

Mathematics and Science Teacher Candidates' Beliefs of Developing Questioning Skills in Turkey

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Abstract

The purpose of this instrumental case study is to investigate mathematics and science teacher candidates' (TCs) beliefs about questioning and acquisition of questioning skills. Twenty-eight seniors from a major university in northern Turkey volunteered for the study. We conducted one to one semi-structured interviews with 10 of the TCs, the remaining 18 TCs provided their answers via e-mail. We utilized the constant comparison method in analyzing the interview transcripts. The coding of 28 transcripts revealed five fundamental themes: roles of questioning techniques in education, development of questioning skills, roles of colleges in developing questioning skills, roles of internships in developing questioning skills, and factors preventing students from answering questions. Results indicated that even though questioning is seen as a critical skill by teacher candidates, the theories and practices about developing questioning skills during the teacher candidates' training in Turkey is inadequate and there is a need for more emphasis on questioning during college and student internship.

Key Words: Questioning skill, teacher candidate, belief, mathematics, science

Introduction

Teachers' questioning technique is a major and pivotal instructional method that all teachers use regardless of their grade levels and subjects (Sahin & Kulm, 2008; Yesil & Korkmaz, 2013). Questioning has been used widely and its role in increasing students' learning has been documented in the literature (Sahin, 2008; Chin, 2006; Shahrill, 2013). Therefore, it is important to investigate the beliefs regarding questioning strategies and techniques held by TCs who were senior students in science and/or mathematics.

One of the major tasks of mathematics and science teachers is to promote students' thinking (Rigelman, 2007). One effective way of doing this is through use of appropriate questioning techniques in the classroom (Adedoyin, 2010). Indeed, a teacher's success of effective teaching is related to the use and development of questioning skills (Nielsen, 2009). An efficient way to utilize questioning skills include waiting for students to attend to the question, decode its meaning, develop an answer, revise the responses based on teacher feedback, and asking follow-up questions (Cumhur, 2016; Cotton, 1988; Shahrill, 2013; Wood & Anderson, 2001). These are research-based strategies that each teacher should follow to accomplish the purpose of posing effective questions (e.g. Cotton, 1988).

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Teachers' questions have paramount value for many instructional purposes: arousing interest and curiosity concerning a topic, developing an active approach to learning, diagnosing and checking understanding, recalling specific facts or information, facilitating classroom management, encouraging higher-level thought processes, challenging deeper student understanding, and structuring and redirecting learning (Sahin, 2008; Borich, 2007; Dyer, 2008; Wragg & Brown, 2001). The acquisition of these purposes can be ensured in designing questions that expand students' knowledge and encourage them to think creatively. Therefore, teachers must be sure that they have a specific purpose for their questions.

Theoretical Framework

Social constructivism served as the theoretical framework for the current study, because social constructivism underlines student-centered education instead of teacher-centered education and supports interaction with students. Constructivists such as Dewey, Piaget, Vygotsky, and Bruner claimed that the individual constructs knowledge by making meaning as he or she interacts with the environment. Constructivists have proposed "the process of learning is active and involves transformation of information, deriving meaning from experience, forming hypotheses, and decision-making" (Cherry, 2004, p. 2). Social constructivists like Vygotsky (1978) believed that students' learning was facilitated by a knowledgeable other, such as a teacher, parent, or peer (p. 86). In addition to learners constructing knowledge, they are also influenced by their own mental models or representations. Kearney and Kaplan (1997) noted, "mental models guide people's perceptions, decisions, and behavior" (p. 579). Understanding how one's mental models influence one's actions is directly applicable to the current study concerning TC's beliefs of questioning techniques. These mental models are largely constructed during their time spent as students in classrooms (Calderhead & Robson, 1991; Goodman, 1988; Matteson et al., 2012). Matteson et al. (2012) conceptualized "phases of development of mental representations of classrooms" (p. 431) in regards to floor plans, but their model is appropriate to other beliefs held by TCs, including questioning.

Questioning usually takes one of three forms in the types of social exchanges in classrooms: teacher with an individual student, teacher with all students, and a student with other students. Our premise has been that TCs would develop questioning skills when involved in social interactions with other knowledgeable individuals (e.g. Cakmak, 2009). We provided related literature to build the framework; research on importance and use of teacher questioning skills in classrooms, teachers' questioning skills and students' learning, research on teachers' questioning skills development, and questioning techniques in the context of Turkey.

Importance and use of teacher questioning skills in classrooms

Questioning is an important part of any lesson and enables students to develop their thinking and effective learning (Almeida, 2010; Sahin, 2007). Teacher questions help to stimulate students' mathematical thinking (Franke et al., 2009; Way, 2008). According to Zhang, Lundeberg, McConnell, Koehler and Eberhardt (2010) questions are used to encourage children to express themselves and facilitate discussion. Cakmak (2009) stated that questioning can be used to evaluate students' learning. Therefore, it is clear that teachers' questioning technique is an easy and economical way to monitor students' learning and re-adjust teaching if needed.

Teachers ask questions for several reasons, such as to keep students actively involved in lessons, provide the opportunity for students to openly express their ideas and thoughts, enable other students to hear different explanations, moderate student behavior, evaluate student learning and revise teaching as necessary (Borich, 2007; Dyer, 2008). These reasons indicate that questioning is an important part of teaching and helps in creating a positive classroom atmosphere for the development of scientific and mathematical ideas and encouragement of student discussions.

Effective questioning encourages all the students to think deeply in the class. To accomplish this, teachers need to acquire some skills. Ideally these technical knowledges should be developed through their teacher education programs (Cakmak, 2009). Teacher education programs that prioritize, use, and allow application of different questioning techniques will prepare teacher candidates as better question posers (Sahin, 2015; Zhang & Patrick, 2012). However, some studies stated that although educators were aware of the importance of questioning skills, these skills were not comprehensively taught in most of the teacher education programs (Cumhur, 2016; Sahin, 2013; Cotton, 1988; Subramaniam, 2005; Zhang & Patrick, 2012). Accordingly, one role of educators in pre-service teacher education programs is to emphasize the importance and use of questioning techniques and to provide pre-service teachers with opportunities to master a variety of questioning techniques. There is research evidence (e.g. Cumhur, 2016; Celik & Guzel, 2016) indicating teachers who participated in questioning training used questions more effectively.

Teachers' questioning skills and students' learning and achievement

There has been a substantial amount of research emphasizing the importance of teachers' questioning skills in exploring students' achievement (Harrop & Swinson, 2003; Ilaria, 2002; Moyer & Milewicz, 2002; Nielsen, 2009; Sahin, 2008; Shahrill, 2013). Specifically, researchers investigated whether teachers' questioning types affected students' learning and performance (Sahin, 2008; Redfield & Rousseau, 1981). Sahin (2008) examined how teachers' question types, quality, and quantity affected 7th grade algebra students' math performance and found that the quality and quantity of probing questions significantly affected student performance. Researchers stated

that oral questions facilitated greater student learning rather than written questions in the class (e.g. Cotton, 1988; Vogler, 2005). According to Vogler (2005), questioning also can monitor student comprehension, help make connections to prior knowledge, and stimulate cognitive growth. In addition, questions that focus the attention of the students on particular points, connect to previous experiences, and help students to see some relationships stimulated better student understanding and mathematical thinking in math class (Way, 2008). As Brualdi (1998), Ellis (1993), Wilen and Clegg (1986) explained some of the behaviours that improve student learning, for example, phrasing questions clearly, asking high-cognitive level questions, giving students time to think, probing student responses, encouraging wide student participation. Research also found that teachers' questions that push students to explain, clarify, and justify ideas are related with increase in student achievement (Martino & Maher, 1999; Metz, 2007). As a result, one way of improving students' achievement could be to improve teachers' classroom questions and questioning techniques.

Research on teachers' questioning skill development

Although the importance of teachers' questioning has been documented widely in educational research, little research has focused on how teachers' questioning behaviors develop (Cumhur, 2016; Celik & Guzel, 2016); Olson, White & Sparrow, 2011; Tanisli, 2013; Weiland et al., 2014). Cumhur (2016) studied development of pre-service mathematics teachers' questioning skills via lesson study and founded that lesson study contributed to developing some of the questioning behaviors including probing, guiding, and clarifying. Similarly, Celik and Guzel (2016) stated that teachers developed better questions to reveal students' prior knowledge, understand their ideas and to ask them explain their correct responses via lesson study. Kreide, Turner and Tomlinson (2015) examined the effects of example video observation on the development of deep questioning skills of pre-service teachers in a mathematical content course for K-8 pre-service teachers. Results revealed that preservice teachers tended toward questioning without justification of a solution and asked only factual and/or yes/no questions that could be answered in one word. Weiland et al. (2014) researched how TCs develop their questioning practice and ability to notice students' thinking about mathematical and scientific concepts. They carried out weekly practice and reflection with TCs and found that TCs developed their questioning practice within the context of face-to-face interaction with students. This finding also shows the importance and necessity of student teaching that may facilitate development of questioning skills.

Questioning techniques in Turkey context

Turkey has attempted to restructure its curriculum by including discussions on mathematical and scientific concepts in order to achieve a balance between operational and conceptual knowledge, instead of relying only on teaching operational

and information-oriented content in the classroom (Ministry of National Education [MoNE], 2013). Accordingly, teachers are expected to possess skills including identifying students' misconceptions to help students develop reasoning and creative thinking (Cumhur & Guven, 2014). This shows that math and science curriculum in Turkey have started focusing on active learning and constructivism (Arslan & Ozpinar, 2008; Erdogan, 2007; Gomleksiz ve Bulut, 2007; Ozturk et al., 2013). New reforms will emphasize the importance of use of questioning both in teaching of teachers and learning of students in Turkish schools.

Currently, students in Turkey have to take central university exams to be able to attend a university. The goal of both parents and schools has become to prepare the students well for the exam. This has prevented teachers from use questioning in their teaching because they have had to drill and practice in order to make sure they cover all the topics and solve enough examples of each topic to better address students' current assessment needs. Therefore, Turkish teachers have neither opportunities nor reasons to utilize questioning skills effectively and comprehensively.

Another reason why the teachers in the Turkish Educational System do not use questioning methods often has been their insufficient training on questioning provided by teacher education programs. Although, TCs take some courses (e.g. Special Teaching Methods, Measurement and Evaluation, School Experience) where the importance of questioning skill is mentioned in the textbooks, the use and implementation of questioning techniques are one of the things they worry the least about. Thus, it is not surprising to see why teachers do not often use questions. However, the goal and expectation now is that teachers will utilize inquiry-based learning in their teaching due to the new standards that were mandated by the Minister of Turkish Education Department.

The purpose of this study was to discover ways TCs in their senior year of the science and/or mathematics teaching program at a major university in northern Turkey, developed their questioning skills, and to design better teacher development trainings and richer student internships. The central phenomena examined in the instrumental case study were the beliefs regarding questioning strategies and techniques hold by the TCs. The overarching research question was "What are mathematics and science teacher candidates' beliefs about questioning and acquisition of questioning skills of both their and other teachers' acquisition of questioning skills to develop better and more effective teacher training programs?"

Method

The purpose of this instrumental case study (Stake, 1998) was to discover ways math and science TCs at a major university in northern Turkey developed their questioning skills. Instrument case studies are appropriate when the researchers desire to provide insight into a specific issue (Stake, 1998). The case study form was particularly appropriate as the participants represented a bounded system (Merriam, 1998).

All of the participating TCs were senior student in science and/or mathematic and they were all from the same universty. The central purpose of the study was to describe the attitudes and skills regarding questioning strategies and techniques.

Participants

This study was carried out in a major research university in northern Turkey. We invited 60 math and science TCs from the university campus to participate in the study via classroom talks and emails. A total of 28 (10 males, 18 females) TCs volunteered to participate in the study. These individuals were in their senior year of studies and had completed courses in Introduction to Teaching Profession, Special Teaching Methods, Measurement and Evaluation, Teaching Methods and Material Design, Theories and Approaches in Teaching. The TCs were currently enrolled in courses requiring school experience and teaching practice. Mathematics and science teachers have amount according to gender and branch as Table 1.

Table 1. Participants amount according to gender and branch

Branch	Male	Female
Mathematics	5	12
Science	5	6

Data Collection

The data we collected for this study were the result of electronic and face-to-face interviews. We conducted one- to-one semi-structured interviews with 10 of the Turkish TCs in their native language. The interviewer for the study was a Turkish doctoral student at the same institution as the TCs. The doctoral student was also a mathematics teacher at a public high school and directly involved in the study as a co-author. Her knowledge of the Turkish language was helpful in conducting and transcribing the interviews. Each of the 10 semi-structured face-to-face interviews lasted approximately 30 minutes in length and was conducted in an institution study hall. Member checking with the TCs occurred during the time of the interview. The interviews were audio-recorded, transcribed, and translated into English. The remaining 18 TCs sent their answers to the interview questions via e-mail to the first author. There was no follow-up communication with these TCs.

Instrumentation

A questionnaire consisting of 17 questions was developed for the semi-structured interviews for this study (see Appendix). These questions were developed in the light of research that focused on teachers or TCs' development of questioning skills. Those questions comprise the beliefs of TCs about what the questioning skills are and how

it is developed. When the interview questions were determined, they were firstly checked by two experts and corrected on the basis of opinions in order to be related and supportive.

Data Analysis

The interviewees' responses, both oral and written, were analyzed utilizing the constant comparison method (Lincoln & Guba, 1985). This method includes reading and re-reading process and so are aimed to find out the similarities and differences between coding (Strauss & Corbin, 1990). According to this method, the author read the verbatim transcripts of 10 TCs' interviews and 18 TCs' e-mail responses twice to complete the initial coding cycles. Repeated words, phrases, and ideas were noted in the margins of the transcriptions. This initial analysis cycle resulted in 507 codes from the transcripts. The two different coding cycles were constantly compared to detect commonalities and variations among and between them. Reading the transcriptions twice allowed the author to become well acquainted with the data.

For the subsequent phase of the analysis the teachers' answers of beliefs towards questioning and acquiring questioning skills was collapsed into 89 categories. This still was a large set of categories, so the data were reread. This allowed for the clustering of data, a technique reminiscent of Corbin and Strauss (2008) where open codes were further analyzed and grouped to formulate axial codes. Interviewer field notes were also examined for evidence of repeating patterns and any alignment to the themes that emerged from the analysis of the transcriptions. Two sample categories have been provided in Table 2. After formulating axial codes into clusters, five fundamental themes emerged from the analysis of the data.

Table 2. Sample categories

Categories	Associated Concepts
Teachers	Motivate students, push students to think deeply, check students' background knowledge, check the effectiveness of their teaching, evaluate teachers' teaching or students' learning, and attract students' attention
Colleges	Course offerings, provide trainings, provide internships, provide seminars, assign research, library, supervisors, instructors

In order to present the findings and provide an audit trail, a coding system was devised for reporting TC answers. The codes include the TCs pseudonym and line number of the transcript. For example, Hatice L26-28 would mean that information came from lines 26 through 28 of Hatice's transcript. Additional information about the

TCs major has also been provided to further assist in contextualizing the perspective of the interviewee.

Reliability and Validity

Lincoln and Guba (1985) emphasized four components of reliability needed to ensure the rigor of a study's findings, including "credibility, transferability, dependability, and confirmability" (Erlandson, Harris, Skipper, & Allen, 1993, p. 29). The credibility of a study refers to the internal validity or "truth" of the findings as was addressed in this study through member checks, peer debriefing, and the interviewer's notes. In addition, themes were discussed and negotiated. Transferability "is judged in terms of the extent to which its findings can be applied in other contexts or with other respondents" (Erlandson et al., 1993, p. 31) and has been addressed by providing the purposive sampling of the participants. The dependability of the findings has been addressed by providing an audit trail that incorporated pseudonyms when quoting from the interviews. Confirmability refers to how consistent the findings are with the focus of the study. We can trace our findings back to the participants' interviews, but also believe that the author's research experiences in the area of questioning skills of mathematics TCs has shown our findings to have been consistent with prior studies.

Findings

We studied Turkish mathematics and science TCs' beliefs of questioning techniques and how to develop questioning skills. Our analyses of 28 TCs' transcripts revealed five themes: roles of questioning techniques in education, development of questioning skills, roles of colleges in developing questioning skills, roles of internships in developing questioning skills, and factors preventing students answering questions. Quotes have been provided from the TCs interviews to illustrate the categories.

Roles of Questioning Techniques in Education

TCs pointed out many roles of teachers' questioning when they were asked what they thought about questioning strategy. This included motivating students, pushing students to think deeply, checking students' conceptual background knowledge, checking the effectiveness of their teaching, evaluating teachers' teaching or students' learning, and attracting students' attention for instructional purpose. Hatice, a Physics TC, shared her thoughts about the roles of questioning by stating:

"Questioning is a method that can be used to check students' background knowledge, to place them in a right group according to their level so they can learn from each other, to check their understanding and re-teach if necessary, and to structure their knowledge in their mind. Also, questioning is a very good method to check whether your students are listening to you or on task and to evaluate their understanding anytime" (Hatice L4-6).

From the TCs' responses, regardless of subject matter (Mathematics or Science), all of them valued questioning skills and willingly shared their opinions on the importance of it. TCs saw the skill as critical for teaching and learning;

"It is a very important skill that each and every teacher needs to have because they can reveal what their students know and don't know. Having this skill will help teachers teach better and easier" (Salih, Chemistry TC, L7-10).

Questioning techniques go beyond the simplistic understanding of just posing a question and demanding an answer. TCs seemed to be aware of other beneficial and critical roles for effective teaching and saw questioning as an integral of their mathematics or science teaching. This included guiding students' learning, involving them, communicating with them, and learning how they think. The TCs suggested that questioning helped them place students in the center of their instruction rather leaving them as passive learners like in a lecture-based teaching.

"Questioning is very important to push students to think about the content being taught as well as organize their thinking. Questioning may also help students learn better as long as appropriate and purposeful questions were asked" (Salih, Chemistry TC, L49-52).

One of the benefits of questioning techniques that TCs kept repeating was its role in revealing and fixing students' misconceptions in math and science subjects. TCs insisted there were serious misconceptions about science and mathematics to be uncovered and addressed. Feyza, Chemistry TC, stated:

"Students have lots of misconceptions in science or mathematics and I believe questioning is one of the best ways to reveal and fix those misconceptions. This will help increase your students' success eventually because they will now the content better and apply it well" (Feyza, Chemistry TC, L52-55).

Development of Questioning Skills

The TCs' answers to questions of how in-service and pre-service teachers develop their questioning skills were very similar in nature. From the perspective of the TCs, in order to be a good questioner, teachers have to learn content knowledge well. Without having rigorous background knowledge, teachers could not ask good or challenging questions. Also, having strong content knowledge would help teachers implement their pedagogical skills better and increase students' trust. Serkan, mathematics TC, expressed this as follows:

“To have a strong content knowledge is crucial. Teachers who are good at content will ask good and challenging questions easily. This will increase both teachers’ and students’ comfort in the classroom as well as students’ learning” (Serkan, Mathematics TC, L28-30).

Having experience was regarded as a positive factor for development of questioning skills. TCs believed that they could develop their questioning skills as they teach and that experience would help them develop important skills. Ayse, a Physics TC, stated, “Experience is the key.” She further explained why she thought experience is such an important factor by suggesting as follows:

“There are other factors like content knowledge and personality, but experience is one of the most important ones because you become familiar with different student types and their reactions to different questions that make you use questioning more effectively” (Ayse, Physics TC, L24-28).

Many TCs said that personality mattered just as much as other factors, such as content knowledge or experience, because it made teachers interactive, and helped them to communicate well, control the classroom, and not be afraid of talking and asking questions. In other words, experience or content knowledge may not be sufficient in using effective questioning strategies.

“Personality makes a difference in developing and asking good questions. If your personality is social and inquisitive, this will help you ask more and great questions. I’ve seen teachers who have lots of years of experience but they are not asking good or no questions” (Menekse, Mathematics TC, L90-100).

TCs reported that preparation enabled them to ask better questions. All the TCs agreed that observing or working with other teachers was a very effective way to develop better questioning skills. Reading books or doing research on questioning was another common response from TCs.

“... one thing I can tell you for sure is reading books. This is especially the only and most feasible way for beginning teachers [to develop good questioning skills]” (Sedat, Physics TC, L14-16).

Other popular responses concerning how to develop one’s questioning technique were student teaching, videotaping your teaching and getting feedback, and attending seminars or courses. However, was not a common practice nor did it exist in their university’s environment. Several TCs believed that most in-service teachers did not have such a concern about questioning. They directly stated that most teachers they observed did not try to develop themselves in questioning.

“Teachers don’t try to improve themselves on questioning technique. They think asking easy, simple, and short answer questions are something important. They don’t spend time to ask higher order questions” (Salih, Chemistry TC, L12-14).

Roles of Colleges in Developing Questioning Skills

Almost all TCs stated that their college experiences did not play an important role in developing their questioning skills. There was no specific course or topic of a course they took that focused on questioning techniques teaching how, when, and what to ask. They also indicated that there was no specific training or seminar held during their college years.

“The courses I took in college have nothing to do with questioning” (Ferda, Mathematics TC, L13).

TCs complained about the lack of appropriate preparation for teachers. This was clearly an frustration for them, stated as follows:

“Questioning is one of the fundamental skills that all teachers use and have to have but there is no focus in colleges. I don’t get this!” said one mathematics teacher candidate” (Berna, Physics, L83-85).

Although there was no specific course or training on how to develop questioning skills, there were instances where an individual instructor briefly addressed the topic for some TCs. However this was not systematic and consisted mostly of a short and oral presentation.

“My method course and Internship mentor talked to us about it. He always had a conference with us before we went to the field. He talked about different instructional strategies and how to use them. For example, he encouraged us to use questioning strategy to check our students’ background knowledge so we could adjust our teaching” (Sevim, Mathematics TC, L27-29).

All TCs agreed on the importance of acquisition of questioning skills and expressed their willingness to participate in any training provided about the use and development of questioning techniques. They thought such training would be very helpful for their personal and professional development. Also, TCs emphasized the necessity of the training before they started their professional life.

“I haven’t heard any of those training but would be great for beginning teachers for their personal and professional development as well as getting ready before they start teaching” (Hacer, Mathematics TC, L21-24).

Roles of Internships in Developing Questioning Skills

Both mathematics and science TCs highlighted the importance of student teaching or internship in developing important teaching skills including questioning. They perceived the internship as a crucial opportunity to acquire questioning skills.

“Because you find opportunities to teach, you interact with students and test your questioning skills” (Nesrin, Chemistry TC, L23-25).

TCs appreciated the importance of questioning in many teacher like situations in order to be a better teacher. This situations included writing questions when planning lessons, practicing their skills with peers, and observing and teaching in classrooms with students.

“It is a transition period from being students to teaching profession. You gain experience by going to schools, teaching and doing observations. We develop and improve our questioning skills. We learn how to prepare lesson plans to teach mathematics better” (Hatice, Physics TC, L21-26).

However several TCs persistently complained that this opportunity had not lived up to its potential as was planned due to the supervisor teachers’ vision and the length of the practicum experience. TCs regarded student teaching as a practical experience in which to check their readiness for the teaching profession.

“Could be a great opportunity to improve it [student teaching] but our supervisor teachers gave us some practice questions to solve and did not let us teach our lesson plan. Also the period for student teaching is not long enough to have enough experience to teach and practice your knowledge and see your weaknesses and strengths” (Defne, Chemistry TC, L28-32).

Some TCs elaborated further about the problems in internships they encountered as follows:

“Internship has a huge potential for teacher candidate to experience how real teaching happens. We can see how ready we are, but there are at least few problems I see. 1. Supervisor teachers don’t give freedoms to interns to teach 2. Duration of student teaching is too short” (Kezban, Mathematics TC, L22-25).

Factors Preventing Students From Answering Questions

TCs were asked to comment on why they thought some students did not answer the teacher’s questions. The TCs mentioned several factors that they thought contributed to the lack of answering questions. For example, the teacher needed to know their students in order to ask questions effectively. Some TCs held the teacher responsible and said that teachers asked questions that were above the students’ cognitive level.

TCs noted that when students lacked preparation or knowledge on the topic being discussed, they did not answer the questions.

“I believe students don’t want to answer or participate in class because they don’t have the knowledge” (Salih, Chemistry TC, L37-39).

Another group of TCs suggested it was the teacher’s responsibility to create a classroom atmosphere where everybody felt safe from any type of teasing or bullying if a student gave a wrong answer. In other words, when a student did not feel safe, the TCs pointed out the student simply chose not to respond to questions. The TCs also reported that knowing the student’s personality would make a difference in whether or not questions were answered.

“Their personality may hinder them answering questions because some students may not be used to talk or express themselves in crowd’ (Murat, Mathematics TC, L27-29).

This pointed another issue that may be the source of why some students were not willing to participate in classroom discussions, that of parenting style.

“Some students might be coming from autocratic parents where their inputs are welcomed. Their thoughts were not asked at all” (Salih, Chemistry TC, L37-39).

The analysis of the data resulted in several categories, five of which were roles of questioning techniques in education, development of questioning skills, roles of colleges and internships in developing questioning skills, and factors preventing students answering questions. Interesting beliefs from the TCs in regards to their preparation and development of questioning skills have been demonstrated by the use of quotes from the interviews.

Discussion and Results

The purpose of this instrumental case study was to explore how mathematics and science teacher candidates from a major university in northern Turkey perceived the roles and acquisitions of teachers’ questioning skills. For this instrumental case study we analyzed the 28 transcripts obtained from face-to-face and e-mail interviews by using constant comparison methods. The analyses revealed the themes of roles of questioning techniques, development of questioning skills, roles of colleges and internships in developing questioning skills, and factors preventing students from answering questions.

The TCs insights concerning questioning were interesting in light of the developing skill sets needed to become effective in using questioning strategies. For example, teachers’ knowledge of students (Ball, Thames, & Phelps, 2008) was an interesting

aspect that has been sometimes overlooked in the literature on questioning, which has tended to focus primarily on the teacher's role. TCs think that questions can provide some benefits, this included motivating students, pushing students to think deeply, checking students' conceptual background knowledge, determining misconceptions, checking the effectiveness of their teaching, evaluating teachers' teaching or students' learning, and attracting students' attention for instructional purpose. Many of them think that evaluation of learning and checking students' conceptual background knowledge are very important facility of questioning. Similarly, Cakmak (2009) remarked that questions can provide certain benefits and be used because of different instructional aims according to TCs. Hence, The TCs comments also point back to questioning as a constructivist activity, which affirms our use of constructivism as a theoretical framework for this study. So, questioning is an important tool in the introduction of a topic, in any mathematical or scientific discussion, in assesment, and necessary for constructivism learning. As stated Guzel (2008) constructivist learning approach contributes more to mathematical thinking processes. Because moving students to the center of teaching take place by keeping the students active and asking them questions. This shows that the questions play an important role in interacting with students and revealing their thoughts in teaching.

The group of TCs in this study were much more student-centered than anticipated. Their comments indicated they had noticed student motivation and conceptual understanding were critical aspects that teachers needed to consider when questioning and engaging students in a lesson. This result is supported by other research (Franke et al., 2009; Hahkionemi 2013; Kosko, Rougee & Herbst, 2014). It can be said that questions are an educational tool that teachers often need to use. The process of questioning is more than just a simple understanding of questions and answers, but rather that TCs are aware of other useful and critical roles for effective teaching and consider questioning as an integral part of mathematics and science.

TCs' think that effective questioning depends on some factors. They most emphasized content knowledge, personality and experience. The TCs believed that while the teacher's content knowledge and experience influences how to ask good questions, his/her personality and relationship with students was also impactful in developing an environment where posing questions and listening to answers was valued and where students could feel safe if they answered incorrectly. Caram and Davis (2005) stated that a positive expression, nod, or verbal acknowledgment of a correct response encourages students to participate in discussions. In addition, posing questions in nonthreatening ways and receiving answers in a supportive fashion, which create a safe environment for students. The TCs also noted a possible cultural factor preventing students answering questions, that of parenting style. The researchers have wondered if the TCs were also subconsciously projecting what they had experienced as learners in the classroom. Had the TCs felt bullied or teased, had they been taught that they should be silent in

class as they did not have the right to respond freely, or had they just seen their own friends acting this way? Maybe shy, shyness, irrelevance, lack of self-confidence, anxiety about making mistakes can prevent students from responding. Therefore, students need safe learning environment they can feel comfortable.

The TCs also expressed frustration with the lack of attention in their courses to development of questioning skills, restricted opportunities to practice questioning skills, and the lack of high quality questions modeled for them in both college courses and by their supervisor teachers. Such concerns mirrored what has already been noted by other educators on this topic (Sahin, 2013; Zhang & Patrick, 2012). Specifically, in this study the TCs would like to gain additional experience in questioning through activities that would allow them to develop and refine their skills.

Finally, the TCs articulated there were many ways to develop questioning skills: reading books on the topic, observation of more proficient individuals, videoing of lessons, reflecting upon teaching sessions, and practicing during student teaching. The TCs in the study seemed eager to work on their skills and were aware of the need to ask good questions in order to know what content the students understood and where they might still have misconceptions. Effective questioning is an important tool for better identifying the depth of students' mathematical ideas (Franke et al., 2007; Moyer & Milewicz, 2002). Questions also are a important tool for identifying misconceptions but the preservice teachers may have insufficient subject-matter knowledge (Tanisli and Kose; 2013). In this way, despite fact that many research emphasized that questioning uncovers students' thinking or misconception, and moves them forward, they pointed to the lack of education in this subject (Subramaniam, 2005; Zhang & Patrick, 2012; Zuya, 2014). Teachers should the necessity of awakening students' curiosity and getting their information needs and be able to ask effective questions (Caram & Davis, 2005). As researchers, our prior work has uncovered that questioning skills are better learned through interactions where the TCs can observe teachers who are good questioners (Sahin, 2013). The idea of reading books to gain questioning skills appeared initially out of place. However, when faced with having no information at all on the topic questioning, reading articles or books appears to be one logical way of acquiring such knowledge. At the very least, the TCs requested that college leaders develop or modify, for those seeking teacher certification, more program courses and seminars that address the quality of questions asked by the teacher and activities or assignments that would assist in questioning technique development.

Limitations and Future Research

There were several limitations to this study, including the number of face-to-face student interviews and that all the participants were from one institution. In order to be able determine if the findings were transferable, more interviews with mathematics and science TCs from other institutions would need to be conducted.

The findings of our study were similar in many ways to what has already been articulated in the literature (e.g., Sahin, 2013, 2013; Zhang & Patrick, 2012), however the participants in this study were all future Turkish mathematics and science teachers, a population that has not had extensive scrutiny. The Turkish TCs had already been through most of their coursework, but still did not feel adequately prepared for the classroom, especially in the skill of using questions as a pedagogical strategy.

The TCs noted reluctance of students to answer questions. They thought that this might be due to the possibility of students not feeling safe in answering questions as they might be bullied or teased. Additionally, they thought that maybe a student might have experienced a parenting style that did not encourage answering questions in class. Two possible studies could be conducted, one of which involves students answering questions either through surveys or interviews about why he or she does not answer in class. The other would be to ask the TCs about their own experiences in school in answering questions, again through either survey or interviews. This type of information would be helpful in developing training on questioning skills as often courses are designed to concentrate on the TC and not the student perspective.

Implications

What strongly emerged from the TCs' beliefs in this study was the need for Turkish Faculties of Education as teacher preparation programs to provide more emphasis on questioning as an intentional skill set to be developed during pedagogical and content courses, thereby putting to an end a practice that has assumed that TCs and in-service teachers naturally know how to formulate effective questions. Questioning as a specific skill set has been under emphasized in methods courses. As a result, many teachers formulate simple questions that focus on recall or knowledge. If, as MoNE has suggested, "Mathematics learning should be considered as an active process; students should be offered research, explore and prove mathematical relationships, modeling and problem solving, sharing solutions and approaches in the classroom and discussion opportunities" (MoNE, 2013, p. 1), then greater attention must be given to the topic of questioning in teacher preparation courses. However, if changes to Turkey's teacher preparation programs are implemented by the MoNE, it would be prudent for researchers to investigate which changes positively impact the quality of teachers' questions as well as collect evidence of how quality questioning techniques affect student achievement.

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Appendix

Semi-Structured Interview Protocol and Questions

1. Please tell me a little bit about yourself including your major here at the university.
2. Why have you chosen to become a teacher?
 - a. Why the field of mathematics/science?
 - b. What do you enjoy about that subject area?
3. How do you generally respond when asked a question by your college professor?
4. Do you think that having good questioning skills is important for teachers? Why?
5. How do you think teachers develop their questioning skills?
6. How do you think you can develop your own questioning skills?
7. What are some of the best ways for TCs to develop their questioning skills?
8. Do you think that the college classes you attend help you develop good questioning skills? Why?
9. Do you think that your education methods classes have helped you develop good questioning skills? Why?
10. What types of activities have you engaged in during your methods classes that have informed you about questioning skills?
11. Have you ever taken a course, seminar, project, or assignment that helped you develop your questioning skills during your college years?
12. What do you think are the factors that help teachers ask questions?
 - a. Years of teaching experience?
 - b. Personality?
13. What do you think stops students from responding to questions?
14. Do you think teachers wait long enough after they pose a question to their students?
 - a. What is your definition wait time?
 - b. How much do you think you wait after you pose a question?
 - c. What do you think is an ideal wait time that teachers need to give in order to provide enough time for students to generate a response?
15. How important is having good questioning skills for science and/or mathematics teachers? Why?
16. Do you think asking good questions increase students' learning/achievement? If so, how does it increase learning/achievement?
17. What do you think about the types of questions that increase students learning?
 - a. Probing, higher order, open-ended
 - b. Factual, lower order, closed questions
 - c. Text-based questions

Researcher: Do you have any questions for me about the research or the questions I have just asked you?