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An Investigation of Mathematics Teachers' Conceptions of Mathematical Literacy Related to Participation in a Web-Based PISA Course

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Abstract

In today's mathematics education, teachers are expected to have a sufficient understanding of mathematical literacy and to know how to incorporate mathematical literacy understanding into their instructional practices. Therefore, the purpose of this study was to investigate mathematics teachers' conceptions of mathematical literacy related to participation in a web-based learning environment about mathematical literacy and Programme for International Student Assessment (PISA). The case study method was used and the participants consisted of 20 mathematics teachers determined by the criterion sampling method. The data were collected by semi-structured interviews. In the data analysis process, content analysis was used. The results revealed that the participants who participated in the web-based PISA course conceptualized mathematical literacy in relation to the use of mathematical knowledge and skills to deal with real-life problems and associated supporting mathematical literacy with supporting the development of problem-solving skills. However, the others conceptualized mathematical literacy as having mathematical knowledge and skills to solve math problems and considered problem solving as a goal in supporting mathematical literacy.

Keywords: Mathematical literacy, conception of mathematical literacy, web-based PISA course, mathematics teacher

Matematik Öğretmenlerinin Matematik Okuryazarlığını Kavrayışlarının Bir Web Tabanlı PISA Eğitimine Katılımları Açısından İncelenmesi

Öz

Günümüz matematik eğitiminde öğretmenlerden yeterli matematik okuryazarlığı anlayışına sahip olmaları ve matematik okuryazarlığı anlayışını öğretim uygulamalarına nasıl entegre edeceklerini bilmeleri beklenmektedir. Bu bağlamda, bu araştırmada matematik öğretmenlerinin matematik okuryazarlığı kavrayışlarının, araştırmacılar tarafından matematik okuryazarlığı ve Uluslararası Öğrenci Değerlendirme Programı'na (PISA) ilişkin olarak desenlenmiş web tabanlı eğitime katılımları açısından incelenmesi amaçlanmaktadır. Bu amaç doğrultusunda araştırma nitel olarak desenlenmiş ve durum çalışması yöntemi benimsenmiştir. Araştırmanın katılımcıları ölçüt örnekleme yöntemi ile belirlenen 20 matematik öğretmeninden oluşmuştur. Araştırma verileri yarı-yapılandırılmış görüşmeler yoluyla toplanmış, veri analizi sürecinde ise içerik analizi yöntemi benimsenmiştir. Araştırma sonucunda, web-tabanlı öğrenme ortamını kullanan katılımcıların matematik okuryazarlığı kavramını günlük yaşamda karşılaşılan sorunların çözümünde matematiksel bilgi ve becerilerin işe koşulması ile ilişkili olarak ele aldıkları ve matematik okuryazarlığı gelişimini matematiksel düşünme becerisi gelişimi ile ilişkilendirdikleri görülmüştür. Diğer yandan, söz konusu öğrenme ortamını kullanmayan matematik öğretmenlerinin matematik okuryazarlığı kavramını matematiksel problemleri çözebilmek için bilgi ve beceri sahibi olmak şeklinde anlamlandırdıkları ve matematik okuryazarlığı gelişiminde matematiksel problem çözmeyi bir amaç olarak ele aldıkları sonucuna ulaşılmıştır.

Anahtar kelimeler: Matematik okuryazarlığı, matematik okuryazarlığı kavrayışı, web tabanlı PISA eğitimi, matematik öğretmeni

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INTRODUCTION

Today, the development levels of countries are associated with many factors such as economic structure, speed of producing and using knowledge, educational opportunities and the number of qualified individuals. In this context, in order to survive in global competition, countries need literate individuals who have the knowledge and skills required by the century and who can actively employ their knowledge and skills in daily life. Thus, the Organization for Economic Co-operation and Development (OECD) (2018) emphasized that countries need mathematically literate citizens in order to develop or sustain development. In this direction, in today's mathematics education, the ultimate goal is to raise mathematically literate individuals. According to Marciniak (2015), the purpose and expected outcome of mathematics teaching is mathematical literacy. It is thus essential that instruction in schools must be significantly revised so that students can have rich experiences to understand the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective 21st century citizens (OECD, 2018).

There are different interpretations or definitions of the concept of mathematical literacy. In this context, while some definitions revolve around basic mathematical skills (e.g., McCrone & Dossey, 2007; Powell & Anderson, 2007), others also incorporate higher order thinking skills (e.g., Hope, 2007; Jablonka, 2003). For instance, Jablonka (2003) argued that mathematical literacy can be considered as "the ability to use basic computational and geometrical skills in everyday contexts, as the knowledge and understanding of fundamental mathematical notions" (p. 76). On the other hand, McCrone and Dossey (2007) defined this concept as the capacity to understand the role of mathematics in daily life and to use mathematics to solve real-life problems. Regarding the different definitions of the concept of mathematical literacy, Madongo (2007) stated that the definitions provided in the literature link the idea of mathematical literacy to how mathematics should be used in real life situations.

It is known that mathematics teachers are one of the most important factors of mathematical literacy development. Martin (2007) stated that mathematics teachers and their educational practices play an important role in students' ability to use their mathematical knowledge to make sense of the world. Similarly, Milton, Rohl and House (2007) draw attention to the expectation from teachers to know how to incorporate mathematical literacy understanding into their instructional practices when and where necessary. As teachers' knowledge and instructional practices significantly influence mathematical literacy development, it is very important for teachers to be able to make sense of the concept of mathematical literacy (Genc & Erbas, 2019). Jamil and Khusna (2020) emphasized that mathematics teachers must have a good conception of mathematical literacy so that they can use right learning strategies.

An overview of the literature on mathematical literacy showed that there is increasing concern about how mathematics teachers conceive or understand mathematical literacy. Among these studies, Genc and Erbas (2019) investigated Turkish secondary mathematics teachers' conceptions of nature of mathematical literacy. They obtained seven different categories regarding participating mathematics teachers' conceptions of mathematical literacy: possession of mathematical knowledge and skills; functional mathematics; problem solving; mathematical thinking, reasoning and argumentation; innate mathematical ability; conceptual understanding; and motivation to learn mathematics. In another study, Boričić, Vulić and Videnović (2020) examined Serbian mathematics teachers' conceptions of mathematical literacy. The researchers examined teachers' description of mathematical literacy and their views of the assessment of mathematical knowledge. The results revealed four conceptions of mathematical literacy: knowledge about basic mathematical concepts (main formulas, operations, geometry objects, etc.); correct use of mathematical symbolism; use of mathematics in everyday situations; and developing a specific way of thinking. Lestari, Juniati and Suwarsono (2017) examined mathematical literacy conception of junior high school mathematics teachers in Indonesia. The results revealed that teachers had the conception that mathematical literacy was associated with problem solving using high-level issues and required higher order thinking skills.

Considering the significance of ensuring opportunities for all students to become mathematically literate, it is an important issue to examine how teachers from primary to high school make sense and perceive mathematical literacy. Besides, investigating teachers' conceptions is important in terms of supporting their professional development for implementing instructional strategies for development of mathematical literacy (Genc & Erbas, 2019). Indeed, Goos, Geiger and Dole (2014) emphasized that understanding teachers' conceptions of mathematical literacy provides insights into why teachers make particular instructional decisions regarding mathematical literacy. However, limited research has focused on middle and secondary school mathematics teachers' conceptions of mathematical literacy and development of mathematical literacy.

Accordingly, a web-based learning environment was designed by the researchers in order to inform mathematics teachers about mathematical literacy, PISA international assessment, and ways to promote students' mathematical literacy. Therefore, the purpose of this study was to investigate the conceptions of mathematical literacy held by mathematics teachers who participated in the web-based PISA course offered as part of the current research and those who did not.

Research Questions

To achieve this overarching goal, we focused on the following research questions:

1.What are mathematics teachers' conceptions of mathematical literacy?

2.What are mathematics teachers' conceptions of development of mathematical literacy?

3.What is the effect of the web-based PISA course on mathematics teachers' conceptions of mathematical literacy?

METHOD

This study aimed to investigate the effect of a web-based PISA course on mathematics teachers' conceptions of mathematical literacy. Accordingly, case study was used. Case study research helps the researcher to analyze and understand a phenomenon related to a specific group of people (Baxter & Jack, 2008; Bogdan & Biklen, 2007).

The Web-Based PISA Course

The web-based PISA course was designed by the researchers to inform mathematics teachers about mathematical literacy, PISA international assessment and how to promote students' mathematical literacy skills. The web-based PISA course consisted of three modules: i) theoretical knowledge module, ii) supporting mathematical literacy module and iii) PISA-like problem-posing module. The content of the web-based PISA course is presented in Figure 1. Registered mathematics teachers were able to access the content of the modules for 24 months.

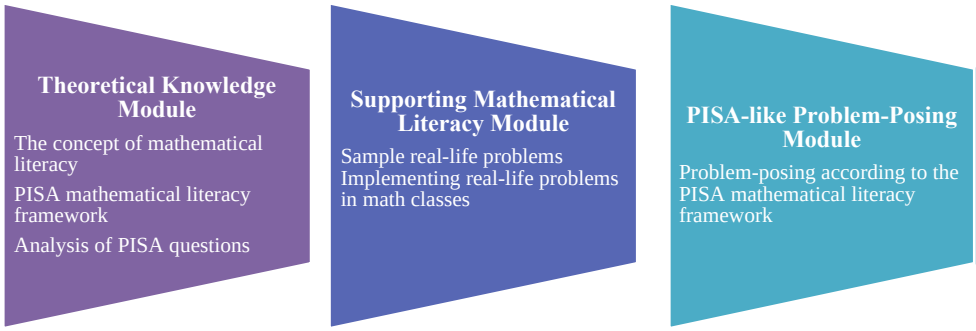

Figure 1. *Content of the Web-based PISA Course*

As seen in Figure 1, the theoretical knowledge module aimed to provide mathematics teachers with basic knowledge about mathematical literacy and PISA. Thus, the content of this module was the concept of mathematical literacy, PISA international assessment and PISA mathematical literacy framework. Besides, some PISA released items were analyzed in terms of mathematical processes and the underlying mathematical capabilities. Here, the reports related to PISA assessment and analytical framework published by the OECD formed the basis for the creation of the content.

In the supporting mathematical literacy module, it was aimed to provide teachers with knowledge about supporting mathematical literacy in mathematics learning environments. In other words, it was aimed to make teachers comprehend the relationship between fundamental mathematical capabilities and supporting them in a learning environment. Thus, sample real-life problems that were developed by the researchers and that can be used in order to support mathematical literacy development were presented. Besides, sample implementations of real-life problems in mathematics classes were also presented. The content of this module was prepared based on the results of the studies carried out by the researchers about designing and implementing real-life problems.

The PISA-like problem-posing module aimed to guide mathematics teachers to pose PISA-like problems gradually by using the components of the PISA mathematical literacy framework. In this module, online support was also provided for teachers.

Study Setting and Participants

The web-based learning environment has been made available with an introductory meeting, which was held in a conference room of the faculty that the researcher (first author) works in. A total of 126 middle and high school mathematics teachers working in Eskisehir central districts attended the meeting. The introductory meeting, which lasted about three hours, was held in the form of a workshop on mathematical literacy. The aim was to inform mathematics teachers about PISA international assessment and PISA mathematical literacy framework. During the meeting, information about the school in which the teachers work, their contact information and their willingness to participate in future studies that will be conducted by the researchers were also collected through a form. The participants of the study were 20 mathematics teachers (As shown in Table 1) who were selected through criterion sampling method. The selection criterion was registering for the web-based learning environment. By this way, 10 mathematics teachers who were registered for the web-based learning environment and 10 mathematics teachers who were not registered participated in the study.

Table 1. Characteristics of the Participants

Name	Gender	Graduation	Type of school	Teaching experience (years)	Registration
P1	Male	Faculty of Education	Middle school	14	Not yet
P2	Male	Faculty of Education	Middle school	17	Not yet
P3	Female	Faculty of Science	Middle school	20	Not yet
P4	Female	Faculty of Education	Middle school	1	Not yet
P5	Male	Faculty of Science	High school	7	Not yet
P6	Female	Faculty of Science	High school	3	Not yet
P7	Male	Faculty of Education	Middle school	10	Not yet
P8	Male	Faculty of Science	High school	4	Not yet
P9	Female	Faculty of Education	Middle school	1	Not yet
P10	Female	Faculty of Education	Middle school	2	Not yet
P11	Female	Faculty of Science	High school	8	Registered
P12	Female	Faculty of Education	Middle school	10	Registered
P13	Female	Faculty of Education	Middle school	16	Registered
P14	Female	Faculty of Science	High school	12	Registered
P15	Female	Faculty of Education	Middle school	12	Registered
P16	Female	Faculty of Science	Middle school	5	Registered
P17	Female	Faculty of Education	Middle school	8	Registered
P18	Female	Faculty of Education	Middle school	14	Registered
P19	Female	Faculty of Education	Middle school	14	Registered
P20	Female	Faculty of Education	Middle school	12	Registered

As shown in Table 1, all the registered participants were female and they had at least five years of teaching experience. On the other hand, teaching experience of the participants who were not registered varied from one to 20 years and most of them were working in a middle school.

Data Collection

In the data collection phase, semi-structured interviews were conducted with the participants. The interviews were conducted nearly four months after the introductory meeting. The mathematics teachers who registered for the web-based learning environment had accessed all module contents within the specified period. A voice recorder was used to record the interviews and each interview lasted nearly 30 minutes. The content of the semi-structured interview form and sample questions are presented in Table 2.

Table 2. Content of the Semi-structured Interview Form and Sample Questions

Section	Content of Section	Sample Questions
1	Questions to examine mathematics teachers' conceptions of the concept of mathematical literacy	-What is mathematical literacy? -What are the skills and/or competencies that a mathematically literate individual should have?
2	Questions to examine mathematics teachers' conceptions of development of mathematical literacy	-What are the roles of mathematics teachers in supporting mathematical literacy? - What are the knowledge, skills and/or competencies that a teacher should have to support mathematical literacy? - Do you think you have received good education to support mathematical literacy? Why/Why not?

A pilot study was also conducted with a voluntary middle school mathematics teacher, who was not involved in the main study. Thus, the clarity and comprehensibility of the semi-structured interview questions were assessed. In line with the teacher's views obtained in this process, the wording and sequence of some questions were updated and the interview form was put into its final form.

Data Analysis

The data of the present study were analyzed by employing content analysis method (Creswell, 2014). In this regard, detailed readings were repeated on the previously transcribed data. In this way, the final codes were identified and re-organized based on the codes created in the first readings of the data. Then, these codes were organized around meaningful categories and themes. Besides, the reliability analysis was carried out with an expert who has a doctoral degree in mathematics education. The expert worked on written transcripts of five participants determined randomly and conducted a study to assign codes and categories. Here, the ratio of the number of agreements to the sum of the number of agreements and disagreements was used as a measure of inter-rater reliability (Miles & Huberman, 1994). The comparison of the two coding outcomes showed 90% agreement, which was strong enough. The raters resolved all disagreements and revised the code definitions until a full agreement was reached for the categories and conferred thoroughness and credibility of the data analysis. Finally, the categories were interpreted in accordance with the purpose of the study.

Research Ethics

The data collection phase of this study was approved ethically in accordance with the decision taken at the meeting of Anadolu University Social and Human Sciences Ethics Committee, dated 19.06.2018 and numbered 64753.

FINDINGS

Regarding the participants' conceptions of mathematical literacy, two main themes and five categories were identified (As shown in Table 3).

Table 3. Teachers' Conception of Mathematical Literacy

Theme	Category	Sub-category	Registered	Not Registered	Total
The concept of mathematical literacy	Functional mathematics	-	10	4	14
	Solving math problems	-	-	6	6
Developing mathematical literacy	Teacher role	Teaching with problem solving	10	2	12
		Teaching for problem solving	-	4	4
		Supporting positive changes in affective characteristics	5	4	9
	Shortcomings in development of mathematical literacy	Lack of knowledge about mathematical literacy	10	10	20
		Negative effect of transition exams between educational levels	6	-	6
		Crowded classrooms and time constraint	2	4	6
	Expectations	Pedagogical support about classroom practices	10	2	12
		Pedagogical support about posing and solving new generation math problems	-	6	6

Findings Related to Participants' Conceptions of the Concept of Mathematical Literacy

Mathematical Literacy as Functional Mathematics

In the semi-structured interviews, the question of "What is the meaning of the term 'mathematical literacy'?" was directed first in order to determine the participants' conceptions regarding what the concept of mathematical literacy means. It was observed that all of the participants who registered for the web-based learning environment were able to provide explanations about using mathematical knowledge to solve problems encountered in daily life. For instance, P11 stated that "Mathematical literacy means to be able to see how mathematical knowledge can be used in daily life or to integrate mathematics with real life" and it reflected that she could associate the concept of mathematical literacy with the use of mathematics functional. Besides, four out of 10 participants who were not registered for the web-based learning environment were also able to provide explanations emphasizing the relationship between mathematics and real life. It was noteworthy that two of these

participants had at least 17 years of teaching experience, while the other two took an undergraduate course on mathematical literacy. For instance, the following expression of P3 reflected that her conception of the concept of mathematical literacy was using mathematics in daily life activities, "Mathematical literacy means associating the problems that we encounter in daily life with mathematical processes...".

Next, the participants' views about the importance of mathematical literacy were explored. All participants who registered for the web-based learning environment emphasized that mathematical literacy allows students to develop their problem-solving skills. For instance, one of these participants explained that "Mathematically literate individuals are the ones with advanced problem-solving skills" (P19). Another participant stated that "A mathematically literate individual can use his/her mathematical knowledge in daily life, think practically, and establish a cause and effect relationship" (P12). In a similar way, it was observed that four participants who were not registered for the web-based learning environment reflected that to be mathematically literate requires skills such as practical and versatile thinking. One of these participants stated that "A mathematically literate individual is the one who can think practically and make quick decisions" (P3). Another participant stated that "Mathematically literate individuals are the ones who have different perspectives and versatile thinking skill" (P9).

When it comes to their views about PISA international assessment, it was seen that all participants who registered for the web-based learning environment were knowledgeable about the purpose, assessment areas and target population of PISA. Inquiries regarding how they acquired knowledge about PISA indicated the informative nature of web-based PISA course modules. For instance, P11 reflected on the knowledge that she acquired from the modules as, "My source of knowledge is PISA training modules. I have learned a lot from the modules".

Mathematical Literacy as Solving Math Problems

The findings from the semi-structured interviews revealed that six out of 10 participants, who were not registered for the web-based learning environment, had the conception that mathematical literacy was associated with solving math problems. These participants thought that the concept of mathematical literacy means being able to understand a math problem and present a mathematical solution. One of these participants stated that it refers to "… a student's ability to understand and solve a math problem correctly" (P6). Similarly, another participant stated that "Mathematical literacy is being able to read a problem, interpret it, and then present a solution" (P5). In line with the aforementioned conception of mathematical literacy, these six participants emphasized that mathematical literacy is very important to improve students' academic success in mathematics. For instance, one of these participants stated that "As mathematical literacy improves, students' mathematics success and our country's PISA success ranking will increase" (P1). Similarly, P10 said, "I think the high school entrance exam, which includes skill-based math questions, has increased the importance of mathematical literacy even more. I believe that mathematical literacy provides the students with success in this exam".

Another remarkable finding is that all the participants, who were not registered for the web-based learning environment, did not have enough knowledge about PISA. Besides, it was seen that two of these participants acquired knowledge from sources such as daily news or social media platforms. For instance, P7 stated that: "I read in newspapers. It is a subject that we do not have much knowledge about. We always think about what we can do for the transition examinations. But a different perspective is needed. Therefore, I can say that I researched about mathematical literacy myself".

Findings Related to Participants' Conceptions of Developing Mathematical Literacy

Teaching with Problem Solving

In order to examine the participants' conceptions of development of mathematical literacy, the question of "What are the roles of mathematics teachers in mathematical literacy development?" was directed. All of the participants who registered for the web-based learning environment thought that mathematical problem solving is a tool for raising mathematically literate individuals. Accordingly, they emphasized the use of real-life situations in mathematics learning process and the adoption of realistic context-based teaching methods. For instance, P14 stated that "...content that reflects students' own lives can be shown and the method of realistic mathematics education can be used". Thus, it clearly highlights the role of teachers as designing real-life problem solving environments. Here, it can be thought that the developing mathematical literacy module and PISA-like problem-posing module play a supporting role in the development of teachers' understanding of the developing mathematical literacy. Similarly, it was observed that two out of four participants who were not registered for the web-based learning environment and whose conception of the concept of mathematical literacy was using mathematics in daily life, had a similar view about the role of teachers. For instance, one of these participants stated that "If students learn mathematics in everyday contexts, their mathematical literacy improves" (P3).

Teaching for Problem Solving

The findings from the semi-structured interviews revealed that four out of six participants who were not registered for the web-based learning environment and whose conception of the concept of mathematical literacy was solving math problems, considered problem solving as a goal for raising mathematically literate individuals. Accordingly, these participants pointed out the importance of supporting reading comprehension and procedural skills. Some sample views are as follows.

P5: It should be ensured that students understand and explain the problem situation and their procedural skills should be supported. Besides, plenty of problems should be solved.

P1: The new generation problems should be introduced to students and they should be able to understand and interpret such questions. At this point, group work should be done and classroom discussions should be created.

Supporting Positive Changes in Affective Characteristics

In addition to the teacher roles described above, nine participants regardless of using the web-based learning environment, pointed out the importance of mathematics interest and mathematics self-concept. They explained the role of teachers as supporting positive changes in students' affective characteristics related to mathematics. For instance, one of these participants (P11) stated that teachers should make students enjoy mathematics. Similarly, another participant (P13) stated that interest in learning mathematics should be encouraged among students.

Shortcomings in Development of Mathematical Literacy

Following their explanations about teacher role in mathematical literacy development, the participants were asked to make a self-assessment of their ability to support their own students' mathematical literacy. In this context, almost all of the participants (19 out of 20) found themselves partially sufficient to support their students. Only one participant stated that he did not find himself sufficient. At this point, almost all of the participants said that they did not receive education emphasizing mathematical literacy in pre-service or in-service periods. For instance, P19 stated, "What should we do, how should we approach, what kind of environment should we provide in order to improve mathematical literacy? I have not received any training on these subjects". Similarly, P11 stated that "There should be different environments, different opportunities, but I think my lacking in this subject is due to the shortcomings of my undergraduate education".

On the other hand, six participants who think that mathematical literacy can be supported in learning environments where realistic context-based teaching methods are adopted, stated that the transition examinations between educational grades (e.g., Transition from Primary Education to Secondary Education Examination) held in Turkey until 2018 were not prepared for the assessment of students' mathematical literacy and that mainly exam-oriented educational activities were carried out. Accordingly, the participants draw attention to the negative effect of this situation on their teaching approaches. One of these participants said that "I think that our lessons are exam-oriented, the lessons are not designed in accordance with constructivist approach or mathematical literacy. Everyone worries about just achieving the learning objectives in the curriculum somehow…". Similarly, P18 said "We are in a system and we are trying to keep up with it. When we talk about mathematics lessons, we say either constructivism, we have problems in designing the lessons accordingly".

In addition to the shortcomings associated with mathematics teachers and the negative effect of the transition examinations, crowded classrooms and time constraints have been identified as another shortcoming in mathematical literacy development. In this context, six participants thought that the crowding in the classroom learning environments negatively affects implementation of teaching strategies emphasizing mathematical literacy development. In other words, these participants stated that real-life problem solving or skill-based problem solving studies require quite a long time. Thus, they emphasized that they all require additional time to provide individualized attention and support to each student. Some sample views are as follows.

P19: … problem solving processes should be used effectively. For this, class sizes should be small. However, our class sizes are big and we do not have enough time.

P15: Developing mathematical literacy is not an easy process, class sizes should be small because every child's level is different.

Expectations

Following the participants' explanations about shortcomings in development of mathematical literacy, all of the participants expressed their expectations of in-service trainings which will be organized by the Ministry of National Education and which is based on practice. In this context, as explained in detail above, 12 participants

who emphasized the importance of learning environments designed for solving real-life problems, emphasized the need for pedagogical support about classroom practices. Some sample views are presented below.

> P18: Mathematical literacy should be addressed through exemplary lessons, in other words, what the teacher is doing, how the students participate in the lesson, we can watch, and it should be a training that allows us to understand.
>
> P15: I expect a training in which we can understand the cognitive processes of students while being alone with real problems.
>
> P19: How can we ensure that students use these processes effectively? I can say that I really need in-service training on this subject.

The expectations of the remaining participants for in-service training to be organized by the Ministry of National Education were related to posing or solving skill-based math problems. For instance, one of these participants expressed that "It would be better if there are skill-based problem posing trainings or skill-based problem solving trainings" (P1). Another participant stated that "There can be a training on how to solve new generation problems" (P8). Finally, all of the participants thought that participating in the above-mentioned in-service trainings for mathematical literacy development and transferring their knowledge to students will have a positive effect on their motivation. However, five participants using the web-based learning environment emphasized the need for similar studies or projects, drawing attention to the fact that the web-based learning environment was highly motivating for them. For instance, P16 stated that “Designing such a learning environment obviously encouraged and motivated me a lot. Such projects should be increased”.

DISCUSSION & CONCLUSION

Considering the importance of mathematical literacy in the 21st-century information societies and the role of mathematics teachers in raising a mathematically literate society, in this study it was aimed to investigate the conceptions of mathematical literacy held by mathematics teachers who participated in the web-based PISA course offered as part of the current research and those who did not. As a result of the study, it was found that participating mathematics teachers' conceptions of mathematical literacy involved two central dimensions, which were functional mathematics and solving mathematics problems. All the teachers who participated in the web-based PISA course conceptualized mathematical literacy as functional mathematics. That is to say, according to these participating teachers, mathematical literacy is the use of mathematical knowledge and skills functionally to deal with real-life problems. Here, mathematics teachers’ conceptions of mathematical literacy were similar to the category of ‘functional/useful mathematics’ which is explained in the study of Genç and Erbaş (2019). However, these researchers emphasized both knowledge of mathematics which is used functionally in societal life and functional use of mathematics in occupational or professional life in this category. On the other hand, these teachers also associated the development of mathematical literacy with the development of real-life problem-solving skills. In other words, these participating mathematics teachers considered mathematical problem solving as a tool in the development of mathematical literacy and pointed out the importance of teaching with a problem-solving approach. This result showed that the web-based PISA course supported mathematics teachers to develop an understanding of mathematical literacy as informal mathematics involving basic mathematical knowledge and skills which enable people to tackle everyday life problems (McCrone & Dossey, 2007; Powell & Anderson, 2007). In addition to this, Jablonka (2003) stated that conceptualization of mathematical literacy as conducting mathematical thinking processes in solving problems encountered in daily life helps to create predisposition towards seeing the world through mathematical eyes. It is also known that development of mathematical literacy is in fact a direct result of the way mathematics teaching/learning is being practiced in schools (Sfard & Cole, 2003). Therefore, these mathematics teachers can be expected to have a tendency to educate their students as individuals with a similar perspective.

Another striking result of the current study was that almost half of the teachers who did not participate in web-based PISA course conceptualized the concept of mathematical literacy as solving mathematical problems. That is to say, according to these participating teachers, mathematical literacy is to generate the most appropriate solutions to math problems and to be successful in mathematics. Accordingly, these participating teachers considered mathematical problem solving as a goal in the development of mathematical literacy and pointed out the importance of teaching for problem solving approach. Here, it is noteworthy that devising strategies for solving problems is one of the fundamental mathematical capabilities that needs to be acquired for the development of mathematical literacy, which refers to selecting or devising a plan or strategy to use mathematics to solve problems arising from a task or context, as well as guiding its implementation (OECD, 2019). The fact remains that, as Zhong and Xu (2019) also emphasize, completion of the problem-solving phases does not necessarily lead to

success in solving real-life problems and it is difficult to achieve this goal by simply engaging students in the problem-solving process. As mentioned in the literature particularly by the OECD, students should be presented problems in real-world contexts that best support the development of real-life problem-solving skills (Stacey, 2015). In this respect, it is an important requirement to ensure that mathematics teachers have detailed knowledge about the process of solving real-life problems and developing real-life problem-solving skills.

Another important result of the present study was that almost all of the participating teachers thought that they did not take an education emphasizing mathematical literacy in pre-service or in-service periods. Accordingly, it was observed that the participating teachers' expectations of in-service training to be organized by the Ministry of National Education differed according to their conceptions of mathematical literacy. In other words, the participating teachers, who drew attention to the importance of solving real-life problems for development of mathematical literacy, expressed their need for pedagogical support about how to develop students' real-life problem-solving skills. On the other hand, the participating teachers who associated mathematical literacy development with solving math problems expressed their need for trainings on how to solve and/or pose new generation/skill-based math problems. As is known, conducting efficient classroom practices that support mathematical literacy is closely related to the subject matter knowledge of mathematics teachers as well as their pedagogical content knowledge about this subject (Botha, Maree & Stols, 2013). In this context, the professional development of mathematics teachers about supporting mathematical literacy, starting in the pre-service period and continuing in the in-service period, is an issue that should be emphasized. At this point, considering the positive effects of the web-based PISA course which was designed by the researchers as a beginning project on mathematics teachers' conceptions of mathematical literacy, it is suggested to conduct teacher trainings to support mathematical literacy and conduct research that will focus on less information sharing and more practice.

Finally, in this study it was investigated mathematics teachers' conceptions of mathematical literacy. In addition to this, this study could also have examined impact of teachers' conceptions of mathematical literacy on their teaching of mathematics. Therefore, it can be considered as a limitation of this study. The number of participants could be considered as another limitation since a limited number of participants might not have represented a wide range of views in order to obtain all different perspectives with respect to teachers' conceptions of mathematical literacy.

Statements of Publication Ethics

The approval of ethics committee for the present study was given by Anadolu University Social and Humanities Ethics Committee with the issue number 64753 and authors declare that the principals of research and publication ethics were followed.

Researchers' Contribution Rate

The contribution rate of each article in the manuscript is equal.

Conflict of Interest

The authors declare that there is no conflict of interest.

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