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Examination of documentational processes of mathematics teachers during their pre- and in-service professional lives

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ABSTRACT

This study aims to reveal the similarities and differences between the documentational genesis processes of the teachers during their pre-service education in the last year of the education faculty and at the beginning of their professional teaching lives. Reflective investigation research design was used in this study. The data collection tools used during the pre-service and in-service lives are their lesson plans, their diaries, their lesson scenarios, the observations and video recordings of their lessons, the self-evaluation form, and the peer evaluation form. Three main categories were determined for the resources that affect the documentation process of teachers: resources from university education, resources from professional experience, and resources related to their personal learning inferences during their student years.

Keywords: documentational approach to didactics, mathematics teacher, reflective investigation, resource system, teachers professional development

INTRODUCTION

Although the role of the teacher in the learning environment has changed in the education system from past to present, it is an invariable fact that teachers are one of the important factors of education. Due to that importance, there are many tasks that the teacher must perform. At this point, some of the duties expected from mathematics teachers are to prepare learning environments where students can understand mathematical concepts, use these concepts in daily life, can easily express their thoughts and reasoning in the problem-solving process (Vos, 2018). Teachers benefit from various resources and use different teaching methods and techniques in the process of preparing learning environments and teaching for this purpose (Basturk Sahin et al., 2021). These resources cover many options such as a supporting material, an activity for classroom practice, an example from daily life, a worksheet. Studies have shown that teachers use different resources in their lessons for the purposes of increasing the academic success of students, providing permanent and meaningful learning by appealing to more senses, associating mathematics with students' daily life, attracting students' attention, supporting their individual learning by activating students, and developing students' problem solving and mathematical thinking skills (Earnest & Amador, 2019; Kablan et al., 2013; Matic, 2019; Wang, 2018).

During undergraduate preservice education, which is the first step of their profession, teachers conduct practical training in different institutions to put the theoretical knowledge they have acquired into practice and to observe the functioning of the teaching profession. It can be hypothesized that the process of selecting and organizing resources for the realization of a teaching goal by the teacher first start with preservice education and continue throughout the teaching profession. As a theoretical framework in the research, the documentational approach to didactics, which is theoretical framework based on the interactions between teachers and resources and the factors affecting teachers' professional development, was used. The documentational approach to didactics offers a new perspective to teachers' documentation work and professional development (Gueudet & Trouche, 2009). The documentational approach to didactics includes all kinds of written, oral, and printed resources as well as digital resources. The focus of the documentational approach to didactics is teachers. It deals with the interactions between teachers and resources and the factors that affect teachers' professional development (Pepin et al., 2013). The concept of resource used in this approach includes any tool that can be thought of as a textbook, any supplementary resource, a piece of software, sharing with a colleague, feedback from a student, and a resource is a part of a resource set that cannot be isolated from other resources. A document is the new resources system and schemes that are formed because of the process that teachers create the

Figure 1. Formulation of a document (Gueudet & Trouche, 2009)

usage schemes of the resources (Gueudet & Trouche, 2012). This process that teachers go through to create new resources is called the documentation process. A document is much more than a list of resources and can be formulated as in **Figure 1**.

A document is developed from several resources. Due to this process, it can be said that there is a dialectical relationship between the resource and the document (Gueudet & Trouche, 2012). In fact, documents change, develop, combine, and create new documents throughout the documentational genesis process. All these processes are a part of the professional development of teachers. The documentational approach to didactics is a strong theoretical approach, and studies conducted within the scope of the documentational approach to didactics are seen as an important need to use the power of this approach in all aspects (Pepin et al., 2017).

When the literature is examined, it is seen that there are studies examining the factors affecting the selection of resources in the course preparation and teaching practices of teachers. Studies have been carried out to investigate the documentation systems of digital resources and the contribution of digital resources to the professional development of teachers (Gueudet & Trouche, 2009, 2012; Guzman & Kieran, 2013). In addition, there are studies in the literature focusing on the design processes of digital textbooks and e-textbooks and the usage processes of a digital mathematics software (de Moraes Rocha & Trouche, 2015; Gueudet et al., 2016; Kieran et al., 2013). As the ordinary daily practice of teachers includes many collaborative aspects, studies have investigated the role of collective dimensions in the work of mathematics teachers with their resources and their professional learning and development (Gueudet et al., 2013; Pepin et al., 2013). In addition to secondary and high school mathematics teachers, research has also been conducted to reveal the resource and document systems of university faculty members and their collective dimensions (Gueudet, 2016). There are also studies focusing on the interactions between teachers and curriculum resources (Pepin et al., 2017; Trouche et al., 2019). There are few studies focusing on the transition from the undergraduate mathematics teacher education to in-service mathematics teacher development concerning the resource systems in a documentational approach perspective (Gueudet & Pepin, 2018). These few studies are focusing on the evolution of teachers' documentation work over a short period of time, this period is called as a period of professional metamorphosis by Assis et al. (2018) referring to the passage from preservice to in-service teachers. Nevertheless, as Trouche (2019) indicates, teachers' documentation schemes develop over long periods of time, through situations calling for operational invariants of very different levels. Regarding through this perspective there is a need to conduct research on the documentation process of teachers over long periods.

In this study, within the framework of the documentational approach to didactics, the similarities, and differences between the resource systems of teachers both in the pre-service period and the resource systems at the beginning of their professional life are investigated. The study search also to determine the factors affecting the documentation process of teachers. With this aspect, this research will contribute to the literature in terms of revealing how the learnings at the undergraduate teacher education affect the teachers' professional life experiences, how they benefit from preservice education in their professional life and how they develop their resources in the process of becoming a teacher. This research will also fill a gap in the literature related to the documentation of teachers because of long follow up of participant-teachers in a period of transition from pre-service to in-service mathematics teachers.

In this context, the aim of the study is to reveal the similarities and differences between the documentational genesis processes created by the teachers during their pre-service education in the last year of the undergraduate teacher education and at the beginning of their professional life as a teacher. The problem statement posed for this purpose is "What are the similarities, differences and continuities between the resources used by mathematics teachers during their pre- and in-service professional lives?"

METHODOLOGY

The research method used in this study is qualitative method. The study was designed according to the reflective investigation research design. The main purpose of reflective investigation research design is to analyze teachers' activity through their documentation work by considering the variety of resources feeding, and produced by, this work; the variety of interactions (collective, institutional as well as social) influencing this work; the time for developing documentational geneses (Trouche et al., 2020). The main principles of the reflective investigation method are, as follows:

1. long-term follow-up,
2. in-class and out-of-class observation,
3. resource collection, and
4. teacher's active involvement (Basturk Sahin, 2015; Gueudet & Trouche, 2012).

Table 1. General characteristics of the participants of the study

Participant	GPA	Pre-service education institution	Employed institution	ME	Classes they teach	WCH
Sophia teacher	3.50	Public school (Middle school)	Public school (Middle school) (Substitute)	On-going	5th & 6th (11-12 years)	28
Amelia teacher	2.98	Public school (Middle school)	Private school (Middle school)	None	5th, 6th, & 7th (main course) (11-13 years) 8 (tutor) (14 years)	34

Note. ME: Master's education & WCH: Weekly class hours

Study Group

The study group of the research was determined according to the criterion sampling method, which is one of the purposive sampling methods. The criterion sampling method is the determination of the participants according to a set of predetermined criteria (Moser & Korstjens, 2018). The criteria used in determining the study group in this study are, as follows:

1. teachers' participation in the data collection process during the pre-service internship in schools,
2. teachers' ability of expressing themselves sincerely and clearly,
3. teachers' professional status after being graduated, and
4. teachers' volunteering to participate in the research.

According to these criteria, the participants of the research are two middle school mathematics teachers. These two mathematics teachers were both students in the same state university in the western region of Turkey; they both realized their practical internship in schools training in the same middle school during the 2017-2018 academic year. Indeed, in Turkey, teacher education begins just after the high school; students pass an exam in order to be admitted to the education faculties. The preservice teacher training lasts four years; in the last year of this training teacher candidates realize practical internship in schools 6 hours a week in a school determined by the education faculty. During this period, teacher candidates prepare lesson plans and teaches in the classrooms in presence of a tutor-teacher who has been formed in tutoring pre-service teacher candidates.

Once graduated one of the participant teachers was employed in a public middle school and the other was employed in a private middle school during the 2018-2019 academic year. **Table 1** presents the general characteristics of the teachers participating in the research. The names of the teachers used in **Table 1** were determined by the teachers participating in the research, and the real names of the teachers were not used.

Data Collection Tools and Data Collection Process

To increase the diversity of data in the research, multiple data collection tools were used in accordance with the reflective analysis method. The data collection tools used during the pre-service education of the teachers are their lesson plans, their diaries, their lesson scenarios, the observations and video recordings of their lessons, the self-evaluation form, and the peer evaluation form. During the in-service professional life of the teachers', data collection tools used in this research were the personal identification form, the semi-structured interview form, their schematic representation of the resource system, their diaries, their lesson plans, the clinical interviews about lesson plans, the observation and video-recording of their lessons, and the interviews about observed lessons.

The data collection process of the research consists of two stages. The first stage of the data collection process had been taken in place when teacher candidates were in the last year of education faculty during the pre-service practical education period; this first stage of data collection was carried out in the spring semester of the 2017-2018 academic year and lasted for three months. The second stage of the data collection process had been taken in place when teachers started their profession, the second stage of data collection was carried out in the spring semester of the 2018-2019 academic year and lasted for two months.

Data collection process during the pre-service practical education period

At the beginning of the spring semester of the 2017-2018 academic year, the aim and the data collection process of the research were explained to the teacher candidates who were in the last year of their undergraduate education. It was stated that participation in the research was completely voluntary, and they were given a week to think. Six teacher candidates accepted to participate in this stage of the data collection. Data collection tools to be used during the pre-service practical education period were introduced to the volunteer teacher candidates one by one. It was stated that teacher candidates were expected to write a lesson plan for each lesson. In addition, the adapted form of the diaries prepared by Gueudet and Trouche (2012) were distributed to the teacher candidates, and they were asked to fill in these diaries in line with the principle of long-term follow-up. Weekly interviews were held by the researchers with the teacher candidates to share their experiences during the pre-service practical education period. During these interviews, the lesson plans and diaries were checked, and self-assessment and peer evaluation forms were filled in. Teacher candidates were asked to prepare a lesson scenario for a lesson to be observed by researchers before the lesson's realization, and lesson observations were made for this lesson. The lesson observed by the researchers was video-recorded to avoid data loss. At the end of the pre-service practical education period, all of the data prepared by the teacher candidates were collected.

Data collection process during the in-service teaching professional life

In the second part of the data collection process only two teachers among six accepted to continue being part of the research. The first interview with two teachers who started their in-service professional life and volunteered to continue the research was held outside of the school. The work to be done during the research process was explained to the teachers and the data collection

tools were introduced. In this interview, firstly, the personal identification form was given to the teachers, and they were asked to fill it in. Then, the teachers were asked to draw a schematic representation of their resource system. During this time, no intervention was made to the teachers. After the schematic representation of the resource system was prepared, questions about the resources in the schematic representation and previously prepared questions in the semi-structured interview form were directed to the teachers. In addition, according to the answers given by the teachers during the interview, questions that were thought to contribute to the study were asked by the researchers. Considering the data collection process in the study of Gueudet and Trouche (2012) diaries were given to the teachers at the end of the first interview and they were asked to fill these diaries. The second meeting was one week after the first meeting; during this second meeting the planning for the collection of data was made with the teachers. It was decided the lesson to be observed and the lesson was chosen by the teachers at two different grade levels for each teacher. Teachers were asked to prepare lesson plans for the next meeting. During third meeting, realized one week after the second one, clinical interviews were conducted with the teachers by asking questions about the resources they intend to use in the lesson. After the video-recorded lessons were watched carefully by the researchers and the questions were prepared, final interviews were held with the participant teachers. During the interview, after watching the video recordings of the lesson with the teachers, the questions prepared were directed to the teachers. The diaries filled by the teachers were received during the last interview from the teachers.

Researchers' Role

In qualitative research, researchers personally collect data by observing behaviors, interviewing participants, and examining data. The researchers are a part of the process and interpret the events from a subjective point of view of their own social identity (Creswell, 2013). In this study, the researchers conducted one-on-one interviews with the participants as part of the process and observed them in classroom settings. During the research, it was declared to the participants that the aim of the research was not to judge their teaching, but to reveal the resource systems they created, in order to relieve the anxiety of the participants, and by providing flexibility in a way that would not disrupt the working order, the teachers were prevented from being in a difficult situation.

Data Analysis

In the analysis of the collected data, content analysis, one of the qualitative data analysis methods, was used in accordance with the reflective analysis method. The content analysis process in qualitative research includes the preparation and organization of data, the coding of organized data, the creation of upper categories by combining codes, and the presentation and interpretation of data in figures and tables (Creswell, 2013). The categories, subcategories, and codes created from the data collected in this study are presented in two different tables for two teachers. Comparative analysis of these codes and categories, which were created as a result of content analysis, was made and the reporting process was completed. The categories and codes that emerged because of the analysis of the collected data were evaluated together with an expert lecturer, and the entire stage of the research was shared with an expert in the field, and it was confirmed that the results obtained in the research were compatible with the findings, thus ensuring inter-researcher harmony.

FINDINGS AND INTERPRETATION

According to the findings obtained to reveal the documentational genesis processes of mathematics teachers during their preservice practical education and in-service teaching professional life, three main categories affecting the documentational genesis process were determined, and the findings obtained from the research were examined under these headings firstly for preservice practical training and then for in service teaching professional life of two participant teachers: Sophia and Amelia. For example, for Sophia teacher the analyses of video data showed different levels of usage of different resources during the pre-service and in-service period: these resources were Ministry of National Education (MNE) textbook and videos, activities, and exercises available on education information network (EIN). In addition, the video analyses of her in-service period showed that she integrated sample questions published by MNE and Sophia teacher mentioned high school entrance exam questions in her schematic representation of resource system. During the interviews she emphasized on these two codes, and she added that she arranged her teaching in accordance with the curriculum during her in-service period. As a result, the codes "MNE textbook", "videos, activities, and exercises available on EIN", "sample questions published by MNE", "high school entrance exam questions", and "teaching in accordance with the curriculum" were revealed for Sophia teacher's professional life about the resources she used related to the Minister of National Education. These resources were finally assembled in the sub-category "resources of MNE".

From the content analyses of the data obtained, three main categories related to the documentational resource systems of the teacher were determined. These main categories are "resources related to the preservice practical training", "resources related to the in-service teaching professional life", and "resources of inferences from the personal experiences during student years". Findings are given in three heading according to these three main categories.

Resources Related to the Pre-Service Practical Training

Concerning the resources related to the preservice practical training during the last year f-of undergraduate education, three subcategories were determined for Sophia teacher and Amelia teacher. These subcategories are "teachings and opinions of the lecturers at the university", "experiences gained during practical education", and "resources created by the influence of vocational knowledge courses". The elements affecting the documentation process of teachers' university education are presented in detail in **Table 2**.

Table 2. Resources related to the preservice practical training affecting the documentational genesis processes

Sub-category	Codes	Sophia teacher's period of using resources	Amelia teacher's period of using resources
S-1	Adopting the constructivist approach in their lessons	PE&P	PE
	Guiding students to mathematical reasoning	PE&P	-
	Guiding students to make mathematical reasoning during problem-solving	-	PE&P
	Involving PISA questions in the lessons	PE	PE&P
	Associating mathematics with daily life	PE&P	PE&P
	Utilizing dynamic geometry software	PE&P	PE
	Teaching in accordance with realistic mathematics education	PE	-
	Supporting lessons with the use of materials	-	PE&P
	Informing students of the goal at the beginning of lesson	-	PE&P
S-2	Using the interactive whiteboard	PE&P	PE&P
	Utilizing educational platforms from the Internet	PE&P	-
	Having knowledge about some educational platforms on the Internet	-	PE&P
	Using the textbooks of MNE	PE&P	PE
	Using supplementary resource books	PE&P	PE&P
	Utilizing videos of the EIN	PE&P	-
	Utilizing exercises in EIN	-	PE
	Repeating background knowledge about subject at the beginning of lesson	PE&P	-
	Including high school entrance exam questions in their lessons	-	PE
	Considering academic success of students in classroom	-	PE&P
S-3	Rewarding students during the lesson	-	P
	Attracting the attention of students	-	PE&P
	Serving purposes of course other than teaching mathematics	-	P

Note. S-1: Teachings & opinions of the lecturers at the university; S-2: Experiences gained during practical education; S-3: Resources created by influence of vocational knowledge courses; PE&P: Practical education & professional; PE: Practical education; & P: Professional

The codes forming the sub-category of "teachings and opinions of professors at the university" were: "adopting the use of constructivist approach in their lessons", "involving PISA (Program for international student assessment) questions in their lessons", "associating mathematics with daily life" and "utilizing dynamic geometry programs" determined jointly for both teachers. This situation can be exemplified by the following sentences formulated by the teachers during the research process.

> Sophia: I had a teacher at my university. I was also very impressed with his teaching lessons. For example, he is very constructivist. I liked those things. I try to use it everywhere. For example, even the name of a polygon cannot be understood by a child. I do not know, you say parallelogram, all sides are parallel. It's as if that name was just given to it, they do not care at all. When they make some sense of it, they see that it is actually very easy.

> Amelia: Actually, it's something like this. So that they can relate a little bit to daily life. You know, we always hear the term "acre" around us. There are fields like this in our village. I've always heard about acres, I do not know, or hectares or something about a land. Children always encounter them. So that they realize that what they encounter is actually the subject of the lesson so that they can relate. … well, this is a little bit about mathematical literacy. It originates from Professor M. at the university.

When the period in which these resources were used is examined, it is seen that Sophia teacher and Amelia teacher used PISA questions, learning by constructivist approach and dynamic geometry programs only during the in-service practical education period. However, both teachers attached importance to associate mathematics with daily life during the practical education period and during their professional life. The code "directing students to mathematical reasoning" for Sophia teacher and the code "guiding students to make mathematical reasoning during question-solving" for Amelia teacher was not seen as a common code. While Sophia teacher aimed for students to reason about the subject at the introduction, teaching, and question solution phases of the lesson, Amelia teacher aimed for students to reason during the problem-solving phase. Apart from these, it was thought that the basis of the code of "course teaching in accordance with realistic mathematics education" for Sophia teacher and "informing the students of the goal at the beginning of the course" and "supporting lessons with the use of materials" for Amelia teacher are based on the teaching and opinions of their professors at the university. However, due to the teaching and opinions of their professors at the university, Amelia teacher informed the students of the goal at the beginning of the lesson in both periods and gave importance to the use of materials in her lessons.

Another common sub-category determined within the scope of this category was the experiences gained during the practical education. During the pre-service training of Sophia teacher and Amelia teacher, interactive board, MNE textbook, EIN, educational platforms on the Internet, and supplementary resource books of different publications become a part of the documentation genesis systems. The following sentences formulated by Sophia teacher and Amelia teacher during the interviews can be given as examples of these codes.

> Sophia: Normally I use EIN. I have been seeing EIN since applied training at work. It was used by our guidance teachers in practical education. That's why, for example, I do something every weekend, I normally open EIN and look at whatever subject I will teach that week in the classes I attend.

> Amelia: You could build a bridge or something between land measurement units and area measurement units in the Morpa app, I liked that more, the way of expression. That's why I watched that video. … I heard about the Morpa app in practical education before, but I started using it in my professional life.

Although the EIN and MNE textbooks were in the resource system of both teachers in preservice periods, they were not included in the resource system of Amelia teacher in her professional life. This situation can be explained by the fact that Amelia teacher started her professional life in a private institution. Both teachers benefited from different supplementary resource books both in the practical education process and in their professional lives. The interactive whiteboard had been a resource influencing teachers' documentational genesis processes in both periods. In addition, Sophia teacher learned the educational platforms available on the internet during her practical training and gained the habit of repeating the past topics at the beginning of the lesson. The habit of repeating the past topics at the beginning of the course has been evaluated under a different category since the documentation genesis processes are different. In addition, Amelia teacher also used some educational platforms on the internet, which she learned during the practical education process, in her professional life. It is a situation that starts during the practical education period and continues in the professional life, considering the academic success of the students. However, while Amelia teacher included high school entrance exam questions in the course content during the practical education period, there was no finding that she included these questions in her professional life.

For Amelia teacher, there was a third sub-category defined as "resources created by the influence of vocational knowledge courses". The codes determined within the scope of this sub-category were determined as "giving awards during the lesson", "attracting students' attention", and "serving the purpose of the lesson other than teaching mathematics". Some of the methods she learned in vocational knowledge courses during his university education were effective in the formation of these resources. According to **Table 2**, Amelia teacher tried to attract the attention of the students in the lesson in both periods. However, it has been observed that she only gave awards during the course in her professional life and served extracurricular purposes. The following sentences formed by Amelia teacher can be given as examples of these codes.

> Amelia: I started with the video so it would start off as a little more interesting. You know, in educational theories, first attracting attention, motivation, etc., for that reason.

> Amelia: Why am I doing this, again because of the university. A reward logic. Why green card? Kids love the green card. They're trying to get it. For them to try. Otherwise, maybe at that moment there was no way for me to get those kids to try. I thought of the green card.

Resources Related to the In-Service Teaching Professional Life

The resource usage experiences of teachers and resources related to their in-service professional life affecting the documentational genesis processes are analyzed. The analyses showed that there was only one sub-category common to both teachers, while the other sub-categories differ. Detailed information about the experiences in the professional life period is presented in **Table 3**.

When **Table 3** is examined, it is seen that four sub-categories were determined for Sophia teacher. As a result of her experiences with students, Sophia teacher paid attention to the individual differences of the students in teaching, considered their attention duration, informed the students about the goal at the beginning of the lesson and tried to draw attention to the subject, gave time to the students to solve questions, determined a flow from easy to difficult during the lesson, gave place to different examples in the classroom environment, took grades and gave homework, and also tried to develop self-confidence in its students. These codes were evaluated under the sub-category of "experiences with students"; because it was thought that there were two reasons why Sophia teacher wrote to the students during the lesson, both her experiences with the students and her approaches to their own learning were evaluated in the sub-category. The following sentences used by Sophia teacher can be shown as an example suitable for this category.

> Sophia: Now, whether the videos are short or long, the shortest is two or three minutes. I do not think it's possible for a student to watch a video for two or three minutes, especially at that age, and not forget it at the end. For one thing, that's probably the biggest reason. In the intervals when I pause that video, I draw their attention back there. For example, he asks a question in the video, but he answers himself directly behind his back. I want to get that answer from the student myself, not from the video. Let them have at least one discussion in class, maybe someone will have a different opinion. Not necessarily the only correct solution in the video, but someone who solves it in a different way. I think it's important for them to see them all. … In the beginning, for example, I was opening a video. I say a short video, let's say three minutes. Let them listen and then let's talk about it. I'm saying, you know, it was like this just now, they're all looking at what they said. That's when the conversations begin. So those three minutes are too much for them. Listening and watching something especially if it is related to the lesson. At first, I thought that this is not the case. I changed too.

The sub-category of "collective work with teachers"; included collective library created by the teachers at the school, benefiting from the experience of teachers who have longer professional experience, benefiting from the activities and studies of other teachers, questions prepared jointly with other teachers. The fact that collective work with the group teachers was included in the documentation system of Sophia teacher can be supported by the following sentences, which she formulated during the interviews.

Table 3. Resources related to the in-service teaching professional life affecting the documentational genesis processes

Sub-category	Codes	Sophia teacher's period of using the resources	Amelia teacher's period of using the resources
S-1	Paying attention to individual differences	P	-
	Considering students' attention durations	P	-
	Informing students of the goal at the beginning of the lesson	P	-
	Letting time for students to solve questions	P	-
	Minding the development of self-confidence in students	P	-
	Watching a sequence from easy to hard during the lesson	P	-
	Enabling students to encounter different examples during the lesson	P	-
	Attracting students' attention to topic at the beginning of the lesson	PE&P	-
	Assigning homework to get students to repeat	P	P
	Making students take notes into notebooks so students can repeat	P	-
	Considering students' abstract thinking skills	-	P
	Changing coursework according to academic success of students in the class	-	P
	Considering the average level of the class	-	P
S-2	Collective library created by the teachers at the school	P	-
	Benefiting from experience of teachers having longer professional experience	P	-
	Benefiting from the activities and studies of other teachers	P	-
	Questions prepared jointly with other teachers	P	-
S-3	Teaching from easy to difficult	P	-
	Ability to address the characteristics of the subject to be covered	P	-
	Having a z-book application	P	-
	Explanation of the topic with instructions	P	-
	Including enough examples to enable students to reinforce subject	P	-
S-4	MNE textbook	PE&P	-
	Videos, activities, & exercises available on EIN	PE&P	-
	Sample questions published by MNE	P	-
	High school entrance exam questions	P	-
	Teaching in accordance with the curriculum	P	-
S-5	Using a smart notebook	-	P
	Using z-Book apps	-	P
	Institutional question banks, leaf tests, & mock exams	-	P
	Using didactical time to terminate curricula on time	-	P

Note. S-1: Experiences with students; S-2: Collective work with teachers; S-3: Experiences with the use of supplementary resource books; S-4: Resources of MNE; S-5: Resources related to the institution; PE&P: Practical education & professional; & P: Professional

> Sophia: We are three substitutes at the school where I work now. We're all mathematicians. I make great use of them. Because the three of us are in the mood for such a novice, when we say "oh, I found something like this", we immediately run to each other. For example, it was a huge advantage for me. It's more important to get an opinion from someone rather than actually doing something outright. For example, I say "I found something like this, shall I do it?". He says "no, this is not appropriate or let's fix this". In the same way, when they come to me, they can say "this is nice, let me do this too". This is a huge advantage for me. Apart from that, I also benefit from the experience of our permanent mathematicians. For example, in the first exam I took, he directly said "do not do this exam". I prepared an exam, he said, do not do this exam. We may not be able to think about how soon children can raise them. We need a lot each other. I think this thread is important.

It is seen that the Sophia teacher determined the supplementary resource books she chose to use in teaching practices according to some criteria. These criteria were determined to be easy to difficult to explain, to address the characteristics of the subject to be covered, to have an e-book application, to explain the subject with instructions, and to include several examples that would enable students to reinforce the subject and were evaluated within the scope of "experiences in using source books". The fact that one of the criteria in the selection of books was supplementary resource books with e-book application can be associated with the presence of interactive whiteboard equipment in the school. The following sentences about the supplementary resource books she used in the clinical interviews with Sophia teacher can be given as an example of this category.

> Sophia: Let me tell you this. There's something in Ar. publishing's At. book. It tells step-by-step what to do. When I look at it, it is given only as a definition in the textbooks, or it is explained with examples in other sources, but it seems to me like this book that gives it as a complete instruction. That's why I like to solve questions from the horse. book. That's how you got into the subject, a book with three or five of its most basic examples in a row, the At. book. Instead of going directly to such difficult practical examples, it includes simple exercises that require the student to comprehend the subject and internalize how to say it. After that, he moves on to problems, more difficult events. It goes from easy to difficult. I so love this. … I especially prefer Ar. publications because it is a Z book. Especially in geometry, constantly draw shapes on the board, then wait for the children to draw, it takes a long time. But when I use the z book, we solve more questions. That's why I prefer it. … Now our topic is the rectangle. For example, a square is a rectangle, and a rectangle is a parallelogram.

> It is very difficult for children to grasp this. I have not seen such a clear comparison in other books in their publications. That's why I used this book.

Since Sophia teacher started her professional life in a public school, the MNE textbook, sample questions published by MNE, high school entrance exam questions, videos, activities, and exercises at the EIN became part of the course processing resource system by considering the curriculum, these resources were collected under the MNE resources sub-category. The sub-category "resources belonging to MNE" can be exemplified by the following answers given by Sophia teacher.

> Sophia: For example, I prepared for the following: In the 5th grade, one point has a position relative to the other. They prepared a very good game there. Let's get the students out of the classroom. Let's use the tiles on the floor of the classroom. For two students to tell their position relative to each other. For example, I really liked this. Things like this can happen when you read the book. I am using these. Apart from that, there are unit evaluations or something at the end of the topics. It is good that children solve these because after all, the state that prepared the system prepares its own questions. It's good for me to see them too.

According to **Table 3**, two sub-categories were determined for Amelia teacher, as "experiences with students" and "resources related to the institution" within the scope of the category of sources of professional experiences. Amelia teacher benefited from her experiences with students, considering students' abstract processing skills, assigning homework to reinforce the subject, teaching according to the academic success level and the average level of the class. The following sentences formulated by Amelia teacher can be shown as an example of this situation.

> Amelia: We covered the issue of equations with that class. Children already have a fear of *x, y, z*, which is unknown in mathematics. It's always something like that, something you do not know is a question mark. I honestly thought so. When I give too many letters, the child has such a direct perception and closes himself. Well, the purpose of giving the question mark is that they were giving them question marks and boxes at four out of three, to make it more understandable. Something bad actually happens this time. I thought it would not be able to reinforce the equation. But when I did not understand at all, I thought I'd at least give a question mark. I started to think that you learned better when you gave a question mark. I used to always give x, y, z, but when I saw that it was not understood in classes, I used a question mark, frankly.

The fact that Amelia teacher started her professional life in a private school was one of the factors affecting her documentation genesis system. Therefore, smart notebooks, e-book applications, question banks, and worksheets belonging to the institution were evaluated in the sub-category of resources related to the institution. In addition, since Amelia teacher was obliged to complete these resources in accordance with the curriculum and within the given time, the code of "using the didactic time to finish the curriculum" has also been included in this sub-category. The following sentences formulated by Amelia teacher can be shown as an example of the influence of the institution on her documentational work.

> Amelia: I have to use the resources provided by the institution. But for some subjects, I like the smart notebook, frankly. You know, there are all kinds of questions, there are easy questions, there are medium questions, there are difficult questions, there are questions similar to PISA questions. So, one source that I like is smart notebooks. But there is another thing. I use it for everything because I have to. But in some subjects, for example, there may be subjects that we will talk about with material, or there may be subjects that we can talk about with another activity at work. I wish I could be free with them, at least. But is there any harm? Well, seven hours is our class with seventh graders. At least, I can reserve a lesson sometimes for the activity. That's why I'm happy.

Resources of Inferences from the Personal Experiences During Student Years

This category covers the resources consisting of the personal experiences of mathematics teachers that affect the documentational genesis processes throughout their student life. In **Table 4**, the documentational genesis processes of the resources for teachers' personal inferences in their student years are presented in detail.

When **Table 4** is examined, it is seen that three sub-categories were determined for Sophia teacher, and two sub-categories were determined for Amelia teacher. Sophia teacher said that she also wrote to students because she thought that she learned better by writing. This code was evaluated under the sub-category of "approaches to their own learning". This sub-category can be supported by the following sentences formed by Sophia teacher.

> Sophia: I was a student like this, since primary school, if something was written on the board, I would write it too. I do not know, even in college. It probably has to do with my own personality. Because everyone has a different learning style, mine is a bit of learning by writing. That's why I want children to write as I learn by writing. Because even if he understands by reading, after a place where he would read what he wrote. I think that's the base to it.

The negative experiences the teacher had with her friends while doing group homework during her student years were evaluated in the sub-category of "inferences from the negative experiences with friends". The following answers given by Sophia teacher are in line with this situation.

> Sophia: I love group assignments. In the past, our teachers used to give group homework. Actually, when I was a student, I did not like group assignments. Because the thing that would happen is that students who are usually irresponsible would

Table 4. Documentational genesis processes of teachers' resources from personal inferences in their student years

Sub-category	Codes	Sophia teacher's period of using resources	Amelia teacher's period of using resources
S-1	Minding students' taking notes	P	-
	Lesson with question-and-answer method	-	PE&P
	Using formulas while solving questions	-	PE&P
	Asking students to write	-	P
	Include the solution of the questions that cannot be done by the students in the homework given in the lessons	-	P
S-2	Ensuring each student's participation in group assignments	P	-
S-3	Including origins of the features related to the subject she covers in lessons	P	-
	Explain in detail the situations in which students may be mistaken	P	-
S-4	Repetition of past topics at the beginning of the lesson	-	P

Note. S-1: Approaches to their own learning; S-2: Inferences from negative experiences with friends; S-3: Inferences from negative experiences with teachers; S-4: Inferences from positive experiences with teachers; PE&P: Practical education & professional; & P: Professional

> stay with me. I would do it, we would come, we would all have homework. That's why I did not like it. For example, I pay attention to him. Maybe it's a reflection of that, I do not know. If I am giving the group homework, who did what in the group, I want him with him in that homework. I want everyone to have a contribution, I want children to learn to divide the work equally with each other, maybe it reflects this. More precisely, I try to give a more accurate and more effective group assignment than the group assignment in my time.

It was observed that Sophia teacher included the starting points of the features related to the subject in the lessons and tried to explain in detail the situations in which the students might be mistaken. These codes belonging to Sophia teacher were evaluated under the sub-category of "inferences from negative experiences with teachers". The following sentences of Sophia teacher can be given as an example of this situation.

> Sophia: Because the thing seems important to me. Maybe it's enough for students to say "yes, a square is also a rectangle" for the students right now. But if we teach only by looking at the present, in the next years, when a child is in the 5th grade, but when he/she passes to 8, when he/she faces important exams, they do not just look at pure information anymore. They need to think a little bit, after a while the child cannot go beyond memorization. I think it is necessary to give a strong foundation, at least at that moment, so that there is no trouble. I'm probably doing this myself by looking at my student years. Because the information given to me was never like this. I learned this in college. I wish they would have told us that too. That's why I'm trying to explain it exactly like this right now.

With these two sub-categories, it is stated that Sophia teacher included practices that will eliminate these negativities in her lessons, based on her negative experiences with her friends and teachers.

The codes determined within the scope of the "approaches to their own learning" sub-category belonging to Amelia teacher were "learning with the question-and-answer method", "using formulas during the solution of questions", "asking students to write papers", and "involving the solution of questions that cannot be done by the students in their homework in their lessons". This sub-category was determined to express the thought that Amelia teacher's students could learn better by using applications that contribute positively to her own learning in her lessons. This sub-category can be exemplified by the following sentences of Amelia teacher.

> Amelia: Why write? Because those types of questions will appear everywhere. I also believe in learning by writing. There are questions in their notebooks and no solutions. They need to complete their solution. There is such a thing. But they also have to write. Because if he says they need to participate actively in some way at least somewhere. They talk all the time, yes they answer questions and so on, but they have to write so that when they look at it later, they can see what the solution to those questions was, which way I went, what I did. … I think I attribute this to my student years. Because by writing, for example, I remember very well in high school, there was such a teacher who wrote a question on the board. Here was a very different permutation question. I could not take that question down very well and I lost it. I mean, when that kind of question came up again, I could not solve it.

Amelia teacher also included these in her teaching practices, as her past teachers' repetitions in the subject introduction while lecturing, and their efforts to develop a common strategy with the students while solving questions had a positive effect on Amelia teacher. For this reason, the two codes, which were determined at the beginning of the course as repetition of the past topics and developing a common strategy in solving questions, were evaluated within the sub-category of "inferences from positive experiences with their teachers". The following sentences made by Amelia teacher can be evaluated within the scope of this sub-category.

> Amelia: Like, "You found it, you saw it was like this, now remember it". Because past experiences affect our learning, I guess that's why. … It may be instinctive. But when I remember my own student years, when my math teacher tells me about the subject, when he talks about his past experiences, it's like when something happens, he finds his past acquaintance. It's like such a situation.

DISCUSSION AND CONCLUSION

When the results of the research were evaluated, it was concluded that the teaching practices of elementary mathematics teachers were affected by the teachings and opinions of the faculty members in the education process they received at the university. Similarly, Tapan-Broutin (2017) concluded in her study that the resources that teacher candidates choose over the internet are directly related to the education they receive at the university. Assis et al. (2018) revealed also that novice teachers benefit from their experiences at the university in the teaching process. In parallel to the conclusion of Assis et al. (2018), this research also concluded that teachers' experiences with teaching practices during the practical education period affect the documentation systems.

Another conclusion related to the use of Ministry of Education resources is that although the teachers used EIN during their practical education period and in their professional life. However, no resource usage related to EIN, and therefore no documentational work was encountered in the pre-education courses they took at the university. Many studies around the word, for example, Alexander (2014) for the USA, Bozak et al. (2016) for Turkey, Mustafa et al. (2022) for Pakistan, Turnsek et al. (2009) for Slovenia, etc., found that education faculties were insufficient in preparing prospective teachers for the profession. This situation is consistent with the result obtained in this research that the education received at the university does not adequately prepare the teachers for professional life in terms of resources. In this context, it has been concluded that the education received by the teachers at the university is insufficient to prepare the teachers for the profession in terms of resource systems at least for the resources concerning the Ministry of Education. This result shows the importance of a collaborative platform between the Ministry of Education and the rectorates of universities.

Moreover, this research showed that while preparing the learning environment, the teachers were influenced by the experiences they had with the students and revised their lessons according to the inferences they obtained from these experiences for their documentational work. Khairunnisak et al. (2022) concluded that teachers take student levels into account while teaching and that the teachers consider the academic success of the students while teaching the lesson. Ozturk and Guven (2012) found also that students' feeling ready emotionally as well as their cognitive competencies will help in creating an effective learning environment. The conclusion of this research show also that teachers consider students' both cognitive and affective characteristics in their teaching practices. In this context, within the framework of the documentational approach to didactics, it has been concluded that the experiences with the students together with the professional life affect the documentational genesis processes of the teachers and become a part of the documentation systems.

Teachers who have started their careers benefit from the collective work with group teachers directly (with the resources they obtain from the branch teachers) or indirectly (the resources prepared by the group teachers working in the institution they work for). Gueudet et al. (2013) concluded that there are always collective dimensions in the work of teachers. This result shows parallelism with the results reached in the research that show that teachers are influenced by group teachers. Miyakawa (2022) found that teachers' documentation systems were also affected by their colleagues, and this aspect supports the result of the research. However, in his study with university professors, Gueudet (2016) concluded that professors do not share interesting resources designed by themselves with other colleagues. This result of Gueudet (2016) does not match with the results obtained that the participants in the research shared their resources with the group teachers. This can be explained by the fact that the study group chosen by Gueudet (2016) in his research consists of teachers from a different teaching level and that these teachers are not open to sharing resources.

When choosing resources for the course process (such as a resource book, notebook, an educational platform that can be used on the interactive board), the equipment of the school they work, the accessibility of the resources and the institution's own rules were effective. In line, Basturk Sahin and Tapan-Broutin (2018) found one of the five categories affecting teachers' lesson preparation processes as institutional factors. Trouche et al. (2019) concluded in their research that teachers tend to find solutions to institutional needs. This result coincides with the result of the research that the documentation systems of the teachers are shaped within the possibilities and rules of the institution where they work.

It has been concluded that the teachers' approaches to their own learning have an impact on the choices they make during the lesson preparation process and during the lesson. In the research of Gueudet et al. (2016) found that the Sésamath teachers, who designed e-textbooks, brought their own beliefs about how concepts and their functions should be learned while technology could help them to introduce some structures more flexibly to learning and teaching mathematics. This research also concluded regarding the beliefs of teachers that their own approaches to learning can also be effective on students' learning. Choppin et al. (2018) concluded that teachers' own personal resources and beliefs affect their documentation systems in their teaching practices. The result of this research supports the conclusions that the inferences of their personal learning affect the documentation system of the teachers.

While teachers reflect their positive experiences in their teaching practices, they make inferences from negative experiences and plan to prevent these negative experiences from happening in their own teaching practices. Basturk Sahin (2015) found also that teachers' own personal development is also effective in the documentation processes. Pepin et al. (2017) concluded that human resources, as well as text and digital resources, have a significant impact on teaching practices. This result supports the research conducted in terms of teachers' documentation systems being affected by their teachers and colleagues. Likewise, Gueudet and Trouche (2009) concluded that the professional, personal, and social development of teachers is related to the environment they live in, and this situation affects their documentation system.

According to the results of this research, the institutions where the teachers work during their in-service practices have a significant impact on the resources they use. In this context, it is suggested that studies on resource systems, resource selection

and usage schemes and documentation processes of teachers in different institutions, different cultural and social environments will contribute to the field.

In this research, it has been concluded that the interaction of teachers with the community group directly affects their resource use, both in their pre-service and in-service lives, and it is considered important to research the effects of the virtual community groups created in digital environments on the use of resources and to examine the documentational work of teachers in these virtual community group environments.

This study was limited to the two participant teachers who had their preservice education at the same institution and who exercised at the same city their in-service profession. In order to reveal the relationship between the documentational genesis process and the pre-service education received at the university, it is suggested to conduct research with teachers from different preservice institutions.

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