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A Glance to Teachers' Work with Resources: Case of Olcay*

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Abstract

When examining success in mathematics education, it should be taken into consideration that it is important to examine teachers' work with their resources. In this study, it is aimed to examine this work through the processes of using and transforming the resources into documents. In this context, the "Documentational Approach to Didactics" is adopted as a theoretical framework. Reflective investigation method is used to analyse teacher's documentational genesis. The study is designed as a case study, with a primary mathematics teacher whom we named Olcay, who is very open to share her experiences that is important for the research. Various interviews with and observations of the teacher are made according to the requirements of the reflective investigation method. As a result, some of the schemes of the teacher to transform her resources into documents are revealed. It is seen that some of these schemes are similar to the ones discovered before and some of them are changeable according to the area where the teaching happened.

Keywords:

Didactic Material, Documentational Approach to Didactics, Documentational Genesis

Introduction

Teachers who open the path to building knowledge perform essential tasks that also provide information on learners' training (Altun et al., 2004; Cohen et al., 2003). These essential tasks include teachers' interaction with their resources. They interact with their resources for "selecting, modifying, collecting and creating new resources" as a daily work (Trouche et al., 2020). In this regard, it is thought that analyzing the resources and the documents that teachers integrate into their courses is crucial because it provides information on student learning and professional development (Adler, 2000; Hewson, 2004).

Teachers improve their courses by interacting with different resources over time and in parallel with the different resources they used (Ruthven, 2013). Teachers gather, select, transform, reorganize, share, implement, and revise resources within processes where design and enacting

are intertwined. The documentation encompasses all these interactions (Gueudet & Trouche, 2009a). It is important to analyze documentation processes that affect both their professional development and teaching processes in this perspective.

Teachers frequently use textbooks to ensure the students' learning (Pepin & Haggarty, 2001). Additionally, they also use digital resources, written or verbal resources. (Gueudet et al., 2018). There is a need for a theoretical approach that covers all the types of resources. "Documentational Approach of Didactics" (DAD) that helps analyze the resources and documents that teachers use comes to the fore at this perspective (Gueudet & Trouche, 2009a). In this study, all the concepts and processes are analyzed as part of the DAD. Thus, the term "resource" refers to any entity (notes, training, events, books, web pages etc.) from which the teacher obtains data to structure his/her teaching. Similarly, the term "document" refers to the teacher's resources that become ready to use. Although the meaning of "document" in the daily sense can be understood as a written source, the concept of the document mentioned in this study is the information in the final state of the teacher's knowledge obtained from the resources; it does not need to be written. Other specific terms of the theoretical framework are described in detail in the next section.

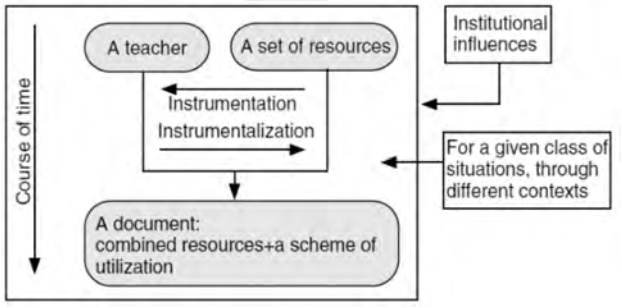
Documentational Approach of Didactics

The DAD is concerned with teachers' professional development by analyzing their interaction with resources (Gueudet & Trouche, 2009a). DAD contains its specific concepts as in French didactics tradition. While some of these concepts define objects such as resources and documents, others define processes like instrumentation and instrumentalization. These processes have been adopted from the instrumental theory (Guin et al., 2006). In the documentational approach, "instrumentation" refers to the teacher's process of adapting himself/herself to the characteristics of the particular resources while using them. "Instrumentalization" represents how teachers use particular resources and shape those resources according to their methods, and aim to use them. The documentation concept is also included within the scope of the DAD. It is defined by how teachers create schemes of utilization for the resources that they regard as necessary for particular situations. From this viewpoint, it can be said that in documentational genesis, the combination of resources and the utilization of the schemes for these resources take place. This combination may be expressed as follows:

Document= Resource + Utilization Scheme

The documentational genesis process examining such a representation may be thought to have a static structure. However, the documentational genesis process has a considerably dynamic structure. A document contains many interrelated resources and can create resources for many documents. As for utilization schemes, just as they may be a constant organization applied for particular situations, in other words, a set of fixed professional behaviors exhibited by the teacher for certain situations, they may also be recreated during the documentational genesis process. The documentational genesis process is shown in the theoretical framework in Figure 1.

Figure 1.
A representation of documentational genesis process (Gueudet & Trouche, 2009a, pg.206)



While examining teachers' transforming resources into documents, DAD also argues that this documentational genesis process is also effective on the teachers' professional development. It is necessary to examine all the documents created by the teacher and discuss his/her document system to understand a teacher's development. The resource system expresses a system created by the teacher from all the resources he/she uses, irrespective of his/her utilization schemes. However, the document system expresses a structured system in which the documents created by the teacher are correlated; in this system, the particular documents that are to be used for particular situations and the utilization of schemes of the resources are definite.

While obtaining schemes, operational invariants and action rules are taken into account. Two concepts describe operational invariants: the theorem-in-action and the concept-in-action. The theorem-in-action is the approach that an individual adopts when performing a behavior, which effectively does it. The concept-in-action is the concept that the individual acts according to and adopts. Action rules include the requirements for an individual to act. It is a set of rules that demonstrate how to act under certain conditions (Chevallard, 1985). Operational invariants and action rules together define the scheme, so, in this study, they are taken as determinatives for recognizing subtle organizations of the schemes.

In the literature, studies using DAD are focused on

examining teachers' schemes to reveal their content knowledge and mathematical concepts (Gueudet, 2017; Gueudet et al., 2013; Pepin et al., 2017; Poisard et al., 2011). Also, there are studies focusing on the metamorphosis of thinking and implementing static and dynamic resources, creating new balances between individual and collective work of teachers (Pepin et al., 2017). In these perspectives, DAD suggests to analyze teachers' work with resources in the lens of what they prepare for their classroom practices and what is renewed in these practices. The basis of the DAD is instrumental approach in the field of technology use in mathematics classrooms (Guin, et al., 2005). The concepts instrumentation and instrumentalization is also essential in the instrumental approach. Pepin and Gueudet (2018) explain the differentiation between digital curriculum resources and educational technology. Adler (2000) and Pepin et al. (2013) also suggests o think the resource as the verb re-source: "to source again or differently" (p.207). Ball et al. (2005) states in their study that teaching cannot be reduced to the work in class, but also includes planning. Also, Psycharis and Kalogeria (2018) studied on teacher educators' work with resources. Kock and Pepin (2018) also, studied on the students' interaction with students by using DAD. In this context, this research aims to analyze how teachers organize their resources by analyzing the schemes and processes that appear in the documentational genesis. The difference between this study and other studies in which DAD is used is that the teacher's schemes related to his/her instructional strategies are examined instead of just the mathematical concepts related to the course. The progress related to mathematical concepts in the context of pre-service and in-service training of teachers is very important, but what differentiates one teacher from another is the instructional strategies teacher utilizes. It is thought that this study will contribute to the field in this perspective.

Method

In this study, qualitative research methods were used because the aim was not to generalize the data to the universe but to deeply analyze the documentational genesis process (Creswell, 2017). The study was designed as a case study.

In the study, the reflective investigation method was used to select data collection tools and conduct data collection. This method is recommended for researchers that use the DAD by the creators of the theoretical framework. Its main principles are as follows:

> Long-term follow-up: Since documentational geneses are long-lasting processes and schemes develop during the process, this principle requires a detailed and long-term observation of the process. (in this study, duration is approximately six months)
>
> In- and out-of-class follow-up: The classroom is a significant environment where the teacher processes her lessons and applies the documents she creates. In addition, much of the interaction of teachers with resources takes place outside the classroom, at home, at school, in-service training courses. For this reason, it is essential to observe the teacher in these different places.
>
> Broad collection: It involves observing all the resources that the teacher has used in documentational genesis and what they have created in the process of documentational genesis.
>
> Reflective follow-up: It requires involving the teacher as much as possible in the data collection process. The teacher needs to be actively involved in examining the teacher's resource collection and following it in and out of the classroom. These parts can be understood only by the detailed explanations of the teacher (Gueudet et al., 2012, p. 27-28).

Concerning these principles, it is thought that the reflective investigation method is highly appropriate for such a study that investigates documentational work.

Participant Teacher: Olcay

This study aims to investigate the schemes that teachers have created in this process. In qualitative studies, when the investigation needs to go deeper, it is suggested to reduce the number of participants and increase the number of data collection sessions (Berg & Lune, 2015). In this context, the study was conducted with one participant teacher (Olcay).

Olcay is a primary mathematics teacher with ten years of experience in a public school in western Turkey. Previously, she completed the mathematics program at a university's science faculty in Turkey; then, she has taken pedagogical training to teach. She chose to work in a primary school instead of high school and completed the in-service training required. In addition, she completed the in-service training given within the scope of the FATİH project and thus, she was able to use the smartboard in the schools where she worked. Olcay mentioned that she benefited from technology by making smartboard and computer interaction in her previous school, but regretted that she could not use it due to lack of technological infrastructure.

She worked as a consultant teacher for the teacher candidates in the "Teaching Practice" internship. Olcay's behaviors about sharing her resources and her usage styles of the resources were very detailed. This situation made the researchers think that she was the most suitable for analyzing the documentational genesis process.

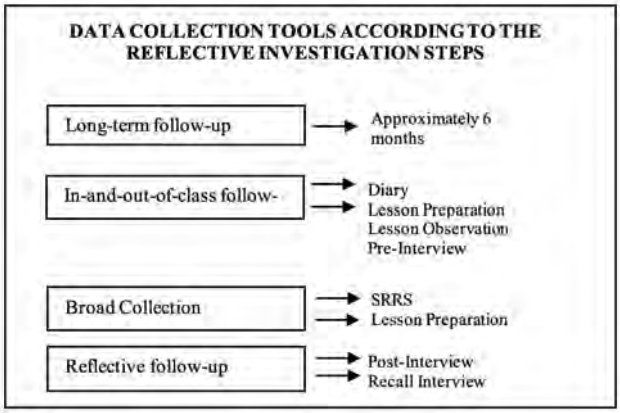
In the selection process of Olcay, the main point was not the excellent documents or the excessive amount

of resources she used. It was Olcay's ability to explain her resources, her usage of the resources and her development styles of her lessons to make us select her. Her approach about sharing resources, being open to explaining her lesson plans and being willing to share her documentational work affected our decision. Also, her 10-year teaching experience made us think that she has the broad constant organization needed for documentational genesis. Olcay has an interest in the studies in her branch and was willing to help in this study. Due to these reasons, this study was conducted with Olcay to analyze her documentational work deeply.

Data Collection Tools

Data collection tools are developed and edited in line with the reflective investigation method (Gueudet & Trouche, 2009b; Trouche et al., 2018; Trouche & Pepin, 2014). The steps of the reflective investigation and the data collection tools are shown in Figure 2.

Figure 2.
The selection of data collection tools in line with the reflective investigation steps



First of all, a "Personal Information Form" was utilized to get more information about the teacher. This form was also used and recommended by Gueudet and Trouche (2009b) using DAD. In this study, this form was translated into Turkish and used in the first visit to Olcay. The form took information about the schools that the teacher graduated from, the in-service training she received, the schools she worked at before, her perspective on technology, and the points she paid attention to in general when lecturing. In the study, the personal information form was translated into Turkish. Since the cultural aspects may differ from the previous study, the form analyzed by the specialists in mathematics education and some of the questions were eliminated because some aspects do not belong to the Turkish educational system. (For example, In France, mathematics teachers have an electronic portal to share their resources, but there is no such portal for mathematics teachers in Turkey. Moreover, the exam systems show the difference between the countries).

A semi-structured diary was utilized to ensure the "in and out-of-class" principle of the reflective investigation. It was mostly aimed at getting information about the out-of-class activities that led to changes in mathematics lesson preparation. (Olcay did not properly fill out the diary, so it is retracted.) Also, the teacher was observed in school between her lessons to see how she arranged her resources. In the study, the diary was planned as a semi-structured form. It was aimed to see the teachers' in and out-of-class ideas about her mathematics lesson. The semi-structured form was examined by the mathematics education academicians and a mathematics teacher, and its final version was completed according to their opinions.

The Schematic Representation of the Resource System (SRRS) was asked to see the teacher's resources and their relations. SRRS is a data collection tool that the teacher prepares independently from the researcher and mentions her resources and usage styles. The SRRS is an unstructured diagram intrinsically because it aims to let the teachers explain their resource systems as they prefer. The shape of the diagram is unstructured for the researchers, but structured for the participant. Because, the participant was free to draw the diagram. With the help of the diagram, it was aimed to see how she represented the relationship among her resources and the resources in detail. While giving information to Olcay about the SRRS diagram, it was stated that there is no right or wrong shape. This diagram aims to see the resources used in structuring the courses and the relationship between them.

A semi-structured interview was implemented to get detailed information about the teacher's resources, opinions about using resources and documents, and what aspects she considered while preparing a lesson. In the structured part of the semi-structured interview, questions were asked about the use of resources and documents to assist the teacher, what she paid attention to in the use of resources, whether she had certain resources for certain subjects, what resources she used and how she continued to use them and to explain the changes in the course and the application methods. The semi-structured interview form was created according to expert opinions of two experienced academicians (different than the authors) in mathematics education field and a pilot study was held with a five-year experienced mathematics teacher to see the view of a teacher. The final version was completed according to their opinions. During the interviews, according to the teacher's explanations, researchers asked additional questions to the teacher.

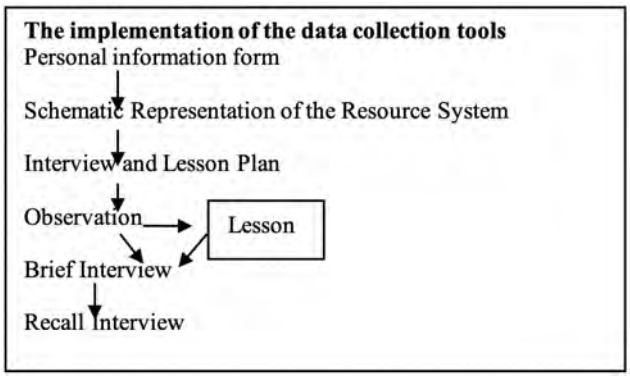
The lessons of the teacher were observed and video-recorded. Also, she was observed in the school between her lessons. Researcher notes were taken during the observations. The notes taken

were about the changes that Olcay made during the implementation of the course, which was out of her lesson plan. As Sabra (2016) mentioned, the cases mentioned in these notes were accepted as documentational incidents. After the lesson, according to the researcher's notes, brief interviews were conducted about the interesting points. Thus, the effect of the changes on the documentational genesis was confirmed by the teacher. For example, rather than making a hypothetical comment on the sudden changes the teacher made in class, the teacher was asked to explain the reasons for these changes. Thus, the validity and reliability of the observation data were increased. The observation was planned as unstructured. That's why the lessons were video-recorded to hinder the data loss and understand the important parts of the lesson using repetitive observations.

After the observations and the interviews, the researchers prepared a recall video from the recorded data. These records were selected, cut, and reunited by the researchers regarding the parts that included valuable data about the elements of the schemes. This new record was watched and interpreted by the teacher. In the recall interview, the previous lesson and the previous lesson's preparation process were seen and interpreted by the teacher. It was important in shedding light on the teacher's changes between the course preparation and the course. She was asked to comment reflectively. In this way, the teacher gained awareness about her decisions and the revisions of those decisions. It can be said that the recall interview had an intensifying effect on the validity and credibility of the SRRS, observations and interviews.

The data collection tools are implemented as in Figure 3.

Figure 3.
The implementation of the data collection tools



Validity and Reliability of the Study

First, the participant teacher was informed about the study topic before the study. Also, she was reminded that the interview and observation records would never be shared with any other person. Moreover, it was guaranteed that, in all the publications, a pseudonym would be used for the teacher.

Also, triangulation was utilized to ensure the validity and reliability of the study. The interview, observation and recall interviews were the components of the triangulation. In addition, the data collection process, details about the data collection tools and data analysis explained thoroughly to provide the reliability.

Data Collection Process

The personal information form was utilized in the first visit to Olcay to obtain information about her personal and professional history. After the personal information form, a semi-structured diary was given to Olcay to fill in day by day. (A semi-structured diary means a diary that includes the concepts we expect her to mention. But, she did not fill in the diary properly. So, the diary was not analyzed.) At the same time, SRRS that showed her resources and the relations between them was requested from Olcay. She asked questions about the diagram, and it was explained that there are no such true/false versions of the SRRS, and it can shape according to the teacher herself to share how she organizes her resources. It was aimed to make her complete the diagram more smoothly.

Two weeks later than the first interview, the semi-structured interview was done. The teacher's views on mathematical topics taught to her seventh-grade students and usage of resources were taken. At the same time, the topic of the lessons (pattern generalization and algebraic expressions) to observe was decided, and the time of the lesson preparation was determined.

A week later, lesson preparation was observed. During this observation, the researcher was involved in the process and asked questions simultaneously about the teacher's resources in the lesson.

In the following week, the lessons were observed and recorded by a video camera. During the observation, the researcher sat in the back seat and did not interfere with the courses. During the implementation of the lessons, notes were taken, and an interview was held according to the notes at the end of the lessons. During the interview, questions were raised about the points that attracted the researcher's attention at the lessons. Also, the researcher spent lots of time with Olcay, between her lessons, to understand her way of thinking about her lessons, students, and resources. So, the out-of-class observations were made from the beginning till the end of the research.

All the data were then transcribed and coded. Then, the proofs of schemes were identified, and they were combined to form parts of a recall video.

About three weeks after observing the lessons, a recall session with Olcay was made and discussed on the video. A three-week break was especially given because it was intended to forget the process a little so that the teacher could look like an outside eye on the lesson and lesson preparation she made.

Analysis of the Data

All the data from different data collection tools were analyzed and coded. After that, all the themes and codes were combined, and the overlapping and non-overlapping codes were specified. Then, shared themes and codes were created to reveal the schemes.

In the semi-structured diary, Olcay did not fill the diary as required. She just shared a few sentences about her experience with her daughter's homework (see in the second paragraph of the Findings section). So, the diary was not fully analyzed because of the data inadequacy. Just the sentences on her time with her daughter are utilized in the analysis.

The studies focusing on the interpretation of the SRRS diagram were considered in the examination of the SRRS diagram (Hammoud, 2012; Rocha, 2018). Firstly, the predictions were made according to earlier studies on SRRS, and the statements of Olcay supported the accuracy of the predictions.

The interviews with Olcay were audio-recorded and transcribed literally after the interviews. Camera recordings of the observation and the researcher notes were transcribed literally, and screenshots were taken where necessary. The transcripts of interviews and observations were subjected to content analysis together, and the themes and codes are revealed.

Finally, a recall video was prepared so that the teacher could explain the reasons for her behaviors more clearly. The data obtained from this recall session were also subjected to content analysis.

Findings

The data obtained from the personal information form was used to know Olcay more closely, and it was given in the part where she was introduced. This section presents findings from the semi-structured diary, SRRS diagram, interviews, lesson preparation, lesson observation, and recall interviews. All the data were analyzed together, schemes and themes and proofs of the schemes (codes) were revealed.

Olcay mentioned the mathematics exercises she had done with her daughter in her diary and drew conclusions for herself. Olcay expressed how she had made inferences in her work with her daughter as follows:

> *"My daughter is older than my students, and I noticed that she misunderstood some subjects from the previous years... So, I decided to increase my repetitions and examples about that issue in the class."*

Although Olcay had expressed things so briefly in her diary, she mentioned the subject later in the recall interview. She thought that repetitive examples could prevent misunderstandings. So, she had this theorem-in-action: "(in a different institution outside the classroom) if a misconception is found, extra repetitions should be done to avoid it." and the associated concept-in-action is: "misconception".

Olcay's SRRS diagram is given in Figure 4a and Figure 4b.

Figure 4a

Olcay's Schematic Representation of the Resource System (her original drawing)

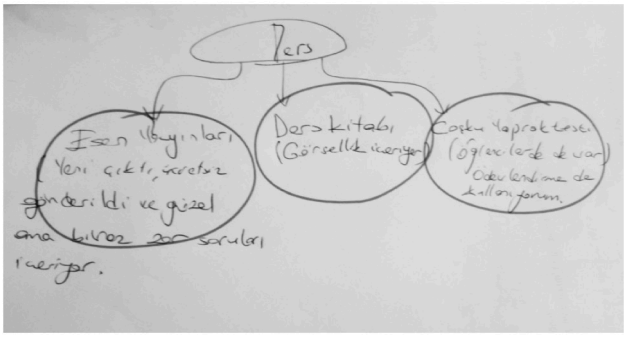
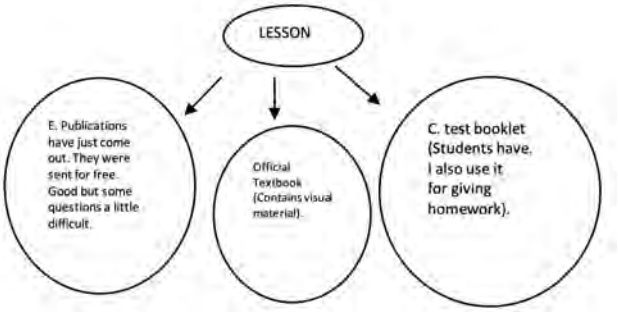


Figure 4b

The reconstructed version of Olcay's SRRS by the researchers



When the SRRS diagram is examined, two schemes are hypothesized. One of them is about the teacher's choice of homework resource. She chooses her homework from the resource that students also have access to, as she wrote in the description above the resource. Her theorem-in-action in this scheme is: "Homework should be given from a shared resource." Her concept-in-action related to the scheme is "equal access to homework resource". She also mentioned in the interview that she cared for equal access to homework in her lesson preparation. Accordingly, in her lesson, she only gave homework from the shared book she mentioned before.

She mentioned in SRRS that she chose some of the resources because they were newly published. Her theorem-in-action in this scheme is "New resources should be used to keep up with changing curricula and systems." The associated concept-in-action is "innovation". She also mentioned this situation in the interview about her resources.

The exam system had a direct effect on the variety of resources that Olcay integrated into her lessons. Considering that the exam system and the inadequacy of the official textbooks affected her choice of resources. She chose resources that would make up for the inadequacy of the official textbook or contain explanations aiming to familiarize students with the types of questions in exams. This shows that she had implemented the instrumentalization process. At the same time, if we were to treat the exams as a resource, we can say that they would greatly affect her teaching schemes. In this respect, since the teacher's adapting herself to the exams also comes into question, it is also possible to observe the instrumentation process.

Although Olcay stressed, in the interviews, that resources were critical in mathematics, she only identified two different resources from the official textbook in the SRRS diagram. Olcay expressed this situation in the following way:

> *"I used to examine every resource available to me, such as official textbooks, webpages, supplementary textbooks and video narrations. As I more or less know the content of those, I pay more attention to the main resources that contain the points I want to explain. These two books are satisfactory for me this year."*

In this statement, another scheme of Olcay can be gathered. She mentioned, "...I pay more attention to the main resources that contain the points I actually want to explain." Her theorem-in-action that constitutes the scheme is "When choosing a resource, the teacher decides according to her teaching method, model and belief."; the associated concept-in-action is "documentation in DAD".

This statement of Olcay also reveals the relationship between the time factor and documentational genesis, which is also included in DAD. Over time, Olcay had eliminated some of the resources, given preference to others, and made decisions thanks to the experience she had gained in this time, showing the effect of the time factor on documentational genesis.

The following statements made by Olcay reveal that she gave importance to making compilations and to using resources containing both easy and difficult questions, as required by the exam system:

> *"...One question from this resource and five questions from that resource...I always collected and composed like that. But this year, I am going through only one resource. I have dealt with two tests in addition. One of those two tests conforms completely with our curriculum. The other contains more selective questions. So, there is no need for me to resort to other resources. C publishing's test booklet is great, aimed at full learning outcomes. The other is A Publishing's intelligent homework test. There are not only multiple-choice questions but also word questions, as well. Filling in the blanks, completing tables... It makes learning more permanent, and there are more selective questions. Frankly, these two resources are sufficient for the students. But as well as these, for example, I ask additional award questions in the class. In addition, I point them towards one or two questions from more difficult textbooks. That is all."*

These comments of Olcay stress the institutional effects included in DAD. Being suitable for the curriculum published by the MoNE is important for Olcay. Besides this, she also wished to assess students with different types of questions. In conclusion, she chooses some of the resources according to the curriculum requirements and selects some of them according to the requirements of the examination system. While the curriculum adopts the constructivist approach and open-ended problems in Turkey, the national exam system comprises multiple-choice questions. This dilemma in the education system is reflected in Olcay's document system. In this case, the teacher's theorem-in-action: "When choosing a resource, both the curriculum and the examination system should be taken into consideration." And the concept-in-action is "The institutional effect in DAD".

It can be seen in Olcay's statements that when planning her teaching, she thought that textbooks including 'word problems, filling in the blanks and completing the tables' helps students' permanent and conceptual learning. Her theorem-in-action is "Word problems, filling in the blanks and completing the tables lead the information to be more permanent." And the related concept-in-action is "conceptual learning".

According to the interviews and the observations, it may also be said that Olcay supported the students in the matter of solving difficult questions by giving extra points. Olcay's associated theorem-in-action is "The resources with difficult questions should be used to reward students." And the concept-in-action is "motivation".

Olcay explained that when selecting and using her resources, she took care to act following the order of the curriculum, with these words:

> *"I include the learning outcomes directly in my lessons. After a topic has been taught, I give extra information where necessary... Let it be beneficial for next year, I say. Especially in the sixth grade."*

Although Olcay stated that she is conformed with the learning outcomes in the curriculum, she also stated that when the learning outcomes were completed, she also taught subjects that would belong to the outcomes of the following year. In this case, she did not avoid including topics outside the schedule because she considered these useful to students in future years. In such a situation, in which her teaching schemes have caused changes to a resource, foreseen as unchangeable like the curriculum, the instrumentation concept manifests itself. Olcay's theorem-in-action for this scheme is "If the part to be told that year is completed, the next year's topic can be told from the previous year." The associated concept-in-action: "Control of the didactic time".

Olcay stated that in choosing her resources, she also paid attention to visual material, as follows:

> *"...the reason why I use them is that there are visuals since we don't have projectors or computers. In the previous years, I used to introduce topics on the computer and show the visuals there. But here, as we don't have computers, I want them to see the visual materials in the books."*

Since the school's physical facilities were not adequate, Olcay, instead of sharing visuals that she could obtain from internet sources, tried to share visual materials included in her textbooks. Besides, both the elements of the concretization scheme of the teacher and the lack of facilities in the institution led to the implementation of concretization via the resources selected by the teacher. This statement of Olcay is important in that it reveals the instrumentation process in DAD. The theorem-in-action of Olcay is "Teachers should use visuals to make students concretize some subjects." The concept-in-action is "concretization".

Olcay explained that in choosing her resources, she preferred resources suited to her conceptions on mathematics teaching, particularly for order of topics, as follows:

> *"I think algebraic expressions should be explained first; then pattern generalization should be taught...In all the resources that I use, algebraic expressions are given first, pattern generalization comes after that. Because students haven't seen it before, when we give them the expression 3n, they cannot convert it into an algebraic expression, so they don't understand the topic."*

Olcay gave the example of the resources she used, and her choosing and adopting of those textbooks among many resources that came to her school shows that she was more prone to use books that were in parallel with her conceptions. Also, she had this scheme about the mathematical topic, that the theorem-in-action is "Algebraic expressions should be taught before pattern generalization." And the associated concept-in-action is: "ground preparation".

Although Olcay had stated in her previous comments that she reflected the learning outcomes in her teaching and that she did not make any changes to them, she admitted that she wanted to make changes in the order of learning outcomes. But she avoided doing so because it would go against the curriculum. Here again, it is possible to mention the institutional effects that are stated in DAD. Although the teacher's professional view was inclined towards changing the order of the learning outcomes, she behaved compliant to the curriculum defined by the institution.

On the other hand, it may be said that Olcay did not follow some of the collective decisions as to the curriculum. The dialogue given below that took place with another math teacher (MT) while Olcay was planning her lessons supports this thought:

> *"MT: In the group meeting, we said that while teaching the patterns, we would proceed as in the official textbook. You can start with this pattern made with matchsticks. I'm going to do it like that.*
>
> *Olcay: The rule for the pattern made with matchsticks is in the form of 2n+5. I think students will find it hard to understand. I think it would be better to start with patterns like 2n, 3n and 5n first.*
>
> *MT: Yes, that is easier but aren't we keeping to the textbook?*
>
> *Olcay: I'll follow it but not in the same order. I'll give the examples in the other books first. Then I'll move on to the official textbook."*

It may be said that for Olcay, the group effects stated in DAD are less effective than the institutional effects. Also, she has the scheme that the theorem-in-action is "First, the patterns in the multiplication form (2n, 3n) should be taught, then, the patterns that include plus form (2n+5) should be taught." The related concept-in-action is: "from easy to hard". In the lesson, she also warned the students to start from the examples she presented in the class and then wanted them to move on to the official textbook. Relying on her experience, she stressed the importance of proceeding in a definite order from easy to hard according to the topic she was to teach. She acted in the way she stated in her lessons:

> *"... We're already going to explain number patterns. Straight after this, I'll draw a table and the step number with the number corresponding to that step and have them discover how to find the rule. I'm planning to start with number patterns and then proceed to shape patterns. Then, I'll give problems that don't require a fixed term, followed by problems that require a fixed term. I did it as in the previous years because students would not understand in another way."*

Olcay planned her lessons based on her experience in a way from easy to difficult. Here, she also expressed the situation stated in the previous dialogue; she will shape her teaching according to her professional

viewpoint despite the mutual decisions. The easy-to-difficult principle possessed by Olcay affected her resource selection. Here, as she stated that she selected her resources according to her schemes, the instrumentalization process may be mentioned.

Resource sharing of Olcay was not the result of a decision made by herself, but rather due to the mutual decision, she made with her colleagues. However, in the case of those who do not want to use the resource they decided collectively, the teacher decides to use resources in the classroom.

> *"...If one student does not want it, I cannot use it in class. It is already forbidden. Even if I wish to share and use them in my lesson, I cannot show them in class. They may complain, or even if the administration sees it, there would be a problem. So, if there is a book I like, I examine it before and relate to the class in this way, or if I have to bring it to the class, I cover it in a way that the students can't see it."*

Even during the research, when Olcay stated her resources, she requested that books and websites be kept secret in particular. Even this reveals how powerful the institutional effect on the teacher is. The scheme associated with this situation becomes clear with the theorem-in-action "If there is a possibility that sanctions can be imposed on teacher's career by the institution, the use of the resource in the classroom can be put into the second plan." and the concept-in-action "institution rules".

Olcay stated that when she gave problems from the shared resources for homework, she solved them again in the class to make sure that they had been correctly solved:

> *"We give some of them for homework, and we also solve most of them in the class. Even if we give homework, we solve them again in class to check."*

These statements show that Olcay is sensitive about giving feedback. Here, the scheme is associated with the theorem-in-action "The problems in the assignment must be solved correctly." and concept-in-action "joint correction".

During the lesson, Olcay proceeded as she had planned. However, in some parts of the lesson, she diverged from her plan, solved additional examples, and gave additional explanations. She explained the reason for this as follows:

> *"...In the class, if we had given only one example as in the plan, n wouldn't have understood. As I was unsure whether they would find it, I felt the need to give a second example, to say that n is a variable, a representative number, the term sought. So n may be 15 or 50. A representative number. I wanted to stress that we are showing the number of steps. We even put an asterisk and wrote an explanation about that."*

Olcay described that the implementations she carried out in the lesson were different from her plan as she revised instantly in the lesson according to the students' level of understanding. Here, Olcay updated her documentation by adding new examples to her teaching. Her changes or arrangements to the resources that she used according to the students' level of understanding constitute an example of the instrumentalization process in this case. The teacher's scheme is associated with the theorem-in-action: "Course content should be based on class level." The concept-in-action is "Adaptation to the class".

Conclusion and Discussion

The schemes can be discussed as internal (particular to the teacher) and external schemes (such as institutional factors). The internal schemes particular to the teacher include schemes such as the teacher's content knowledge, pedagogical content knowledge, and acting by some approaches like easy-to-hard when organizing the lessons. The internal schemes particular to the teacher may be said to show similarity with the factors revealed by Gueudet and Trouche (2009b). However, differences were observed in external schemes like institutional factors and effects of the exam system.

In the study conducted by Pepin, Gueudet and Trouche (2013) related to sharing of resources by teachers, it was stated that teachers especially shared resources with their colleagues. In their study, the researchers revealed that the teacher shared resources with math teachers and physics teachers. She selected exercises that would also be suitable for physics lessons in structuring her lessons. There is no such evidence that Olcay shares resources with different branches in this study, but she shares resources with her colleagues.

As for the scheme related to documentation, there are also studies conducted in the literature about the teachers' selection of resources and classroom practices according to their beliefs and teaching methods (Shaw et al., 2008; İlter, 2018). Shaw et al. (2008) mentioned, in their study, that teachers' practices and the resources they use reflect the beliefs they have about teaching the course.

In the scheme related to the didactic time, it is mentioned in the literature that the teacher keeps the didactic time under control. In the literature, it is stated that especially experienced teachers tend to keep didactic time under control so that students can understand efficiently. Sometimes, they move on to the subjects of the following year (Maurice & Allégre, 2002; Calmettes, 2007). Chevallard (1985) has imposed a godlike character on them, considering that teachers can accurately predict students' understanding periods and the didactic time to be given to a subject (Margolinas, 2002).

The teacher's behavior, similar to the scheme obtained concerning concretization, has also been reported in the literature (Danesi, 2007; Presmeg, 2006; Presmeg, 2008; Usta et al., 2018; Rösken & Rolka, 2006). Danesi (2007), in his theoretical framework on conceptual metaphors, stated that teachers and students tend to concretize verbally given abstract mathematical issues to understand them. He reported that they did this by drawing the data of the given problem, trying to visualize it and making it into an equation. Similarly, Polya (1957, p.174) also emphasized concretization by expressing the path needed to solve a problem as "translating from one language into another".

According to students' level, the scheme of Olcay to structure the lesson is also reported in the literature (Dursun & Dede, 2004). Cohen et al. (2003) mentioned in their study that teachers consider the students' level of learning to make instant arrangements on the lesson plans.

Solving the problems that were given as homework and the wish to be sure the students give the right answer is also mentioned in the literature as a factor that should be considered while giving homework (Ilgar, 2005; Korkmaz, 2004; Schmitz & Baumert, 2002; Turkoglu et al., 2007). Turkoglu et al. (2007) mentioned homework correction techniques in their studies. One of the most important of these techniques is the common correction technique Olcay adopted.

The scheme about using new resources to adapt to changing curriculums and follow innovations is similar to Ozmantar et al.'s (2009) studies, and it is similar to the finding that change in curriculum necessitates a change in the classroom norms.

The institutional effects can be discussed in two aspects. The first one is seen as an element that affects kneading the resources during documentational genesis. In the second, it is seen as an element that interrupts this process. In the first case, it is possible to use resources appropriate for both approaches to eliminate the problems arising from the difference between the curriculum and the national exam system. In the second case, if the resource used will affect the teacher's career negatively by the institution, the use of the resource will be restricted.

Similarly, in the study of Butlen and Vannier (2010), determining the course content appropriate to the curriculum and exam system is regarded as respecting the student's rights for the teacher. It is considered the pressure by the institution. However, it affects the teacher's development of the document system. Similar to the second institutional effect mentioned, a study was conducted at the university level and discussed the impact of the changes in the exam system on the content of the exams (Gueudet & Lebaud, 2008). Although this study is related to the exams, the effect of the institution that limits the content and duration of the exam is more appropriate to the second situation.

Although it differs among schools, it is advised by the school administrators not to recommend any resources to students. It may be attributed to the fact that some students can easily access the resource, and some will not if there is a financial difference among the students in the school. However, the effects of this prohibition at school were observed once again because Olcay hesitated to share the resources with the researcher. It is also notable that the stress experienced by Olcay is also one of the reasons for the teachers' occupational stress and burnout in the psychology literature (Dinham, 1993; Kyriacou, 2001; Louden, 1987; Punch & Tuetteman, 1996; Pithers & Soden, 1999).

Examining the research by Gueudet and Trouche (2009b), it can be seen that the teachers filled in their diaries in the way that was explained to them. Yet, in this study, Olcay filled in her diary similarly to the class notebook she used in the class. Although Olcay included the developing experiences that she considered mathematical in her diary, these sections made up only a small part of her full diary. It is hypothesized that the semi-structured diary given to the teacher reminded her of the schools' class notebook in form. Such a situation did not arise in other studies examining documentational genesis because class notebook concepts did not exist. Even if there were such concepts, they did not resemble the diary in form. Moreover, it was reported in the literature that in the use of a diary as a data collection tool, people had difficulty expressing themselves in a diary in writing (Bolger et al.,2003).

Unlike Gueudet and Trouche's (2009b) research, the participant teacher stated rather few resources in her SRRS diagram. In Gueudet and Trouche's study, the teachers also included internet sources in their SRRS diagrams. Yet, in this research, Olcay did not show these in her SRRS diagram, despite stating that internet resources influenced her lessons in the interview. This situation may be interpreted as although Olcay examined internet resources, she did not regard them as a basic resource influencing her lessons this year. Also, such a concept as "resource book" in Turkey may influence the teacher to mention only the resources in the textbook format in her SRRS diagram. In addition, in the literature, when the resource is mentioned, besides the other meanings of the resource, some studies take the books as the "classic and the usual" version of resources (Drijvers et al., 2013, Maschietto & Soury-Lavergne, 2013; Ruthven, 2013).

Furthermore, when representing her resources in the diagram, Olcay used arrows led from the lesson to the

resources. But, she stated during the interviews that she had tried to explain that the resources and the lesson have a mutual effect on this representation. (Hammoud, 2012; Rocha, 2018). Also, she placed the lesson in the center of the diagram. It may because she considered the lesson itself as the main resource.

In Turkey, there are many schools with different views regarding resource sharing. This situation caused a conflict between the internal and external schemes possessed by Olcay. In France, where the Authors carried out their study, there isn't such an exam system in Turkey, which may be why factors related to the exam system differed. It can be said that the national exam, which the students were expected to do well in at the end of middle school, considerably affected Olcay's documentational genesis process.

Recommendations for Further Researches

It was observed during the research that teachers were worn out between the curriculum and the exam system. While the approach adopted in the curriculum was process-oriented, the evaluation method was result-oriented, which was an important factor in creating a dilemma for the teachers. For this reason, it is suggested that a study should be conducted to determine how teachers manage the items that are compatible and incompatible with the curriculum and the exam system in future studies and how these differences affect the process of the documentational genesis.

Considering that teachers draw on their previous experience and the questions that have been used in exams from the previous years, it may be said that the exam questions also have the characteristic of being a resource for teachers. In this study, the documentational genesis processes of teachers were examined in the case in which the curriculum outcomes and the exam system did not match. It is considered that it may be important to carry out studies that demonstrate how resources from the national exam system affect the documentational genesis process in matching with the outcomes of the curriculum.

Moreover, if a diary is to be used in the studies carried out with teachers in the Turkey sample, the design of the semi-structured diary should be different as much as possible from the class notebook. In this way, the negative situation that arose in this study can be avoided, and more productive data can be collected from the diaries. The literature also recommended that the information given to teachers about diaries should be detailed, and the diaries should be checked at every stage (Bolger et al., 2003).

For closer and more detailed analyses of the documentational genesis process, longitudinal qualitative studies can be held. Also, this study was conducted with only one teacher. With the increase in the number of such studies, different situations and schemes can be seen, or various situations can be identified that show similar schemes.

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