Key Experiences in Becoming an Independent Mathematics Education Researcher

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ABSTRACT

The key experiences in becoming an independent mathematics education researcher were investigated through interviews with eight doctoral students with academic job intentions at a Turkish university. Findings showed that doctoral students conceptualized a mathematics education researcher with several types of knowledge, skills, and attitudes, including research methods, mathematics, critical thinking, and being ethical and patient. They felt like a researcher when they collected and analyzed data at a research study. However, only the ones who were involved in team research identified themselves as independent researchers. Providing doctoral students with more research opportunities during the doctoral programs might support their development as independent researchers.

RÉSUMÉ

Les expériences clés pour devenir chercheur indépendant en enseignement des mathématiques ont été analysées au moyen d'entrevues auprès de huit étudiants au doctorat poursuivant une carrière universitaire en Turquie. Les résultats montrent que les doctorants conceptualisent le chercheur en enseignement des mathématiques comme ayant plusieurs types de connaissances, habiletés et attitudes, y compris les méthodes scientifiques, les savoirs mathématiques, la pensée critique, l'éthique et la patience. Ils se sentaient « chercheurs » lorsqu'ils recueillaient et analysaient des données dans le cadre d'une étude de recherche. Cependant, seuls ceux qui faisaient partie d'une équipe de recherche se sont identifiés comme chercheurs indépendants. En donnant aux doctorants des occasions de recherche plus nombreuses au cours de leur programme de doctorat, on pourrait favoriser et soutenir leur développement comme chercheurs indépendants.

Introduction

Mathematics education research studies have not focused much on understanding doctoral students' experiences. Though doctoral programs are designed to provide essential experiences for becoming a researcher, how these experiences help mathematics education doctoral students in their efforts is not much documented. Focusing only on the knowledge and skills required to become a researcher does not provide information on what doctoral students consider as key experiences in becoming an independent researcher and how these key experiences are related to key skills they define for researchers. The purpose of this study was to identify the key skills and experiences of becoming an independent researcher as perceived and experienced by doctoral students in the field of mathematics education. Their conceptions of being a mathematics education researcher and how they positioned their knowledge and skills in

becoming an independent researcher were investigated through interviews conducted with mathematics education doctoral students. It is expected that findings will provide a better insight into the structure of doctoral program experiences.

Becoming an independent researcher

Lovitts (2005) describes graduate education in two stages as dependent and independent. The dependent stage is about gaining disciplinary knowledge and building relationships within the graduate program community. It might include coursework and additional research experience. In the independent stage, on the other hand, students are expected to independently produce knowledge by creating it through research. The transition is affected by the structure of the doctoral program, doctoral students' knowledge of research processes, and proximity to a community of researchers.

With a socialization lens, Gardner (2008) perceives being an independent researcher as a socialization process during the doctoral education where being independent is being less structured in one's own studies and as feeling the need for one to direct one's own work. It is reached by improving or gaining disposition, knowledge, and interpersonal skills within cultures of academia, institutions, and disciplines. Being able to manage most of the dissertation process on one's own is an indicator of being an independent researcher or having a successful transition to become one (Gardner, 2008). Independence could also be identified through how one learns and internalizes "values, norms, knowledge, beliefs and interpersonal skills" (Gardner, 2008, p. 333) of the profession or the specific scholarly context in which one is involved. Gardner (2008) suggested that transition to independence might be supported by providing doctoral students with more research experiences before they conduct their dissertation research study. With a social cognitive perspective, being an independent researcher means gaining self-efficacy in research tasks (Albold, 2011) where research self-efficacy is the degree of confidence in carrying out the tasks of a research study from the beginning to the end (Holden, Barker, Meenaghan, & Rosenberg, 1999). For all perspectives and any doctoral program, being an independent researcher identifies the doctoral degree and the holder of that degree (Gardner, 2008). Therefore, the aim of the doctoral program is to help doctoral students to gain independent researchers' competencies and dispositions (Albold, 2011; Mendoza & Gardner, 2010).

Being an independent researcher is a necessary step in the development of doctoral students during which they do not conduct their work depending on others' opinions and assistance but become independent producers of knowledge (Jones, 2009). When the more structured coursework period ends, doctoral students need to make a transition to a less structured and more self-directed process of conducting a dissertation study (Gardner, 2008; Lovitts, 2008). The institutional structure in which doctoral students conduct their studies, such as departments hosting research groups (e.g., Chemistry) or departments directing students toward isolated research experiences (e.g., History), does not always provide smooth transition to independence (Gardner, 2008).

Albold (2011) found that education doctoral students' self-efficacy in conducting a research study was closely related to their evaluation of self as an independent researcher. As Albold (2011) argues, the way they identify themselves as researchers varies according to whether they have research experience or not. She uncovered that performance or mastery experience, vicarious learning, and social persuasion or feedback of others are effective in the development of doctoral students' research self-efficacy and therefore becoming independent researchers. Having strong beliefs on task performance might lead to identifying one as an independent researcher. When doctoral students interact with faculty members and peers, they gain behaviors of an independent researcher from role models. Even sharing the same workplace seems to help doctoral students enhance each other's experiences (Albold, 2011). Getting feedback and encouragement during these interactions supports doctoral students in becoming independent researchers. Indeed, doctoral students might need to be validated by a community of researchers in order to feel like researchers (Mantai, 2015). Feeling like a researcher is important for one's identification of self as a researcher (Åkerlind, 2008). The moments of feeling like a researcher are described by doctoral students as instances of development as a researcher through producing formal research outputs such as publications, doing research, and talking about research (Mantai, 2015). These feelings might sometimes

appear when students simply realize these moments. Being a researcher, on the other hand, is acting and behaving like one (Mantai, 2015).

Doctoral supervisors have identified competencies that distinguish an independent researcher as "practical and creative informal knowledge, perseverance in the face of frustration/failure, tolerance of ambiguity, self-direction, a willingness to take risks, and intrinsic motivation" (Lovitts, 2008, p. 323). These might have been facilitated or impeded by the doctoral students' undergraduate studies, social and scholarly contexts in which they participate, and personality (Lovitts, 2008). Previous studies addressed the concept of being an independent researcher through what an independent researcher is able to do through several stages. *Independent researcher* in the present study addresses the doctoral student as someone who has the confidence to conduct a research study, such as the dissertation study or a non-dissertation research study, with minimal guidance. The minimal guidance includes asking advice from peers or supervisors from time to time (Lovitts, 2008) but still pursuing one's study mostly on one's own. Doctoral students, who do not have the confidence to take initiative during their studies and who cannot initiate and complete a research study and progress without their supervisors' advice or direction most of the time, are not considered independent researchers.

Methodology

The study was a part of a more comprehensive study focusing on doctoral students' experiences in doctoral programs in the field of mathematics education. Phenomenology was employed because the study explored the meaning of the experiences in becoming a mathematics education researcher (Creswell, 2007). Key concepts and experiences in becoming an independent mathematics education researcher and how doctoral students draw on these experiences were investigated and interpreted using a socialization lens on becoming an independent researcher. A sociocognitive view was employed to provide a complementary explanation.

Context and participants

The study was conducted in a doctoral program at a Turkish university in which the language of instruction is English. The Elementary Education Doctoral Program (EEDP) is a comprehensive program focusing on the fields of mathematics, science, and early childhood education at all levels. The program is offered by the Department of Elementary Education (DELE) at the College of Education. Applicants with or without a master's degree in related fields are required to provide the scores of international or national general aptitude tests and English language examination, Cumulative Grade Point Average document, and a letter of intent. However, a related master's degree is strongly encouraged. Following this application process, applicants with higher scores are interviewed by a program committee. Accepted students start the program with a temporary advisor and are required to appoint a dissertation supervisor before they start the second year of the program.

Thesis track master's students take several courses, including research methods and statistics courses; conduct a study under the guidance of a supervisor; and write a master's thesis and defend it to a committee of three or five faculty members in at most six semesters. The EEDP after the master's degree requires that students should take one obligatory advanced research methods course and six elective courses from a wide range of graduate programs within the college. Doctoral students are encouraged to take elective courses focusing on mathematics education. They are required to take a doctoral comprehensive examination after completing the coursework. Students who pass the examination appoint a doctoral dissertation monitoring committee of three faculty members and defend their proposal to this committee 6 months later. They then keep the committee informed about the progress of their doctoral dissertation study every 6 months. Doctoral students defend their dissertation to a doctoral dissertation defense committee of five faculty members and are awarded the title "doctor" if they are successful. The EEDP requirements should be completed within 12 semesters.

There were 14 faculty members in the DELE from the fields of mathematics, science, and early childhood education at the time of the study, 4 of whom had a mathematics education background. There

Table 1. Degree information and occupations of participants.

Participant	Semester	Phase	Occupation
Yasmin	11	Writing dissertation (Diss)	TA at DELE with further appointment at another university
Karen	11	Writing dissertation (Diss)	TA at DELE
Daisy	9	Analyzing data (Analysis)	TA at DELE with further appointment at another university
Aaron	7	Collecting data (Coll)	TA at DELE with further appointment at another university
Abby	6	Defended proposal (Prop)	TA at DELE with further appointment at another university
Erin	5	Defended proposal (Prop)	TA at another university
Sarah	4	About to take comprehensive examination (Comp)	RA at a project at another university
Debbie	2	Taking courses (Course)	TA at DELE

was another comprehensive doctoral program at the college offered by a department with a secondary education focus and four faculty members from the field of mathematics education at the time of the study. Graduate courses focusing on mathematics education topics were offered by a total of eight faculty members in these two programs. However, not all faculty members were offering graduate courses during all semesters.

A total of 95 students were enrolled in the EEDP at the time of the study, 36 (4 males, 32 females) of whom were working in the mathematics education field. Among these 36 students, 5 were teachers and the rest were either graduate assistants at universities including the program university or working in research projects. The four faculty members supervised 6–9 doctoral students each and 5 students had not chosen their doctoral dissertation supervisors at the time of the study.

A total of eight doctoral students (one male, seven females) participated in the study. Though these students were conveniently selected, I was careful about selecting at least one student from each mathematics education supervisor in the program and tried to represent doctoral students with different phases of their studies in the EEDP. All participants had BS and MS degrees in elementary mathematics education. Aaron and Abby received their MS degrees and Erin and Debbie received both BS and MS degrees from the programs in the DELE. All participants except Debbie had appointed a doctoral dissertation supervisor at the time of the study. Five participants were teaching assistants (TAs) at the DELE and three of them had further appointments with other universities as future faculty members. One participant was a TA at another university and one was a research assistant (RA) at a project conducted at another university. Aaron was the only male participant in the study. Table 1 shows details regarding participants' semesters in the EEDP, phases in the program, and information regarding occupation at the time of the study. All names are pseudonyms.

Typically, graduates of doctoral programs start working at Turkish universities as assistant professors with at least three courses to teach and administrative duties. The tenure process is centralized through the governing body of Turkish universities, the Higher Education Council (HEC). Candidates are expected to satisfy certain publication criteria, which had been recently changed at the time of the study, to apply to the HEC for tenure examination. HEC assigns a jury of five professors, who examine the candidates' academic work. When the jury approves, candidates take an oral examination administered by this jury and are awarded an "associate professorship" title after a successful examination. Doctoral students are expected to proceed through this process when they start working as faculty members at Turkish universities.

Doctoral programs have diverse characterizations in terms of funding, entry requirements, coursework and research requirements, and completion requirements (Nerad, Trzyna, & Heggclund, 2008). The study was conducted in a doctoral program in Turkey requiring compulsory coursework, doctoral comprehensive examination, and dissertation commitments with all materials and outputs in English, which has become the language of doctoral education worldwide (Nerad & Trzyna, 2008). The program has attracted international faculty members for short-term visits and joint coursework due to the language

of instruction and common materials. The dissertation process in the EEDP is mostly an individual process during which doctoral students individually work with their supervisors on the research topics of their choices, which characterizes the EEDP as an individual program compared to the collective doctoral programs where doctoral students conduct their research study within a group of researchers working on a large-scale project (Hakkarainen, Hytönen, Makkonen, & Lehtinen, 2016). Therefore, though the EEDP does not fully represent a specific group of doctoral programs, it has several practices and characterizations common to doctoral programs across the world.

The focus of this study was only on the doctoral students' experiences and the study did not include recent graduates of the EEDP because graduates have already defended their dissertations, which might provide validation as an independent researcher (Mantai, 2005). Therefore, graduates of the EEDP were not recruited as participants in order to eliminate the effect of the dissertation defense experience and to capture the most of the program experience while participants were still experiencing them.

Data collection and analysis

I contacted the participants via e-mail and explained the study, indicating that I was interested in their experiences in the doctoral program and not in any issues of doctoral student–supervisor communication and attached the consent form approved by the university's ethics committee. I specifically emphasized that the interview data would be meaningful only if they wanted to participate in the study but not if they felt like they had to. Participants indicated that they were willing to express their experiences of and ideas about the EEDP for my study.

I was a faculty member at the DELE and I had nine doctoral students at the time of the study. Some of the participants took some of my undergraduate and/or graduate courses on either mathematics education or research methodologies during their studies in the department. I was supervising Yasmin and Aaron for their doctoral dissertations and I supervised Debbie for her master's thesis. Interviewing the doctoral students whom I supervised could be an issue of credibility; however, the study did not focus on controversial issues but rather on what participants experienced in the program. It seemed that all participants in this study openly discussed and criticized the EEDP structure and practices, and they did not hesitate to give detailed information when I asked for clarification.

The semistructured interview protocol used in this study was developed by considering the EEDP structure and findings of the previous studies conducted in doctoral programs. The protocol had 22 questions, including some questions with subquestions and those for demographic information. I asked additional questions based on participants' responses in order to explore their experiences deeper and clarify the meaning behind certain terminology they used. For the purposes of the current study, I asked doctoral students how they would identify knowledge, skills, values, and attitudes that mathematics education researchers would have. This question led to further subquestions as participants responded. Though I had the expectation that participants would express certain issues such as knowledge of mathematics and research methods, problem-solving skills, ethical values, and being respectful to their participants, I was careful about the unclear expressions they used, such as *sufficiently competent*, and explored these expressions with further questions. Then, I asked them to evaluate their current status based on these characteristics. Additionally, questions as to whether they had non-dissertation research study experiences, whether or when they felt like a researcher, and how confident they felt in conducting a research study independently were addressed. Analyses of responses to these questions led to further distinctions between participants as independent and not independent researchers based on their explicit self-identifications.

One mathematics education faculty member from the doctoral program with a secondary education focus reviewed the protocol and commented on the questions and the inclusiveness. My aim was to gain insight from a faculty member supervising several students at a similar program and not to miss any issues that might be related to the courses participants took in that program. I made changes in the expressions of some of the questions and added a few subquestions to help me organize and deepen the responses. I conducted the initial interviews with experienced doctoral students and asked them whether the protocol addressed the doctoral program experience adequately and whether the questions

Table 2. Themes and subthemes in data analysis.

Characteristics of a mathematics education researcher	Feeling like a mathematics education researcher	
	Independent researcher	Not independent researcher
Researcher traits (knowledge, skills, attitudes, values, personality, and interpersonal skills) Strengths as a researcher Need for self-improvement	Team research Obstacles in research Doctoral program experiences Confidence Reflection on learning/improvement	

were clear at the end of the interview. They indicated that the questions in the protocol covered the EEDP experiences and were clear. I did not make any further changes to the questions and included these initial interviews in my data.

Interviews were conducted individually in one-on-one settings and took 60–120 min. All interviews were audio-recorded and transcribed verbatim for analysis. Data analysis was guided by thematic analysis steps (Braun & Clarke, 2006) and the aims of the research study. The transcription process helped me to see the commonalities and emerging issues within and across the interviews and provided me with an initial list of possible codes by considering the knowledge (such as knowledge of research methods), skills (such as communication), values (such as awareness of ethical responsibilities), attitudes (such as being open to improvement), and opportunities for research socialization (such as being involved in team research). I read the interviews several times, clarified the list for possible codes, and tried to determine whether these codes fit most of the data. I also summarized certain issues that might be related to the scope of the study and might help me in data analysis for each participant. Then, I refined the code list once more, coded the data, and constructed a comprehensive table while downsizing data into subthemes of common key experiences and skills of becoming a researcher. I focused on researcher characteristics, strengths, need for improvement, being an independent researcher, obstacles in research process, the EEDP experiences, and reflection on learning. This process helped me to reconsider the themes and finalize them. At the end of the analysis, characteristics of a mathematics education researcher included what participants identified as specific traits of a mathematics education researcher and their own status as a researcher. Identification of an independent/not independent mathematics education researcher included the extent to which doctoral students were involved in team research, reflected on their own learning, felt confident, and stated program opportunities and obstacles. Table 2 presents the themes and subthemes of the findings.

Findings

Findings related to the characteristics of a mathematics education researcher are presented first. Then, the experiences as a result of which doctoral students felt like a researcher for the first time are presented in the Feeling Like a Mathematics Education Researcher section. A further analysis showed that not all participants were confident about conducting a research study independently. Therefore, those who were confident that they would be able to conduct a research study independently were grouped as independent researchers and those who were not confident were grouped as not independent researchers. I assigned these identifiers based on their perceived and explicitly stated state of independence in conducting research because I stressed on the word *independently* in my questions during the interviews. It should be kept in mind that these identifiers do not ascertain that the participants can or cannot actually perform an independent research study. Further findings focusing on common issues within these groups, and differences between the groups are presented under related subsections. Illustrative examples of participants' expressions are provided. The word describing the third person in Turkish language does not distinguish gender. Therefore, *she* was employed when the female participants referred to the third person and *he* was employed when the male participant referred to the third person in the quoted expressions.

Characteristics of a mathematics education researcher

The characteristics of a researcher were explored in terms of knowledge, skills, attitudes, and values by how doctoral students defined those characteristics, how they evaluated their strengths as a researcher, and what they needed to improve. All participants claimed that a mathematics education researcher should have knowledge of research methods, mathematics, mathematics teaching, and the fundamental and current knowledge of research topics she or he worked on. These types of knowledge were accompanied by a set of skills such as critical thinking, reasoning, communication as well as study skills, such as being a planner and systematic. Scholarly skills such as discussing the findings and providing effective implications for implementation were also mentioned.

> Mathematics is full of conjectures and I think, first, we should know why accepting those conjectures is usable and logical. (Debbie, Course)
> Critical thinking skills. … She should be a person who questions, who feels uneasy about a word she reads and explores [that word]. (Karen, Diss)
> A researcher should be able to produce effective and grounded implications and inferences. She should be able to provide concrete implementation suggestions for teachers and teacher educators. (Erin, Prop)

A mathematics education researcher should have ethical concerns for her or his participants and consider the good for her or his study group and society. Respect for the field of mathematics education research was also expressed.

> It is not only about having my work done. There should be mutual benefits [for both the researcher and the participants] in the studies that we conduct. (Daisy, Analysis)
> I think all mathematics education researchers and education researchers should respect their studies, participants, and should believe that [good] things will happen in time. (Sarah, Comp)

Patience, as well as having a desire to learn and explore, was a trait that doctoral students associated with a researcher. Being motivated, determined, and rigorous during the research study was also stated.

> There is a need to be patient and rigorous. We need to be rigorous in order to understand whether our findings are meaningful or not. (Aaron, Coll)

Yasmin (Diss), Aaron (Coll), and Karen (Diss), who spent considerable time in the EEDP, claimed that one cannot fully have these knowledge and skills because there would always be many issues one should improve. Doctoral students expressed different strengths, most of which were personality traits, such as desire to learn, being patient, being systematic, and being hard-working.

Participants felt that they needed to improve their skills in writing research and knowledge of research methodologies. They expressed that writing research in general and discussing findings were difficult and that they needed to write more to improve these skills. This was also related to the difficulty of not being able to express oneself effectively to the research community in formal settings, such as conferences, and informal settings, such as doctoral courses. Daisy (Analysis) and Abby (Prop) specifically addressed this difficulty and added that this was a personality trait that they have improved to some degree since they started the EEDP.

> A researcher should express herself really well. She should be able to express what she knows and what she does not know. I can feel that I don't have this [skill] much. I am not much of an enterprising and extravert person. […] You are trying to explain or describe a problem or a situation. So, you need to have better skills of expressing your ideas. (Daisy, Analysis)

The findings addressed that doctoral students identified knowledge of mathematics, mathematics teaching, and research methods as vital for a mathematics education researcher regardless of their current phase in the program. Mathematics-related norms, global competencies such as critical thinking, and research skills were also important. When they talked about improvement, they addressed written and verbal communication skills as traits of a researcher. These skills were also associated with personal traits such as being extravert, patient, motivated, and determined. They expressed that the knowledge, skills, and traits would not be fully reached and a researcher should always be open to improvement.

Feeling like a mathematics education researcher

When I asked when and how they felt like a mathematics education researcher, all but one of the doctoral students expressed a previous research experience with emphasis on data collection process and the product, reflecting the description by Mantai (2015), which was also employed in this study. This research experience was mostly the master's thesis study participants conducted before they started the doctoral program.

> After I finished my master's thesis because I generated a product [and] I completed a research study. I have never completed a research study before that. It was the research study I started and progressed until the end. (Aaron, Coll)
> When I collected my data, master's thesis data. […] While I was collecting my data [I saw that] there were answers for my [research] questions. I mean I could see [the answers]. I was very happy. I started to think how I would discuss the findings. (Debbie, Course)
> During my master's thesis study, […] when I analyzed the data […] I had ideas, [but] would I be able to reach those ideas? How would that be? I had the excitement. I think I felt that it was a research study when I analyzed the data. […] The teacher did let me teach the topic. I realized that I was observing the students with the eyes of a researcher, not a teacher [while I was teaching]. (Karen, Diss)

Findings indicated that being able to conduct a research study from the beginning to the end made them feel like researchers. Participants described certain steps of the research process such as collecting or analyzing data as the time they felt like a researcher because they were able to associate data or analysis with their research questions.

Erin (Prop) expressed that she felt it after defending her doctoral proposal, which was quite recent; however, she was not fully confident despite the sense of approval conferred by a research community through passing the proposal defense (Mantai, 2015).

> I think I am still learning. […] I think we are … still learning how to do it. (Erin, Prop)

Although almost all participants felt like researchers during a previous research study they conducted, not all of them were confident about their abilities and knowledge to conduct a research study independently. Yasmin (Diss), Karen (Diss), Aaron (Coll), Debbie (Course), and Sarah (Comp) were confident that they were able to conduct a research study as an independent researcher, whereas Erin (Prop), Daisy (Analysis), and Abby (Prop) stated that they did not think they were able to do so. It seemed that identifying oneself as an independent researcher was not related to the participants' phase in the program.

What made them state this? The findings revealed that being confident in conducting a research study independently seemed to be related to a mixture of team research experiences, reflection on learning, the meaning attached to program experiences, and perceptions of obstacles in conducting a research study. In the following, these issues are presented for the groups of doctoral students who were confident in being an independent researcher and those who were not.

Independent researchers

Five doctoral students at different phases of the EEDP claimed that they were able to independently conduct a research study, but they added that the quality would not be as high as a supervised research study.

> I can [independently conduct a research study] because I know the necessary conditions to conduct a research study and I can conduct it from the beginning to the end. But, the product might not have the desired quality because I am alone and I am still a researcher who is still trying to improve himself. […] The product will probably not satisfy me because I conducted it myself. (Aaron, Coll)
> I think I can. I learned a lot. […] But it won't be a quality (research study) at the beginning. Then, it will eventually get better. […] Even though it will be a longer way to conduct a research study, I think I can do one. (Sarah, Comp)

Karen (Diss), Yasmin (Diss), Aaron (Coll), Sarah (Comp), and Debbie (Course) were working on at least one research study other than their dissertation studies in teams either with their peers and/or with their supervisors. They also had either journal papers or national and international conference presentations emerging from the research studies they conducted with their teams. They valued the different

perspectives about the issues raised during these studies, opportunities for discussion, addressing a larger picture, and reaching more meaningful findings.

> Team research is very important in terms of management of the process, the quality of the product, discussion and writing. […] You gain different perspectives. (Karen, Diss)
> [In doctoral dissertations] we can only have one perspective. […] [But when we work as a team,] the topic could be investigated better. […] If we investigate different aspects of a topic as a team, our findings would be more meaningful. (Aaron, Coll)
> One can see what the other cannot see [during the team work]. When we work on something [alone], we cannot see [what is missing]. […] Everyone can have a different idea. (Debbie, Course)

Sarah (Comp) was working as an RA for her master's thesis supervisor in another city and she had other projects with her doctoral supervisor. She continuously referred to her RA project during the interview. This project started about the time she started the doctoral program and she was conducting interviews and analyzing data for this project. She valued team research for different perspectives and ideas that were triggered during these studies.

The projects that these five doctoral students were working on seemed to provide them with an additional context in which they would use their research knowledge and skills. Their doctoral dissertations were not produced within these additional projects, but they were remotely related. The studies they conducted as a team with their peers were initiated by these teams, not by any faculty members, even when faculty members were involved. For independent researcher participants, being an independent researcher seemed to be related to having more opportunities to perform observable researcher practice during team research. The multiple perspectives discussed with their teams seemed crucial for improving their research practices.

Although independent researcher participants were confident that they were able to conduct a research study independently, they had hesitations about the quality of the research study. They maintained that the quality would get better as they improved by gaining experience. The lack of multiple perspectives also seemed to be a major reason for lack of quality.

Independent researcher doctoral students reflected on their own learning in the interview when I asked about the difficulties they had in their studies in the doctoral program. They commented on the complexity and amount of knowledge they felt they had to know because there was "always something missing while conducting a research study" (Aaron, Coll) and they "still needed to improve their knowledge and skills" (Yasmin, Diss). Although participants expressed difficulty, they were confident about knowing what they needed to do in order to learn.

The doctoral program seemed to provide several opportunities in helping doctoral students become researchers. Research methodology courses helped them deepen their knowledge in methodologies, especially when they were encouraged to bring in and discuss their perspectives and collect data to enhance course experiences. Independent researcher participants expressed that the structure of the other courses in the EEDP required them to conduct a small-scale research study, which helped them implement research knowledge and skills.

> [Thinking about the courses] I actually conducted a research study in each of them. They improved me a lot. […] I tried to investigate different topics in the courses. They contributed to my [researcher traits]. (Sarah, Comp)
> The courses in which I conducted a research study or I learned how to conduct a research study [made me feel like a researcher]. […] In these courses, we conducted a research study on our own. They made me feel so because the focus was on conducting a research study. (Aaron, Coll)

There were years in the program in which courses with a mathematics education focus were not offered and, thus, students had to take mathematics education courses and other courses from other programs to complete their coursework requirements. Independent researcher doctoral students expressed that the lack of a sufficient number of mathematics education doctoral courses was an obstacle and stated that they wished to have more and varied courses to take.

The five participants also talked about obstacles in conducting a research study and/or being a researcher in a broader context during the interview. The rapid, unforeseen, and large-scale changes in educational policy in Turkey were mostly stated as the greatest obstacle in conducting education research

studies in Turkey. Therefore, "conducting long-term research studies at schools was difficult and not much manageable" (Karen, Diss). They also reflected on issues such as the lack of university–school collaboration and the lack of more formal and national organizations for graduate student development in the field. They added that the new criteria for tenure would reduce the quality of the publications. Participants' opinions about program experiences and research obstacles revealed that they had a broad perspective in evaluating the challenges in the research context ranging from doctoral program–wide to nationwide issues and from current to further obstacles.

Not independent researchers

Three doctoral students, Daisy (Analysis), Abby (Prop), and Erin (Prop), stated that they did not feel confident in conducting a research study independently. They indicated that they still needed to gain competence in many skills.

> For now …I don't think so. I may collect data on my own, I can design the [research] process maybe, but maybe, but I am not sure about that either. […] I don't feel that I had the competence. I immediately ask my supervisor what to do when I get stuck. I even think about to whom I will ask [my questions] when I [graduate]. (Daisy, Analysis)
> No, not for now. […] I can be one, only after, first, I finish my dissertation, and second, I work in a project as a researcher. I still need to learn many things from the team research. […] What I understand from being an independent researcher is to find the answer to my [research] questions. Then, I will be able to answer the questions [others will] ask. That is a lot [to do]. Therefore, [I don't feel] right now. (Abby, Prop)

Not independent doctoral students valued team research, but they had rather limited non-dissertation research experience in a team. They did not conduct any research study with their peers in an out-of-course context in the EEDP. They mostly talked about dissertation chapters when they referred to a research study and about the participants, the unwillingness of teachers to cooperate, and the limited impact of the studies they conducted when they talked about their doctoral dissertation studies.

> Sometimes I feel that the methods section in most dissertations in Turkey are similar. When I read the completed dissertations in other countries, I see that they write the methods section in more detail. (Erin, Prop)

These doctoral students did not reflect much on the course experiences or on their learning when I asked about the difficulties they encountered during the research process. They expressed that they had difficulties when they thought about how to find an answer to their research questions, how their research study would impact teachers, and how to narrow down their research topics. The difficulties they faced in their studies were generally not related to lack of knowledge, although Daisy (Analysis) and Abby (Prop) said they needed to improve their knowledge of research methods and Erin (Prop) still had doubts about how to frame her research study.

Not independent researcher doctoral students did not mention the contribution of the courses in which they conducted a small-scale research study, although they mentioned how collecting data for these courses made them feel like researchers, referring to rather observable researcher behaviors. The obstacles they stated were not related to the issues of research and being a researcher. Only Abby (Prop) mentioned new tenure criteria, and she commented that researchers would not enjoy conducting research to meet these criteria. These doctoral students did not reflect on the research context much except for teachers' unwillingness to improve and change, and they did not connect this issue to research.

> Teachers should not be left alone when they graduate from teacher education programs. They have many problems. Teachers are on their own. They know [something] and they go on with what they know. If they don't know, they go on without knowing […] because there is nobody to question teachers, nobody to ask "Why don't you know this?" (Daisy, Analysis)

Not independent researcher doctoral students discussed the contribution of doctoral courses; however, this contribution seemed to be limited to improvement in reading and writing skills and being a more critical reader of research studies. Daisy and Abby stated that courses also provided them with different perspectives about the discussed issues. However, they did not use the new skills or knowledge in further studies or initiate a research study to use and improve these traits. It seemed that the lack of

sufficient confidence about being able to conduct a research study caused them not to be involved in any team research study.

Discussion

Doctoral students' conceptions of mathematics education research reflected not only global knowledge and skills (such as knowledge of research methods and critical thinking skills) but also the traits (such as having patience, being a planner, and establishing effective communication) they believed should be improved. However, feeling like a researcher was mostly expressed in terms of producing a research output such as a master's thesis and performing certain research phases such as data collection, confirming previous findings (Mantai, 2015), even though they expressed several traits of a researcher. It might be the case that doctoral students described the researcher traits rather in isolation when there was no context. On the other hand, when they reflected on self as a researcher, which was the context, they considered their research experiences and could not elaborate on the rather unobservable researcher traits such as critical thinking and being rigorous. Instead, they seemed to reflect on their observable or visible behaviors such as collecting or analyzing data.

Feeling like a researcher and identifying oneself as an independent researcher were not the same for mathematics education doctoral students in this study. Although all participants felt like researchers, not all of them had confidence regarding being an independent researcher. It might be that participants who did not have the confidence to be an independent researcher felt like a researcher even when they were supervised, because they were able to perform the observable behaviors of a researcher such as collecting data. However, when they thought about conducting an unsupervised research study, they did not have the confidence of being an independent researcher.

Research opportunities before dissertation study might provide doctoral students with thinking practices of independent researchers and help them in their transition to independence (Gardner, 2008). These experiences might be available through coursework and research projects that doctoral students conduct with either the faculty or peers, as was the case in this study. All participants in this study conducted small-scale research projects through the courses they enrolled in in the EEDP. However, it appeared that these experiences did not help all participants identify themselves as independent researchers. Though independent researchers stressed the contribution of these experiences to their research practices, not independent researchers did not perceive these experiences as effective in becoming independent researchers because they did not mention these experiences. This difference did not seem to be related to the phase in the program. Doctoral students with less experience in the program, such as Debbie (Course) and Sarah (Comp), identified themselves as independent researchers despite their short course experiences in the EEDP.

One reason for this difference in the perception of program opportunities might be doctoral students' reactions to them. The microenvironment (such as supervisor, peers, other faculty members, and department) and macroenvironment (such as the culture of graduate education and the culture of discipline) of doctoral programs influence doctoral students in different ways, most probably due to their personalities (Lovitts, 2005) and research self-efficacy. Doctoral students with higher research self-efficacy benefited from the small-scale research study experiences in doctoral courses and seemed to take initiatives to improve their researcher skills by forming their own research teams. Independent researcher participants in this study were confident that they could conduct a research study on their own even though they stated that they needed to improve as researchers. This seemed to help them identify themselves as independent mathematics education researchers, as it did for doctoral students in other education fields (Albold, 2011). On the other hand, the participants who had a lack of confidence in their research skills seemed to derive limited benefit from the program experiences, did not attempt to collaborate with their peers for non-dissertation research studies, and did not identify themselves as independent researchers. Not independent researcher participants expressed difficulties in being focused and patient and in narrowing down the scope of their dissertation studies. They also stated that they needed to consult their supervisors at several steps of their dissertation study. It seemed that these participants lacked self-direction skills, which are among the traits of an independent researcher (Gardner, 2008). They had

research experiences only with their supervisors, which isolated them from intense research interactions with their peers. However, opportunities for such interaction were found to be a way of feeling like an independent researcher for doctoral students in other fields (Mantai, 2015). Lacking this context for validation of ideas (Mantai, 2015) and lacking closeness to a continuous research community (Lovitts, 2005), these participants had difficulties in transition to independence (Gardner, 2008), which they have not been able to overcome.

In the present study, it was remarkable that participants built their own research teams or collective microcultures within an individual program, which helped them practice researcher skills, engage in discussions of research (Mantai, 2015), and has the potential to provide a rather smooth transition to independence (Gardner, 2008). These initiatives might be related to the nature of the mathematics education research in which collaboration opportunities for doctoral students, such as division of labor in data collection and analysis, and joint work with science education and educational psychology researchers are available. Indeed, Yasmin (Diss) mentioned the contribution of small research projects she conducted with a graduate student from the science education field several times. It should be kept in mind that how these team research experiences influenced the transition to being an independent researcher and whether independent researcher participants were actually able to conduct a research study independently were not the focus of the present study. Yet, the study showed that the team research experiences helped participants gain confidence in research practice by practicing research within a community of peers.

Both independent and not independent researcher participants stressed that the EEDP provided students with a context where they built a community working together and discussing and learning issues, different perspectives, and skills through either courses or small-scale research projects. It might be the case that doctoral students would enhance their self-efficacy for research and identification as independent researchers by mastering research skills in a project, observing and learning from others, and receiving support and encouragement (Albold, 2011) within their community. It seemed that even when doctoral students lacked sufficient research self-efficacy, they participated in a community of researchers rather passively through course practices such as discussions. However, this participation discontinued and did not result in conducting team research for doctoral students with less research confidence.

Participants in this study did not elaborate on their current or future dissertation study practices and on whether they were conducting their studies independently. They might have thought that one would not conduct doctoral dissertation study independently because it was supervised by a faculty member and monitored by a committee in the context of the EEDP. On the other hand, because the dissertations had to be written in English, they might need their supervisors to help them with writing. Indeed, Karen (Diss), Yasmin (Diss), and Daisy (Analysis) specifically emphasized the difficulties they had with the language and how they tried to improve their English language skills.

It should be noted that most participants were graduate assistants at the DELE. I focused on doctoral students with academic job intentions and/or appointments for their future careers. Doctoral students who worked as full-time teachers or at different universities most probably had different experiences because they might not spend much time with other doctoral students in the EEDP.

The ultimate aim of doctoral programs is to train doctoral students to be scholars who have mastery of knowledge in a specific field through courses and who exhibit independence in research (Mendoza & Gardner, 2010). Findings of the study showed that the transition to independence could be possible when there are opportunities for non-dissertation research for doctoral students, such as courses requiring small research projects. Independent researcher participants in this study had these opportunities throughout the courses in the program and were able to develop and practice researcher skills in the team research studies they conducted. These teamwork opportunities provided a continuous research community in which they received feedback, had discussions about research, gained different perspectives, and received validation for their ideas, which in turn increased their research self-efficacy and eventually led to identification as an independent researcher (Albold, 2011). Based on the independent researcher participants' expressions in the present study, it might be speculated that such experiences might even help doctoral students gain different perspectives about the broader research context. It

seems that although team research studies are not conducted independently, they might have the potential to provide a context for the development and improvement of researcher traits for doctoral students. Therefore, the findings of this study suggest that doctoral programs might provide more structured non-dissertation research experiences for doctoral students. This might begin by informing doctoral students about the aims of the program, expectations from them, key experiences, and how they might work in a research team within the program.

There are other factors, such as career expectations and opportunities and relationship with supervisors, that might influence the process that doctoral students go through while becoming independent researchers. These and many other possible factors were outside the scope of the study. The way mathematics education supervisors support doctoral students in their team research efforts and how they model independent research could be investigated in further studies. The extent to which collective mathematics education doctoral programs or research teams managed by experienced researchers help mathematics education doctoral students to become independent researchers could also provide insight for individual programs.

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References

Åkerlind, G. S. (2008). Growing and developing as a university researcher. *Higher Education*, *55*(2), 241–254. doi:10.1007/s10734-007-9052-x

Albold, C. A. (2011). *Emerging scholars: Predictors of independent researcher identification in education PhD students* (Doctoral dissertation). The University of North Carolina at Greensboro. Retrieved from https://libres.uncg.edu/ir/uncg/f/Albold_uncg_0154D_10588.pdf

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. doi:10.1191/1478088706qp063oa

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: SAGE.

Gardner, S. K. (2008). "What's too much and what's too little?": The process of becoming an independent researcher in doctoral education. *The Journal of Higher Education*, *79*, 326–350.

Hakkarainen, K., Hytönen, K., Makkonen, J., & Lehtinen, E. (2016). Extending collective practices of doctoral education from natural to educational sciences. *Studies in Higher Education*, *41*(1), 63–78. doi:10.1080/03075079.2014.914910

Holden, G., Barker, K., Meenaghan, T., & Rosenberb, G. (1999). Research self-efficacy: A new possibility for educational outcomes assessment. *Journal of Social Work Education*, *35*(3), 463–476. doi:10.1080/10437797.1999.10778982

Jones, L. (2009). Converging paradigms for doctoral training in the sciences and humanities. In D. Boud & A. Lee (Eds.), *Changing practices of doctoral education* (pp. 29–41). London, England: Routledge.

Lovitts, B. E. (2005). Being a good course-taker is not enough: A theoretical perspective on the transition to independent research. *Studies in Higher Education*, *30*(2), 137–154. doi:10.1080/03075070500043093

Lovitts, B. E. (2008). The transition to independent research: Who makes it, who doesn't, and why. *The Journal of Higher Education*, *79*, 296–325.

Mantai, L. (2015). Feeling like a researcher: Experiences of early doctoral students in Australia. *Studies in Higher Education*, *42*(4), 636–650. doi:10.1080/03075079.2015.1067603

Mendoza, P., & Gardner, S. K. (2010). The PhD in the United States. In S. K. Gardner & P. Mendoza (Eds.), *On becoming a scholar: Socialization and development in doctoral education* (pp. 11–26). Sterling, VA: Stylus Publishing.

Nerad, M., & Trzyna, T. (2008). Conclusion. In M. Nerad & M. Heggelund (Eds.), *Toward a global PhD?: Forces and forms in doctoral education worldwide* (pp. 300–312). Seattle: University of Washington Press.

Nerad, M., Trzyna, T., & Heggelund, M. (2008). Introduction. In M. Nerad & M. Heggelund (Eds.), *Toward a global PhD?: Forces and forms in doctoral education worldwide* (pp. 3–16). Seattle: University of Washington Press.