatically (Holbrook & Kolodner, 2002) which leads more effective learning experiences (Kirschner, Sweller, & Clark, 2006). Pedaste and Sarapuu (2012) stated that inquiry helps students to grasp the idea on what science is about and what scientists are doing.

Similar to the definitions of inquiry-based learning in the field of science education, mathematics educators and researchers (e.g. Guffin, 2008; Wilkins, 2008) portrayed that inquiry as a mathematical instructional approach is characterized by students' active participation in meaningful mathematical problems and activities. These activities require hypothesizing, investigating, collecting and analyzing data, making some conclusions and inferences, and communicating the process with the related outcomes. Inquiry-based instructional approach encourages students to share their ideas about the issues with others through proposing some solutions. In these classrooms, students should also have some opportunity to extend these ideas, and then revise them (Bransford, Brown & Cocking, 2000). Stipek, Givvin, Salmon and MacGyvers (2001) added that the role of the teacher should be to support and guide the constructive process rather than to transmit discrete knowledge to students.

Engeln, Euler and Maass (2013) stated that inquiry-based learning reflects multi-faceted nature of teaching and learning culture. Scientific inquiry is seen as the core of learning process but also in the inquiry-based learning, social contexts can reinforce meaningful learning. Such a learning environment allows students actively engage in the construction, evaluation, and reflection of scientific and mathematical knowledge. Thus, students may develop some competencies to solve authentic problems in the complexity of life. However, teachers may or may not be supportive of inquiry instruction in their classroom environments. Complexity of the inquiry instruction (Marshall et al., 2009), teachers' lack of knowledge or experience regarding non-traditional teaching approaches (Borko & Putnam, 1996) may be the reasons of this avoidance.

In construction process of students' meaningful learning through inquiry, technology usage was offered as the vehicle for achieving that process (Owens, Hester & Teale, 2002). Owens et al. (2002) advocated that inquiry-based learning is not an innovative approach, but enrichment of this process with technology, especially computer and internet-related technologies play an important role in science teaching. These researchers supported the usage of inquiry-based teaching approaches enhanced with technology in that technology can stimulate students' curiosity and facilitate learning by providing a real world context that engages learners in solving complex problems. Furthermore, some evidence have been reported indicating that technological tools facilitate teachers' implementation of inquiry practices with the help of simulations, digital media, modeling tools, data analysis and interpretation programs, and visualization opportunities (Bell, Maeng & Binns, 2013; Lee, Linn, Varma & Liu, 2010). Owens et al. (2002) also pointed out that computer technologies provide new opportunities for accessing information, allow students to organize and edit that information for projects, and promote significant learning among students. Supporting these ideas, Leu (2001) proposed that students could communicate with expert that they are interested in and create striking presentations integrating visual images and sounds into texts that allow them to share the interpretations based on their inquiry.

Teachers' beliefs

In order to make usage of inquiry-based and technology-enhanced instructional approaches more prevalent compared to the traditional approaches, it is essential to go deeply into teacher beliefs. Anderson (2002) claimed: "task of preparing teachers for inquiry teaching is much bigger than the technical matters… the matter must be addressed… at a level that includes central attention to beliefs and values". In line with this perspective, *'belief'* attracts the attention of many researchers from various disciplines though no consensus has been reached about its definition. The definition of this term which guided us in the present study belongs to Pehkonen and Törner (1996, p.6) and stated as follows:

> "Beliefs are composed of a relatively long-lasting subjective knowledge of certain objects as well as the attitudes linked to that knowledge. Beliefs can be conscious or unconscious, whereby the latter type are often distinguished by an affective character."

As supported by Bishop, Seah and Chin (2003), teachers' beliefs about science and mathematics, and about the process of their teaching have been proposed to have a potential impact on the implementations of the reform-based instructional approaches. If a teacher does not believe that students can learn through inquiry then teacher's belief becomes a major obstacle for such implementation (Kazempour, Amirshokoohi, Colak, 2009). From a different viewpoint, Kaiser (2006) stressed that reform movements reflected by the curriculum are open to teacher interpretations which require a fit into their belief system, and only the parts that are consistent with the existing belief systems could be implemented successfully. Thus, to create inquiry-based technology-enriched classroom environments, teachers should believe that these teaching approaches facilitate students' meaningful learning (Damnjanovic, 1999).

Although teachers' belief regarding the effectiveness of inquiry-based and technology-enhanced teaching plays an important role in motivating students in the process of learning, teachers' confidence in their ability in teaching scientific and mathematical concepts through appropriate classroom practices is also eminent (Damnjanovic, 1999). One of the psychological constructs representing teachers' confidence is efficacy beliefs. Teacher efficacy is viewed as teachers' beliefs in their abilities to organize and execute courses of actions necessary to bring about desired results (Ashton, 1985; Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998). Research studies showed that teachers with high self-efficacy are more likely to use hands-on teaching methods (Riggs & Enochs, 1990; Ross, 1998), devote more class time on academic activities (Gibson & Dembo, 1984), find teaching meaningful and rewarding (Ashton, 1985), learn and use new approaches for teaching, and adapt their teaching practices according to student needs (Minke, Bear, Deemer, & Griffin, 1996).

Cochran-Smith and Lytle (1999) stated that in the process of improving teachers' instructional approaches, one has to consider teaching from various perspectives. In consideration of this vision, teacher beliefs were pointed out as the central factor in understanding teaching practices (Richardson, 1996). Thus, in order to get students involved in inquiry-based environments, teachers should believe that inquiry-based teaching is an effective instructional approach and they should have high efficacy beliefs in their understandings of scientific and mathematical concepts and ability to teach these concepts effectively (Damnjanovic, 1999). In other words, teachers with high self-efficacy may be more motivated to conduct inquiry-instruction compare to teachers with low efficacy (Marshall et al., 2009).

As it was carried out in the PRIMAS project, a baseline study of science and mathematics teachers' beliefs on the status of inquiry-based instructional approaches across 12 European countries, we adopt a broader perspective on this instructional approach in the current study. State differently, we aimed to investigate teachers' belief toward using different instructional approaches including inquiry within the scope of curriculum movements in Turkey. As Marshall et al. (2009) stressed searching teacher self-efficacy belief regarding inquiry may provide information regarding teacher motivation toward using inquiry in their classrooms.

Educational reform movements in Turkey

In 1924, the Turkish education system was centralized and all educational institutions were put under the control of the Ministry of National Education (Binbasioglu, 1995). Since then, there have been some changes in elementary and secondary education in Turkey in order to increase the quality of education. This reformation started in 2003, when the Turkish Ministry of National Education organized a curriculum development team to revise the existing elementary school curriculum (grades 1-8). The elementary school curriculum is being implemented in five school subjects: mathematics, science, social science, life science, and Turkish language. The latest revision in the curricula was conducted in 2013 that middle school mathematics and science are two school subjects being involved in the revision process. According to these movements, students will no longer be seen as passive receivers of the information (MoNE, 2005a; 2005b, 2013a, 2013b). Reform movements in science and mathematics education have common aims where students will be given opportunities for engaging in thinking processes through inquiry, including problem solving, critical thinking, communication, and reasoning (MoNE, 2005a; 2005b, 2013a,2013b)). In science and mathematics classes learning environments will be created where students can share their ideas, actively participate in discussions, relate various disciplines to each other, and benefit from different teaching methods within the enriched environment through inquiry. More specifically, elementary science and mathematics programs designate learning as an active process which allows students create new understanding for themselves and be a subject of their learning process. The teacher coaches, monitors, moderates, and guides in learning process which require students' active engagement. Elementary teachers in science and mathematics classes are expected to pose some problems and issues in real life contexts, and then guide their students to help them come up with a resolution of these problems and issues. In this process, teachers may prompt students to formulate their own questions while encouraging them to work in a group and also use their peers as resources. Thus, curricular reform aims to create environments where students could explore, inquire, communicate, think critically, reason, suggest alternative solution strategies and share their ideas. Since students engage in an exploration, they pose questions, construct arguments, gather some data and are required to draw some conclusions and inferences based on the data collected. Actually, exploration is a continuous process leading students to ask more questions. Thus, approaches like hands-on, problem-based, student-centered, and inductive (Anderson, 2002) are common methods that favor inquiry-based instruction in Turkish elementary mathematics and science classes. Thus, Turkey is one of the countries implementing inquiry-based approaches in recent years as a consequence of curricular reformations (Kazempour, Amirshokoohi, Colak, 2009). Effective use of instructional technologies to enable multiple representations of concepts is also emphasized by the curriculum. During the learning process, technology will be a means for students to explore and discover relationships among concepts, to discuss and communicate ideas, and also to solve problems.

Additionally, the curricular reform in Turkey is closely linked to in-service training programs and improvement of the infrastructure of school units. Reform initiatives give particular importance to the basic requirements of children's knowledge, learning, emotions, skills, attitudes, interests, and social skills. That is, in light with these curriculum movements more emphasis is directed to the students' cognitive, affective, and psychological developmental processes through inquiry (MoNE, 2005a; 2005b, 2013a, 2013b). Based on curricular initiatives, Turkish in-service teachers' belief system should be explored to shed light on the effectiveness of curricular reform movements and to grasp an idea regarding teachers' motivation for implementing inquiry in elementary mathematics and science classes.

Purpose

Teachers using the appropriate teaching approaches are the key points in implementation of the science and mathematics curricula in Turkey since they are the people who are responsible for executing those changes. However, what is known about teachers' beliefs and preparedness for the changes that the recent reforms in science and mathematics education demand is limited. Bandura (1986) emphasized that beliefs are the best indicators of the decisions people make throughout their lives. Teachers possess beliefs regarding their professional practices. In other words, teachers' beliefs could impact their actions and those beliefs could be critical change mediator in their science and mathematics teaching. That is, it is believed that teachers' beliefs are key to the success of reforms in education (Beck, Czerniak, & Lumpe, 2000) and special attention should be given to the teacher beliefs since they are interactive with practices (Richardson, 1996).

Through this literature review and current reform movements in science and mathematics curricula in Turkey, we aimed to investigate the relationship among teachers' beliefs toward using alternative instructional approaches in their science and mathematics classes. More specifically, our goal is to construct a path model to examine the relationship among Turkish classroom, science, and mathematics teachers' beliefs toward using inquiry-based learning environments, traditional teaching approaches, and technology in their science and mathematics classrooms as well as their teaching efficacy beliefs toward teaching those subjects in the light of curriculum movements. The hypothesized path model (Fig. 1) was formalized on the basis of empirical data, theory and results from previous correlational studies.

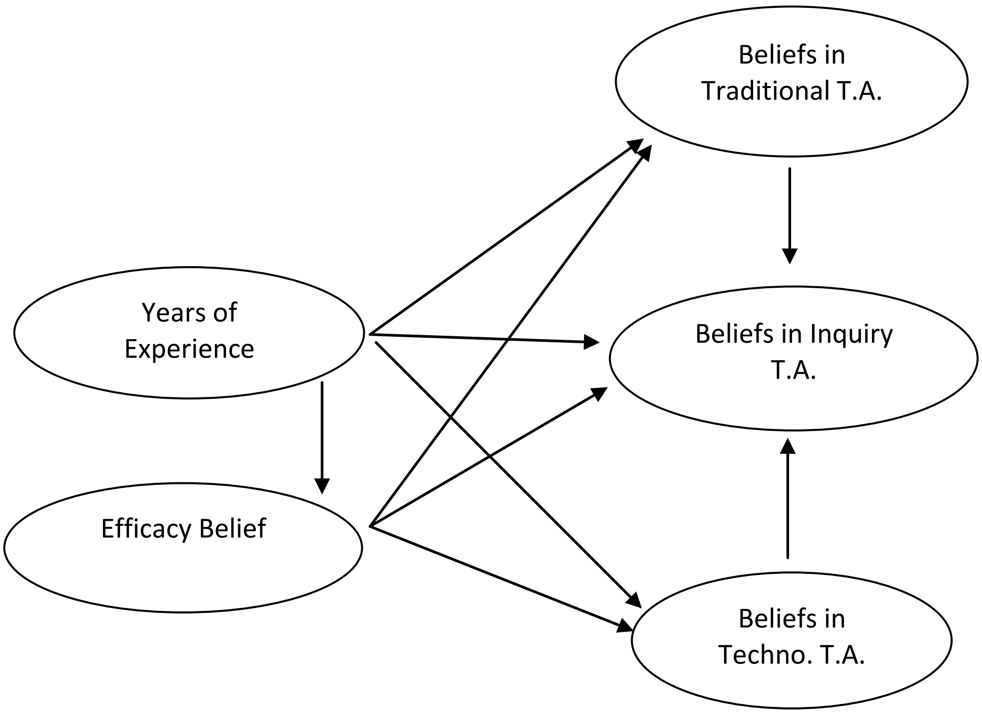

Figure 1. Hypothesized Model

Key: *Years of Experience* – Years of experience in teaching science/math; *Efficacy Belief* – Teaching efficacy belief toward mathematics and science; *Beliefs in Traditional T.A.*– Beliefs in using traditional teaching approaches; *Beliefs in Inquiry T.A.*– Beliefs in using inquiry-based teaching approaches; *Beliefs in Techno. T.A.*– Beliefs in using technology-enhanced teaching approaches

Teachers' instructional experience that they spend on teaching could be an indicator for the time that is devoted to the inquiry teaching (Marshall et al. 2009). Thus, it was hypothesized that teachers' experience in teaching science and mathematics directly affects their beliefs in using inquiry-based instructional approach, traditional teaching approaches and technology in science and math classrooms based on previous research findings (Damnjanovic, 1999). In addition, teachers' experience was hypothesized to affect their teaching efficacy beliefs toward teaching science and mathematics. Based on the literature review, it was also hypothesized that there is a significant correlation among teachers' beliefs in using inquiry-based instructional approach, using traditional teaching approach, using technology in their science and mathematics classes, and their efficacy beliefs toward teaching science and mathematics (Damnjanovic, 1999; Johnson, 2006; Langone, 2006; Minke, Bear, Deemer, & Griffin, 1996; Owens et al. 2002; Riggs & Enochs, 1990; Ross, 1998).

METHODOLOGY

Participants

Data were collected from 54 (20.5%) elementary science, 62 (23.6%) elementary mathematics, and 142 (54.4%) K-5 classroom teachers where 6 teachers did not identify their majors. In terms of teaching experience, 77 (29.3%) had five or less years' experience teaching, 62 (23.6%) had six to ten years' experience, 34(12.9%) experience eleven to fifteen years' experience, and 84 (31.9%) had more than sixteen years' experience.

Teacher education in Turkey

In Turkey, until 1980, teachers graduated from a variety of institutions with diverse experiences could be candidates for teaching in schools (Cakiroglu & Cakiroglu, 2003). Thus, teachers with different backgrounds in terms of knowledge and experience were teaching specific disciplines including science and mathematics. However, in 1981, for a unified system of teacher training, all teacher education institutions were placed under the authority of Turkish Higher Education Council (HEC). Thus, teachers should have a four-year teaching diploma from the teacher education programs of a university in order to work as science, mathematics or classroom teachers in elementary schools. In addition, after completing their undergraduate degrees, teachers are required to pass the Government Personnel Selection Exam (KPSS) in order to work in public schools. Based on their scores and needs in schools, teachers could be assigned to the schools all around the country. On the other hand, teachers who are planning to teach in private schools should fulfill the certain criteria offered by the institutions. In this research study, data were collected from elementary science, mathematics and classroom teachers who were working in both public and private schools with diverse educational backgrounds. Classroom teachers in Turkey are required to teach math and science from first to fifth grade levels, but also may teach these subject areas from sixth to eighth grade levels when there is no branch teacher in science and math at school.

Instruments

In order to measure teachers' beliefs toward using different instructional approaches, the "Teacher Beliefs toward Instructional Approaches Questionnaire-Revised" (TBIAQ-R; Race, 2001) was used. The TBIAQ-R was originally developed, validated and revised by Race (2001). After making modifications based on the principal components and varimax rotation, Race (2001) proposed a four-factor solution structure accounting for 40% of the total variance. The revised questionnaire consisted of 49 items measuring the following constructs: Inquiry-based Instructional Approach, Traditional Teaching Approaches/Pedagogy, Use of Computers and Technology in the Classroom, and Teacher's Teaching Efficacy toward Mathematics and Science. Race emphasized that the internal reliability of each sub-scale was high and stated Cronbach's alphas as .91, .83, .81, and .80 respectively. The first factor included 23 items related to teachers' beliefs in using inquiry-based learning involving problem solving, real-life situations, and tasks that foster a connection between application and understanding. The second factor was related to teachers' beliefs in using traditional teaching approach and consisted of 8 items related to using the textbook as a primary source, and stressing the students learning best through teacher explanations. Items related to teachers' beliefs in using computers for learning and using computers to aid decision making were loaded in the third factor. There were 11 items loaded in this category. The last factor consisted of seven items related to the teacher's level of efficacy beliefs in teaching hands-on mathematics and science and teachers' efficacy in their understanding of these disciplines. An example of items for each factor is given in Table 1. The TBIAQ-R used a 5-point, Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In addition to the TBIAQ-R scale, some demographic information involving teachers' gender, branches (classroom, science or mathematics), school type (private or public) and year of experience were collected from the participants.

For this research study, the TBIAQ-R was translated and adapted for Turkish science, mathematics, and classroom teachers by the researchers. In the original scale, the statements proposing the same argument but involving different subject areas were included as two separate items. However, in the current study, teachers who were teaching science responded to the science related items and similarly, teachers teaching mathematics responded to the mathematics related items. In other words, during implementation process, science and mathematics teachers were told to respond to the items with respect to their teaching subjects. Thus, in the questionnaire, science and mathematics words were used together (science/mathematics) as seen in Table 1. That is, two items proposing the same argument but different subject area were combined and stated as one item. Additionally, some items that were unclear or that might have created misconceptions among the teachers were removed from the questionnaire. Some of the content specific expressions were simplified based on the language variety in different curricular contents. For content validity concerns, original and translated questionnaires were given to two professors from the education department. The questionnaire was revised until 90% agreement was reached among the professors. Additionally, one of the Turkish language teachers checked the grammar before the questionnaire was piloted and implemented. At the end of the adaptation process, the number of items in the questionnaire was reduced to 37.

To investigate the construct validity of the questionnaire, factor analysis was conducted based on principal components analysis and varimax rotation. Analysis was based on 37 items and data from 159 teachers. Factor analysis results revealed that individual items could be grouped into a four factor solution (based on scree test) and accounted for 37.5% of the common variance with eigenvalues. Results also revealed that items in the translated questionnaire loaded on four factors overlapped with the four factors in the original scale. Thus, the 37 items in the Turkish questionnaire loaded on four factors were teachers' beliefs in using: inquiry-based instructional approaches (17), traditional teaching approaches (7), computers and technology in the classroom (8), and teacher's teaching efficacy beliefs toward science and mathematics (5).

Table 1. Example of items and related factor from TBIAQ-R Scale

Factor/Item Description	Representative Items
Belief in Using Inquiry-Based Instructional Approaches	• Worthwhile science activities/mathematical tasks foster a connection between application and understanding. • A primary objective of mathematics/science is to develop the ability to identify and solve problems generated from real-life situations. • A student's scientific ability is strengthened by developing his/her inquiry skills. • Teachers should provide students with the opportunity to develop and build upon their own understanding of mathematics/science concepts. • Understanding the process in mathematics/science is as important as obtaining the right answer. • Problem solving can be facilitated by students working in groups. • Problem solving can be taught when teachers explain students the prevalent strategies used to address problems. • It is essential that students at all grade levels know and understand good scientific methodology. • Reflective thought is an important criteria in mathematics/science learning activities. • Students learn best in mathematics/science when they are allowed to explore problems and test ideas about possible solutions.
Belief in Using Traditional Approaches to Teaching Pedagogy	• Students learn best in science/mathematics through teacher explanations. • Students learn best in science/mathematics through textbooks. • If more time could be spent on recall of facts/drill and practice, students would do better in science/mathematics. • The textbook should be the primary instructional tool for mathematics/science.
Belief in Using Computers and Technology in the Classroom	• Students should be able to use computers to help them solve problems in mathematics/science. • Computers should be as important and available to students as pencils and books. • I really enjoy using computers and the internet instructionally. • Using computers for learning takes students away from important instructional time. • Students can use computers and technology to help make informed decisions.
Teachers' Teaching Efficacy Toward Science and Mathematics	• I understand science/mathematics concepts well enough to be effective in teaching science/mathematics for my grade level. • I am confident in my ability to teach hands-on science/mathematics. • When a student has difficulty in understanding a mathematics/scientific concept, I sometimes don't know how to help the student understand it better. • I am confident in my understanding and teaching of scientific/mathematical concepts.

In order to measure the internal consistency, Cronbach's alpha for the items loaded on inquiry-based instructional approaches was calculated as 0.84, for the items on traditional approaches factor as .70, for the items on using computers and technology in the classroom factor as .73, and for the items on teaching efficacy toward mathematics and science factor as 0.62.

Procedure

Before the data collection, necessary permissions were taken from the elementary school administrators. Teachers selected randomly from public and private schools. The aim of this study was explained to teachers and they were asked whether they would voluntarily participate in the study or not. The applied questionnaire package consisted of the Teacher Beliefs toward Instructional Approaches Questionnaire and demographic data form. Additionally, a cover letter and informed consent form were attached to the questionnaire. Teachers who volunteered to participate in the study filled out the questionnaire in their break hours at schools and returned them in packets. It took approximately 20 minutes to complete the questionnaire with demographic information. Before the analysis was conducted, the informed consent forms were removed from the questionnaires to ensure the anonymity of the participants.

Data analysis

In order to examine the differences on elementary teachers' beliefs on usage of instructional approaches with respect to branches they taught and their experience in teaching, descriptive statistics and two-way multivariate analysis of variance (two way- MANOVA) were conducted.

For the path analytic model, the latent variables were formed considering the factor structures. Latent variables were generated by using two criteria. First, the minimum three observed variables were used (Schumacher & Lomax, 1996) and items with greater factor loadings were selected to define each latent variable. The first latent variable is related to teachers' beliefs about *inquiry-based instructional approaches* where *'Students learn best in mathematics/science when they are allowed to explore problems and test ideas about possible solutions', 'A student's scientific ability is strengthened by developing his/her inquiry skills',* and *'Reflective thought is an important criteria in mathematics/science learning activities'* were among the items that constituted the latent variable. Teachers' beliefs about using *traditional teaching approaches* was the second latent variable and *'Students learn best in mathematics/science through teacher explanations', 'If more time could be spent on recall of facts/drill and practice, students would do better in science/mathematics',* and *'The textbook should be the primary instructional tool for mathematics and science'* were among the items that explain the variable. The use of *computers and technology in the classroom* was the third latent variable and *'I really enjoy using computers and the internet instructionally', 'Students should be able to use computers to help them solve problems in mathematics/ science',* and *'Students can use computers and technology to help make informed decisions'* were examples of items. Teacher's *teaching efficacy toward science and mathematics* was another latent variable used in the model and *'I understand science/mathematics concepts well enough to be effective in teaching science for my grade level', 'I am confident in my understanding and teaching of scientific/mathematical concepts',* and *'When a student has difficulty understanding a mathematics/scientific concept, I sometimes don't know how to help the student understand it better'* were the examples used to explain the latent variable. For the teachers' experience in teaching science/ math, that is the last latent variable, an item in the demographic information part of the TBISQ-R was used.

Lisrel 8.30 for Windows (Jöreskog & Sörbom, 1999) with SIMPLIS command language was used to analyze the data. Modeling with maximum likelihood estimation was used to evaluate the degree to which the hypothesized model fits the data, and to estimate the magnitude and relationship among the variables. In order to evaluate the model fit, Standardized Root Mean Squared Residual (SRMR), Root-Mean-Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI) were used. The expected values for the good model fit interpretation were above 0.90 for GFI, and AGFI indexes and below 0.05 for the SRMR and RMSEA indexes. However, values of .08 or less in SRMR and

RMSEA indicate a reasonable error of approximation as well (Browne & Cudeck, 1993).

RESULTS

A description of elementary teachers' beliefs on usage of instructional approaches

As a preliminary analysis, the present study aimed to portray elementary teachers' beliefs on usage of instructional approaches discussing the inquiry based, technology-enhanced and traditional ways with respect to branches they taught and their experience in teaching. The results of descriptive statistics (Table 2) indicated that compared to the usage of traditional approaches, the teachers held more favorable beliefs toward using inquiry-based and technology enhanced approaches. Two-way MANOVA results showed no statistical difference between teachers' beliefs toward using traditional and innovative instructional approaches with respect to their branches (Wilks' K= .978, $F(6,206) = 0.76$, $p = .606$). In other words, regardless of being mathematics, science or classroom teacher, elementary teachers believe that students' learning should be supported with educational opportunities which allow them explore the problems and test their ideas about the possible solutions. Additionally, these teachers seemed to support the idea that using internet or computers instructionally would facilitate students' learning. However, they appeared to hold less strong belief system on using traditional instructional approaches which emphasize using textbooks as the primary instructional tool, support student learning by allowing them recall facts and practice, and focus on teacher explanations.

On contrary to the findings pertinent to branch differences, the results of two way MANOVA revealed statistically significant difference on using instructional approaches with respect to teachers' teaching experience (Wilks' $\lambda = .854$, $F(9,206) = 3.70$, $p < .001$) but with a small effect size as partial eta squared indicated (Partial $\eta^2 = .051$). In this respect, the effect size statistic revealed that only 5.1% of variance in elementary teachers' beliefs toward using instructional approaches could be explained by differences in teaching experience. A follow-up analysis of pair-wise comparisons indicated a significant difference in the mean scores for beliefs about inquiry-based instructional approaches ($F(3,206) = 6.968$, $p < .001$). At this point, we should note that significance level was adjusted by using Bonferroni method which involves dividing alpha level on the basis of the number of analyses conducted. Thus, the new adjusted alpha level became .016. Differences in teaching experience on beliefs about technology-enhanced ($F(3,206) = 2.817$, $p = .04$) and traditional approaches ($F(3,206) = 1.903$, $p = .130$) were found to be nonsignificant.

Table 2. The results of descriptive statistics for teachers' beliefs on using alternative instructional approaches

	Inquiry		Traditional		Technology	
Branches	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Mathematics	4.29	.38	3.28	.64	3.92	.62
Science	4.40	.34	3.23	.64	4.07	.52
Classroom	4.36	.35	3.22	.58	3.99	.56
Experience						
1-5 years	4.33	.33	3.10	.59	4.13	.57
6-10 years	4.23	.35	3.26	.66	3.96	.60
11-15 years	4.30	.37	3.28	.62	3.93	.51
16-more years	4.47	.33	3.33	.57	3.93	.55

Regarding the differences in beliefs about inquiry-based instructional approaches in terms of teaching experience, Bonferroni follow-up test showed that the teachers with an experience of more than 16 years (M=4.47) had significantly more favorable beliefs on these instructional approaches than the teachers with an experience of 6-10 years (M=4.23).

Modelling the relationships among the attributes on usage of instructional approaches

The significance of the path coefficients was evaluated through t-tests. To revise the model data fit, modification indexes were also considered. The paths from *Experience in teaching science/math* to *Inquiry-based instructional approaches;* from *Teaching efficacy toward science and mathematics* to *Traditional teaching approaches;* and from *Teaching efficacy toward mathematics and science* to *Inquiry-based instructional approaches* were found to be nonsignificant. Furthermore, the path between *Traditional teaching approaches* and *Inquiry-based instructional approaches* yielded nonsignificant results. These paths were deleted from the model. Through the modification indices *'Students can use computers and technology to help make informed decisions*' represented both *Traditional teaching approaches* and *Use of computers and technology in the classroom.* Finally, the model presented in Figure 2 was obtained with .92 GFI, .86 AGFI, .056 SRMR, and .056 RMR fit indexes values.

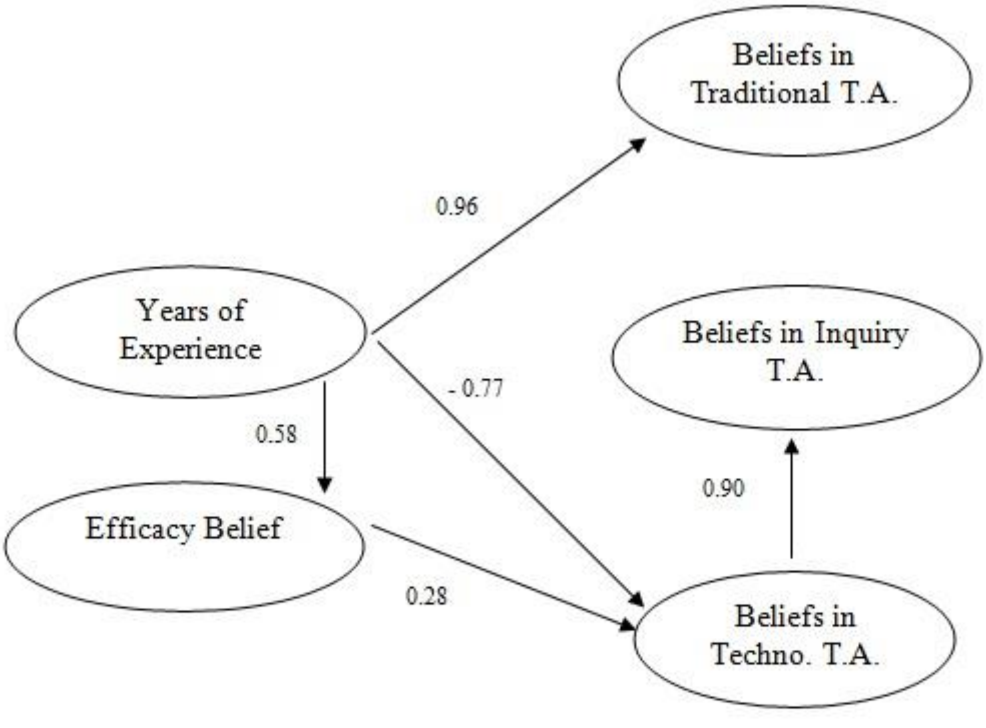

Figure 2. The Fitted Model of beliefs in using alternative instructional approaches

Table 3 presents the Beta estimates, which are the coefficients among teachers' teaching efficacy toward science and mathematics, teachers' beliefs in using technology in science and mathematics classes, and their beliefs in inquiry-based instructional approaches. In addition, Gamma estimates which are the coefficients among exogenous variable (teachers' experience in teaching science/math) and endogenous variables (teachers' beliefs in using traditional teaching approaches, their beliefs in using computers and technology in science and math classrooms, and their teachers' teaching efficacy toward science and mathematics), and *t*-values are presented in Table 3.

Table 3. LISREL Estimates and *t*-values for LISREL Model

Latent variables	Beta	Gamma	*T*
Techno and Efficacy	0.28	-	3.18
Inquiry and Techno	0.90	-	2.57
Expert and Tradition	-	0.96	3.11
Expert and Techno	-	-0.77	-2.75
Expert and Efficacy	-	0.58	4.95

When the significance of the path coefficients was considered, the results revealed that teachers' experience in teaching science/math had significant effect on teachers' beliefs in using traditional teaching approaches and using technology in science and math classrooms. Furthermore, teachers' experiences had significant effect on their teaching efficacy beliefs toward science and mathematics. On the other hand, teachers' teaching efficacy beliefs toward science and mathematics was only related to teachers' beliefs in using technology in science and mathematics classes. Additionally, teachers' beliefs in using technology were significantly related to teachers' belief in inquiry-based instructional approaches. With respect to the structural model of Turkish teachers' beliefs in using different instructional approaches, the standardized path coefficients varied from .28 to .96 in the fitted model.

Cohen in 1988 (Stevens, 2002) made some interpretation on the absolute magnitudes of standardized path coefficients. Considering Cohen's criteria, the path coefficient from *Use of computers and technology in the science/math classroom* to *Inquiry-based instructional approaches*, which is above .50 indicated a large effect size. Furthermore, the path coefficients from *Experience in teaching science/math* to *Traditional teaching approaches*, *Use of computers and technology in the science/math classroom*, and to the *Teaching efficacy toward science and mathematics* showed large effects for these latent variables. The other path coefficient from *Teaching efficacy toward science and mathematics* to *Use of computers and technology in the science/math classroom* which is around .30 could be regarded as medium effect size in the model fitted.

An additional fit measure, R^2 or "coefficient of determination", could be reported as an index of overall fit (Kelloway, 1998). Coefficient of determination is also accepted as a measure of variation in latent variables that is attributed to the combination of observed variables. The path model explains 80% of variance in *Inquiry-based instructional approaches,* 92% of variance in *Traditional teaching approaches,* and 92% of variance in *Use of computers and technology in the science/math classroom,* which constituted the large amount in total variance. Furthermore, the model explains 34% of the variance in *Teaching efficacy toward science and mathematics*, which is moderate amounts of total variance (Kelloway, 1998).

DISCUSSION AND IMPLICATIONS

Our starting point in this study was the idea that the implementation of inquiry-based and technology-enhanced instructional approaches can yield a favorable influence on student meaningful learning in science and mathematics. We came across with many factors that have an impact on a teacher's instructional practices, and these factors covered both cognitive and affective elements. However, teacher beliefs became the major component of this study with its potential to have a predictive power on teacher's inquiry-based and technology-enhanced instructional practices. As claimed by Guffin (2008), although instructional practice has not always been reported to be consistent with beliefs, teachers' beliefs appear to indicate a strong base for the ways they choose to teach their subject area in the classroom.

In the present study, the relevant data were gathered from science teachers, mathematics teachers, and classroom teachers working at elementary schools. It appears that the teachers showed similar trends in their teaching beliefs regardless of their educational branches since no statistical difference was found in their beliefs on using inquiry-based, technology-enhanced, and traditional approaches in terms of their educational branches. More specifically, independent from being mathematics, science or classroom teacher, elementary teachers have strong beliefs in that students learn better when they pose questions, formulate tentative explanations, explore and test ideas, rather than obtaining information through teacher explanations. These teachers also believe that technology could be a vehicle for those processes. The findings were consistent with Kazempour, Amirshokoohi and Colak (2009) who investigated Turkish pre-service and in-service physics teachers' beliefs about inquiry teaching. These authors reported that the participants agreed with the belief statements dealing with asking questions to initiate discussion, having students work in groups, using various assessment methods, and not accepting teachers as main source of information. Thus, we can infer that the movements on the instructional approaches reflected by the elementary science and mathematics curriculum (MoNE, 2013a; MoNE, 2013b) fitted into teachers' belief system. In other words, our findings would be motivating in order to rate the effectiveness of curricular movements in Turkey which supports inquiry in mathematics and science classes. However, reminding the potential gap between teacher beliefs and instructional practices, further studies should be conducted to examine how effectively elementary teachers use inquiry-based and technology-enhanced instructional approaches in their real science and math classes. These findings also showed us that we can combine the data which belonged to science, mathematics, and classroom teachers in order to investigate the relationships among teacher beliefs on using inquiry-based, technology-enhanced, and traditional approaches regarding their teaching experience via using path analysis.

The results of path analysis revealed that when Turkish elementary teachers got more experienced in teaching, their beliefs on using traditional teaching approaches in science and math classes increase. Though we reported a significant relationship between teaching experience in years and beliefs on using traditional teaching approaches, the results of descriptive statistics and two-way MANOVA revealed that regardless of being an experienced or a beginning teacher, these elementary teachers do not hold a strong belief system on using traditional teaching approaches. On the contrary, examining the results of descriptive statistics and two-way MANOVA, the teachers possess strong beliefs on using inquiry-based teaching approaches. However, the strength of beliefs varies over the years. To be more specific, in their first five-year period of teaching experience teachers hold strong beliefs regarding using of inquiry based approaches. However, in their second five-year period of teaching, there is a decline in their beliefs, but after spending more than 16 years in teaching, their beliefs regarding use of inquiry reaches the highest level. Whilst, this is not a longitudinal study that investigates the changes of same teachers' beliefs over time, we could discuss our findings by taking into consideration the experiences of teachers held during their teaching career in general.

In their study with prospective teachers, Haefner and Zembal-Saul (2004) mentioned that prospective teachers in teacher education program mostly view science in terms of elements of scientific inquiry and develop in-depth understanding of the experimental aspects of science. In this study beginning teachers being graduated from the university recently might have strong beliefs on using inquiry approaches based on their experiences in the teacher education program since those programs provide chance to learn and practice many alternative teaching methodologies. However, during the next 5 years period, teachers might be demotivated with using those approaches because of time limitation. Preparing students for the national exams might be another reason for the teachers' avoidance of inquiry based instruction. Thus, it is not surprising to observe decline in teachers' beliefs regarding the use of inquiry in their classes. However, as stated above, during the last 5 period of experience teachers' beliefs on using inquiry show an increase. Such an irregular trend in teachers' beliefs on using inquiry-based instructional approaches over the years might also explain the non-significant path coefficient in the model between the experience in teaching and the beliefs regarding the use of those approaches in classes. Hence, a phenomenological study may be conducted to reveal the experiences of the elementary teachers in terms of inquiry-based practices in science and math classes so that we can better portray the reasons underlying this irregular trend in their beliefs over the years. Furthermore, in their second five-year period of teaching when a small decline in their beliefs on inquiry-based teaching approaches was observed, as suggested by Guffin (2008), these teachers should be encouraged and provided with the opportunity more to engage in these approaches to experience the positive value of the ways for themselves. As stated above, further longitudinal studies could be conducted to detect changes in same teachers' beliefs over a period of time at the both group and individual level.

The results also revealed that experience in teaching was also an important factor in having a higher level of efficacy in teaching science and mathematics. Mastery experience was defined as one of the important sources for increasing efficacy belief (Bandura, 1986). Thus, having spent so many years in teaching science and math concepts could be the factor that increased experienced teachers' efficacy in teaching those subjects. Additionally, the results revealed that those experienced teachers with higher efficacy in teaching science and math had less strong beliefs on using technology in classroom activities. Use of technology is important in enhancing students' achievement and their social interactions (Langone, 1998). However, as reported by Morehead and LaBeau (2005), teachers struggle to integrate technology into their classrooms. Previous research (Drijvers, Doorman, Boon, Reed & Gravemeijer, 2010) implied that if teachers do not accept technology as valuable tool for their educational goals they do not attempt to use it. One of the important reasons for this avoidance is teachers' lack of technological pedagogical knowledge (Mishra & Koehler, 2006). Thus, in order to strength efficacious teachers' belief in using technology as tool for learning in classrooms, they must understand the computer applications truly (Morehead & LaBeau, 2005) since the effective use of technology in classroom is directly related to the teachers' knowledge and technological skills. However, Stover and Veres (2013) implied that professional development programs generally pointed out the significance of technology but ignored its link with pedagogy and content. In other words, although teachers receive technology training, they do not generally implement technology in their classrooms (Niess, 2005).Thus, professional development programs should be offered to the teachers to well-equip them with the knowledge and experience to use computer technology in their classrooms effectively. Those programs should encourage teachers to participate in collaborative, sustained, inquiry-based, and technology-enhanced activities and professional development experiences. These opportunities for elementary teachers should reflect the construction of meaning from new experiences, using scientific knowledge including its connections with technology, mathematics and other disciplines, and promotion of scientific ways of thinking. By this way, it is believed that those teachers with a high sense of efficacy about their teaching might feel more efficacious about using technology to enhance their students' learning.

Consistent with the results of previous research (Darling-Hammond, 1999; Morell & Carrol, 2003; Owens et al., 2002; Roehrig & Kruse, 2005), the present study showed that teachers who favored of using technology in science and math classes had higher beliefs in using inquiry-based instructional approaches during their teaching practices. Technology could be used as vehicle to facilitate collaborative inquiry where students use technological devices to share and test their understandings. Use of technology is also important in effective implementation of inquiry-based teaching to increase students' curiosity through visualization (Owens et al., 2002). Similarly, Coble and Koballo (1996) proposed that using technology especially computers guide teachers' visions on what and how to teach in a science or math class. The students in computer-based classes have a chance to develop science process skills, science content, problem solving, and graphical skills (Krajcik & Layman, 1992). According to Krajcik and Layman (1992), in these interactive classroom environments, students ask questions, search for answers, test the explanations in different ways, and communicate their findings with others. Thus, teachers who had higher beliefs in using technology in science and math classes possibly let students conduct their inquiries through technology. In addition, by using technology, those teachers might aim to promote significant learning among students through technology-enhanced and inquiry-based learning projects (Owens et al., 2002).

Limitations

This research study has some limitations that further research studies could address. Firstly, as could be seen from the measuring tool used in the present study, items regarding the teacher beliefs in using computers and technology in the classroom reflects a general perspective. Thus, more specific items regarding the use of technology in inquiry based learning environments could be added to the measuring instrument. For instance, the use of technology in designing experiment, collecting and analyzing data to enhance students' learning process could be used in order to identify participants' belief regarding the use of technology in science and math classroom. Furthermore, in the present study, teacher beliefs toward using instructional approaches were modeled by taking into consideration some related variables but the effect and relationship of other cognitive and non-cognitive variables like content knowledge, learning styles, and epistemological conceptions could be added to the model. Teachers' content knowledge on their competencies to use inquiry-based instructional approach could also be investigated. In addition, those studies could be replicated with pre-service teachers to portray the role of undergraduate education on their content knowledge and pedagogical competencies. In terms of technology usage, further investigation should be done to examine teachers' content knowledge on using technology-based instructional approaches in their teaching practices.

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