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Mathematical Literacy of Middle School Students Improving Awareness Levels: Design-Based A Research

Sümeyye Güner Bedir[1], Prof. Dr. Ayten Pınar Bal[2]

[1,2]Çukurova University, Faculty of Education, Departmant of Math Education, Adana, Turkey

ORCID: 0000-0002-2090-0044[1], ORCID: 0000-0003-1695-9876[2]

ABSTRACT: Design-based research develops practical solutions to complex real-life challenges through reasoning to improve students' mathematical literacy achievement levels and mathematical literacy awareness levels. In this context, this method was used to determine the needs of the students and to see whether the applications made in line with their deficiencies worked or not, thus to observe that the system worked and their mathematical literacy improved. Working with the real world in the design-based research method provides formal evaluation beyond narrow measurements in reaching research results of contextual learning.

This research was designed according to a design-based research model in order to improve the mathematical literacy success levels and mathematical literacy awareness levels of secondary school students. The study group consists of 43 sixth grade students in Dörtyol district of Hatay province in the 2018-2019 academic year, according to the criterion sampling type, one of the purposeful sampling types. Mathematics literacy achievement test and mathematics literacy self-efficacy scale (MOÖYÖ) were used as data collection tools in the study. Descriptive statistics, ANOVA, and independent groups t test were applied in the analysis of quantitative data. According to the quantitative results of the research, students received low scores in the preliminary achievement test, but their intermediate success, final success and retention scores increased; It was concluded that mathematical literacy (ML) scores also increased positively.

KEYWORDS: PISA problems, non-routine problems, mathematical literacy, PISA, TIMSS, academic achievement, question writing process characteristics, problem posing, contextual problem

ENTRANCE

In the 21st century, which is the dynamic information age, the inevitability of change has increased the interest in rapidly developing technology and science. One of the concepts that gains popularity with change is literacy. Mathematical Literacy (MA) is the ability of a person to reason and research by questioning outside of the four operations. In other words, MO; Mathematics responds to the needs in individual life by using mathematical situations, content and processes (Özgen and Bindak, 2011; Organization for Economic Co-operation and Development [OECD], 2009). There is a need to determine the ML proficiency levels of individuals. Exams are needed to follow and measure all these developments. PISA; ML comes to the fore here because it is desired to establish a relationship between realistic problems and realistic results and mathematical problems and mathematical results.

The international PISA exam, organized by the OECD and conducted in three-year cycles, is a research that evaluates the knowledge and skills acquired by students in the 15-year-old group who continue formal education in the fields of reading, science and mathematics (one area being predominant in each cycle) by analyzing in depth. PISA; It consists of ML contexts (personal, social, educational and professional, scientific) and ML contents (quantity, change and relationships, space and shape, uncertainty and data). It also includes ML process (formulating, executing, interpreting and evaluating) and ML competence (explaining and presenting/solving the problem by thinking and reasoning, discussing and communicating using symbolic and technical language, creating models using mathematical tools/equipments) skills. These skills include the mathematical thinking processes necessary to solve PISA-style mathematical problems (Kabael, 2019; OECD, 2019a). When students face problems, the emphasis should be on developing these processes and strategies rather than directly learning solutions (Hopfenbeck, 2005; Greiff, 2012; OECD, 2004; Reeff, 2006; Ali, Bahri & Samah, 2014; MEB, 2005).

While the score of the countries participating in PISA 2018 in the field of mathematics is 459 (OECD score is 489), our score is 454 and our success rank is 42 among 79 countries (37 of which are OECD). In our country, it has been determined that the proportion of students in the field of mathematics is below the 1st level (13.8%) and at the 1st level (22.9%), while it is at the 5th (3.9%) and 6th level (0.9%). The rates of students at the 2nd level and above, where basic operations are performed in the field of mathematics, are the same as those of the OECD (76%) and our country (63.4%) (MEB, 2019). The deficiencies here were noticed and the PISA MO results were investigated in detail. There is a need to determine individuals' ML awareness levels. In line with the

2023 vision, efforts are being made to establish a systematic structure in order to improve national and international exams in Turkey. Some of these studies are as follows: The curriculum has been updated to give importance to its role in daily life, and measurement and evaluation and central exams have been revised within the framework of this new approach. As long as improvements continue in all these field studies, positive developments will be made in national and international exams (MEB, 2019). Realistic mathematics problems appear in international exams and are expected from students today; They solve such problems and even write them down. Questions similar to those evaluated in the PISA MO field in our country are required. It is important for students to be prepared for PISA questions with ML.

When the relevant literature is examined; Most of the students are at medium and low levels of ML (Ekawati, Susanti, Chen (2020; Yeğit, 2019; Yıldız, 2019) and they have problems understanding the questions because they are not familiar with ML and encounter the questions for the first time (Dewantara, Zulkardi & Darmawijoyo, 2015; Mayan , 2019; Oktiningrum, Zulkardi & Hartono, 2016; Yeğit, 2019; Yıldız, 2019; Bozkurt & Altun, 2019), but ML education given with such activities and a contextual approach increases students' ML (Bozkurt, 2019; Korkmaz, 2016; Nuurjannah & Sayoga). , 2020; Taşkın, 2017). In order for students to have more opportunities (MO PISA-like problem solving), students should learn and solve ML problems (Ekawati, Susanti, Chen; 2020). In this context, students should be ready for these questions and increase their ML skills. The problem posing skills that come to the fore are of critical value (Şahin and Başgül, 2018). It is seen that ML questions are needed in our country (Yıldırım, 2019). When the theses written in the last 5 years are examined, it is seen that they are with 6th graders (Köysüren, 2018; Beautiful, 2017; Korkmaz, 2016; Taşkın, 2017) is rare, which makes this study important, distinguishing it from others. When the articles and theses on ML until 2020 are examined: The fact that there are fewer studies in the field of ML education and at the secondary school level compared to others makes this study valuable (Fırat, 2019). In short, what makes this research important; The development of ML success levels and ML awareness levels is due to the fact that it is studied with different variables and is a design-based research. In this way, it is expected to meet the need for students to improve their awareness levels.

The general purpose of this study is to improve secondary school students' mathematical literacy achievement levels and mathematical literacy awareness levels within the scope of design-based research. In line with this general purpose, an answer will be sought to the sub-problem of what are the mathematical literacy awareness levels of secondary school students.

2. METHOD

2.1. Model of the Research

This research was conducted according to a design-based research model in order to improve the mathematics literacy success levels and mathematical literacy awareness levels of secondary school students. One of the approaches that forms the theoretical framework of design-based research is Realistic Mathematics Education (RME). TTA is designed and integrated with a realistic mathematics education approach framework and tested in an application. Afterwards, retrospective analyzes are carried out and new arrangements are made for implementation when necessary (Gravemeijer 1994). Design-based research is required to achieve successful results in these cyclical processes (Aşık & Yılmaz, 2017). Additionally, since most of the research conducted is far from real-life applications, has limited impact, and is insufficient in providing direction and guidance, Levin and O'Donnell (1999 and Lagemann and Shulman (1999) think that TTA will fill the gap in this context.

Shaping the learning processes with a realistic mathematics education approach and basing it on the student's actual participation has brought the design-based research method to the fore (van den Heuvel-Panhuizen and Drijvers 2014). In this study, 6th grade students actually participated in the application. In addition, within the scope of the research, teachers; As active practitioners who ensure the flow of in-class lessons, they supported the progress of the study and the introduction of innovations by sharing their experiences with the research group.

TTA develops practical solutions to complex real-life challenges through reasoning. Design-based research, which encourages the development of creative thinking and gives ideas about possible solutions, also provides cyclical feedback to make the process more efficient. In addition to revealing what works, it also reveals the development by showing that the mechanism works (Bakker, 2018). In this context, this method was used to determine the needs of the students and to see whether the applications made in line with their deficiencies worked or not, thus to observe that the system was working and that their MOs were developing.

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According to Collins, Joseph and Bielaczyc (2004), working with the real world in the TTA method provides formal evaluation beyond narrow measurements in reaching research results of contextual learning. Design-based research is deemed appropriate for this study because the activities created from ML questions used throughout the process are context-based questions and include formative evaluation.

In summary: In action research, the research is only implemented by the teacher to the students, but he/she has no role in designing, analyzing the research during the process and at the end. In action research, while there is a solution to a local problem, there is no detailed analysis of the problem and the creation of different applications and new regulations in line with these analyses. (In TTA, the design, evaluation and re-correction/development processes are intertwined, and the researcher takes an active role in the implementation together with the participants in the continuous process). The role of the teacher in design-based research is to actively benefit from the expertise (knowledge and experience) of the researcher at every stage and to actively participate in classroom practices with students in the process of finding solutions to the problem situation. Here, the teacher both designs the process, analyzes it during and at the end of the process, and also makes new arrangements on the issues he sees as deficiencies in the process. In addition, by working with the students who are the implementers of the process, they have the opportunity to observe what is happening better.

2.2. Working group

The study group of this research consists of 43 sixth grade students in Dörtyol district of Hatay province in the 2018-2019 academic year. The research was determined according to the criterion sampling type, one of the purposeful sampling types, as information-rich situations were selected in order to conduct in-depth research. Criterion sampling type; It is used to select information-rich situations in order to conduct in-depth research (Cresswell, 1994; Yıldırım & Şimşek, 2008). As a criterion in this study; Among the secondary schools in Dörtyol district of Hatay province, where the research was conducted, it was determined to be one of the most successful schools according to the High School Transition Examination (LGS). The study was conducted with 43 students studying in one of the sixth grade classes that were most successful in mathematics exams at the specified school.

The socioeconomic level of the study group being researched is mostly at high and medium levels. In addition, the students in the study group stated that they had not received any training on PISA problems before, that they had not encountered such problems in the textbook or question books, and only two students had encountered one or two such examples. 9 of the students have a mathematics average of 100, 6 of them have a mathematics average of 96.67, 6 of them have a mathematics average of 95-85, 5 of them have a mathematics average of 85-80, 9 of them have a mathematics average of 80-70, 4 of them have a mathematics average of 70-55, and 4 of them have a mathematics average of 70-55. The math average is below 50. Accordingly, the class is a mixed class consisting of students with upper, middle and lower achievement levels. In addition, the success of the study group is among the top 3 among 6th graders at the school.

According to the 2018 LGS exam results, the achievements of the students at the school are as follows: 3 Ankara Çankaya Science High School, 1 Istanbul Beşiktaş Kabataş Male Anatolian High School, 6 Adana Seyhan Science High School, 1 Adana Seyhan İMKB Science High School, 2 Osmaniye TOBB Science High School, 1 Kayseri Sümerler Science High School, 19 İskenderun Tosçelik Science High School, 1 Gaziantep TOBB Science High School, 1 Kahramanmaraş Süleyman Demirel science high school, 1 İzmir Çiğili Science High School, 32 Dörtyol Science High School, 4 Osmaniye Düziçi Science High School, 2 Erdemli Science High School, 1 Şereflikoçhisar Science High School, 4 İslahiye Istanbul Borsa Science They were placed in Anatolian high schools and many science high schools. According to the 2019 LGS exam results, the school where the application was implemented came first in Hatay province in mathematics, ranked second in Hatay in general, and ranked first among public schools. Since the majority of students taking the PISA exam were selected from the Mediterranean Region, the study group reflects the research problem in the best way and makes the study valuable.

2.3. Data Collection/Process

It was noticed that the participants were not knowledgeable about ML and were not accustomed to ML questions. In line with this impression, the literature on ML, PISA, TIMSS, non-routine problems, and new generation questions was scanned. ML achievement tests created at the end of this scanning were applied to 7th grade students as pre- and post-tests. The final version of ML achievement tests is given according to ML achievement levels. An application was planned based on ML sub-dimensions, evaluation process, and ML skills acquisition. The final ML achievement test was applied to 6th grade students to determine their ML achievement and their awareness by applying MLÖÖÖ. Deficiencies in the preliminary application were identified and ML training was designed by the researcher. This training continued for 16 weeks, two hours one week, one hour the next week, for a total of 28 hours. Within the scope of ML training; by giving information to students about ML (with a Powerpoint presentation and a worksheet containing ML explanations distributed to students); Students were informed about what PISA is and its purpose, as well as PISA-style questions and their solutions. Since students who are unfamiliar with ML questions will improve their ML levels by gaining information about the nature of the problems and their solution processes, 2 activities (with 4 questions in each) have been prepared to be used in the application process. Context-based activities were created and finalized after being submitted to expert opinion. In each lesson, 2 questions were solved in the classroom under the supervision of the researcher, first individually, then in groups of two students with different MOs (in order to exchange ideas and compare solutions with each other), and finally together with the researcher. Thus, both student-student and student-teacher interaction was ensured. In this renewed process, an intermediate achievement test was conducted to see the students' ML development. Education continued by making necessary arrangements according to the deficiencies identified in line with the results obtained from the ML intermediate achievement test. 2 activities (with 4 questions in each) were prepared for the problem characteristics and solution processes that students need in ML. Through group activities, students were asked to constantly ask questions during the course to determine their opinions and to actively participate in the course. Each of the students who had thoughts about the questions shared their ideas in the class. In this evaluation, a post-test was conducted to determine whether ML success levels and awareness levels reached the goal. In this regard, it was investigated whether the post-test was statistically significant compared to the pre-test. In order to increase the reliability of the results, the MO retention test was performed three weeks after the last achievement test. While the achievement tests were applied, the awareness levels on this subject were also examined by applying the preliminary, intermediate, final and permanence MOÖYÖ. In this way, the development levels of the students in the final, permanent mathematical literacy achievement test and the final, permanent mathematical literacy awareness were determined.

2.4. Data collection tool

Design-based research is generally conducted to solve a problem. In TTA, the research process should not only be conveyed descriptively, but also predictions about the progress in practice should be shared so that another researcher can continue the research. At this point, presenting the application steps and the resulting intermediate results will be important both to understand the contributions of the researcher and to direct innovations in the continuation of the research (Barab 2006). In the light of this information, the implementation plan of the phased process carried out within the scope of design-based research can be summarized as follows. In the preparation of the mathematics achievement test, two forms (A and B) consisting of 15 open-ended questions were prepared. These forms include pre-test and post-test application questions with similar purposes. The features of these questions are as follows: They are questions aimed at measuring cognitive level (remembering, understanding, applying, analyzing, combining, reasoning), skills (establishing relationships with daily life, developing creativity, problem-solving skills), attitudes and values (desire to access information). At the same time questions; The selected case studies, selected from real life, depending on socio-cultural conditions, appropriate to the development levels and interests of the students, consist of problems related to daily life, designed in a way that the students may encounter in daily life and prepared in line with the context. During the preparation of the questions; By scanning the literature on PISA questions, TIMSS questions, new generation questions, non-routine problems and current studies on PISA mathematical literacy, 15 clear problems suitable for the sixth grade level were created by understanding the logic and questions of such problems. The prepared problems were consulted for the opinions of experts in the field of mathematics (4) and mathematics education (2). The 36-question A and B forms, which were finalized in line with the feedback from experts, were applied to 220 seventh grade students.

In selecting the items in the mathematics achievement test (form A), which consists of 36 questions, item difficulty indexes are expected to be between 0.20 and .080 (Özçelik, 1981). Accordingly, since the item difficulty indexes were not within the desired range, 25 items (4,5,6,7,8,9,11,12,13,15,16,17,18,20, 21,22,23,25,30,31) .32,33,34,35,36) and 6 items with item discrimination index below .30 (8,18,25,30,32,35) were removed from the test (Büyüköztürk, 2006). Then, independent groups t-test was applied to test whether there was a significant difference between the lower group arithmetic score of 27% and the upper group arithmetic score of 27%. According to this test result, five questions (25, 30, 32 35 36) in which there was no significant difference between the two groups were excluded from the achievement test. As a result, 21 questions were excluded from the mathematics achievement test (form A) and 15 questions remained. The analysis results of form A show that the arithmetic mean of the test is 4.58, the standard deviation is 3.40, the median value is 4, the mode is 3, the average difficulty of the test is .13 and the KR-20 value is .74. Accordingly, the average difficulty of the test is difficult, but the reliability value is sufficient. In selecting the items in the mathematics achievement test (form B), which consists of 36 questions, item difficulty indexes are expected to be between 0.20 and .080 (Özçelik, 1981). Accordingly, since the item difficulty indexes were not within the desired range, 25 items (1, 2, 6, 8, 9, 11, 12, 13, 14, 16, 18, 19, 20, 21, 23, 25, 26, 27, 28, 29) , 30, 31, 32, 34, 36) and 12 items with item discrimination index below .30 (1,8,11,14,15,16,18,20,26,27,28,32) were removed from the test. (Büyüköztürk, 2006). Then, independent groups t-test was applied to test whether there was a significant difference between the lower group arithmetic score of 27% and the upper group arithmetic score of 27%. According to this test result, five questions (2,25,30,32,35) for which there was no significant difference between the two groups were excluded from the achievement test. As a result, 21 questions were excluded from the mathematics achievement test (form B) and 15 questions remained. According to the analysis results of form B, the arithmetic mean of the test is 6.44; standard deviation 3.28; The median value is 6, the mode is 7, the average difficulty of the test is .178 and the KR-20 value is .68. According to these results, it is understood that the test is reliable (0.00-0.39 is unreliable, 0.40-0.59 is low reliability, 0.60-.79 is reliable, 0.80-1.00 is high reliability). One of these two tests was applied as a pre-post achievement test, while the other was used as an intermediate achievement test.

MOÖÖÖÖ, developed by Özgen and Bindak (2008), was used to determine students' ML levels. Permission was received from Özgen and Bindak to use the scale in the thesis. This scale, which measures attitudes towards mathematical literacy self-efficacy belief, is a five-point Likert type scale. Positive items in the scale are scored from 5 to 1, starting from the "Completely Agree" option to "Completely Disagree", while negative items are scored from 1 to 5. It is a valid and reliable scale with 25 items, with item-total correlation values ranging between 0.48-0.75, split-half reliability coefficient of 0.924, and Cronbach's alpha internal consistency value of 0.942. The single-factor scale has 4 negative and 21 positive items. This scale was applied to 220 seventh grade students and the data obtained was analyzed. Cronbach's alpha was found to be .90. As a result of the analysis, it was seen that scale reliability was achieved.

2.5. Analysis of Data

In the analysis of the data, first of all; Item difficulty level (pj), standard deviation (sj), discrimination index (rjx) and independent groups t-test were used in the preliminary achievement test and final achievement test analysis of the A and B forms administered to seventh grade students. Data collection in the research. Mathematics achievement test, MOÖYÖ and semi-structured interview form were used as tools. Descriptive statistics, ANOVA, and independent groups t test were applied to analyze the data. Content analysis was used to analyze qualitative data. While creating the codes of the research in the analysis of the data, they were prepared by making use of the relevant literature (PISA; Şahin & Başgül, 2018; Altun, 2016; Gürbüz, 2014; İpek & Okumuş, 2012; Ulu, Tertemiz, Peker, 2016). The prepared data analysis form was presented to the opinion of two mathematics education and measurement and evaluation experts, and the items measuring the same feature were removed and given its final form by considering what the items in the items stated and what they meant one by one. During the reliability of the data analysis, two experts on mathematics and mathematics education, apart from the researcher, were given their final form. All questions and data obtained from 43 students were coded by the expert. During the data analysis process, the documents obtained from the students were coded according to their order while being examined. In this context, the first written document examined was given codes as Ö1, Ö2. During the coding process, the following formula suggested by Miles and Huberman (1994) was used: Reliability=(Agreement)/(Agreement+Disagreement). Accordingly, as a result of independent coding, the agreement between the two coders was found to be 96%. This value is quite sufficient for social sciences (Miles & Huberman, 2016). Then, the experts and the researcher came together and agreed on the coding that differed, and the data analysis process was completed. Frequency (f) and percentage (%) were used in the analysis of the problems posed by the students.

3. FINDINGS

3.1. MO Achievement Test Findings

According to the first sub-objective of the research, the arithmetic mean and standard deviation values of the mathematics achievement test scores applied to determine the mathematical literacy achievement levels of sixth grade students are given in Table 9.

Table 9.Statistical Data Obtained Regarding Students' Mathematics Achievement Test Scores

Mathematics Achievement Test	N	$\bar{X}$	SS
Front	43	4.86	3.53
Dec	43	7.88	3.98
Last	43	8.07	4.41
Persistence	43	9.37	4.07

When Table 9 is examined, it is seen that the arithmetic average pre-test score regarding the students' mathematics achievement test scores is $\bar{x}$=4.86, mid-test score $\bar{x}$=7.88, post-test score $\bar{x}$=8.07 and permanence test score $\bar{x}$=9.37. Accordingly, it was concluded that the students had the lowest success in the pre-test and the highest success in the retention test. On the other hand, one-way variance analysis values regarding the scores of sixth grade students according to the application time of the mathematics achievement test are given in Table 10.

Table 10. One-Way Variance Analysis Values for Students' Mathematics Achievement Test Scores

Source of Variance	Sum of Squares	Sd	Mean of Squares	F	p	Significant Difference (Scheffe Test)
intergroup	3.043	3	1.014	2.930	.035	Intermediate, Final, Permanence> Front
within groups	58.160	168	.346			
Toplam	61.203	171				

When Table 10 is examined, it is seen that there is a significant difference between the one-way variance analysis results applied according to the application times of the mathematics achievement test [$F(3-168)=2.93$, $p<.05$]. In other words, mathematics achievement test changes significantly depending on the time of administration. Scheffe test was applied to find the direction of the significant difference between the mathematics achievement test application times. According to this mathematics achievement test result, it was revealed that the mid-test, post-test and permanence test scores were higher than the students' pre-test scores.

3.2. MOÖÖÖ Findings

According to the second sub-objective of the research, the arithmetic mean and standard deviation values of the students' mathematical literacy scale are shown in Table 11.

Table 11.Statistical Data Obtained from Students' Mathematics Literacy Scale

Mathematics Literacy Scale	N	X̄	SS
Front	43	3.44	.70
Dec	43	3.68	.51
Last	43	3.77	.61
Persistence	43	3.86	.50

When Table 11 is examined, the scores obtained by the students from the mathematical literacy scale are respectively the preliminary mathematics literacy scale scores $\bar{x}$=3.44, the intermediate mathematics literacy scale $\bar{x}$=3.68 scores, the final mathematics literacy scale $\bar{x}$=3.77 scores and the permanent mathematics literacy scale $\bar{x}$=3.86 scores. Accordingly, it was concluded that the students got the lowest score from the pre-application and the highest from the application made during the retention period. On the other hand, the one-way variance analysis values applied to the sixth grade students' scores according to the application time of the mathematics literacy scale are given in Table 12.

Table 12.One-Way Variance Analysis Values for Students' Mathematics Literacy Scale

Total	Sum of Squares	Sd	Mean of Squares	F	p	Significant Difference (Scheffe Test)
intergroup	4.186	3	1.395	4.062	.008	Persistence> Front
within groups	57.720	168	.344			
Total	61.906	171				

When Table 12 is examined, it shows that there is a significant difference between the types of achievement tests according to the one-way analysis of variance results regarding the application times of the mathematical literacy scale [F(3-168)=9.758, p<.05]. In other words, the mathematical literacy scale changes significantly depending on the time of application. Scheffe test was applied to find the direction of the significant difference between the application times of the mathematical literacy scale. Accordingly, it was concluded that the students got the lowest score from the pre-application and the highest from the application made during the retention period.

4. DISCUSSION

In this study, secondary school students' mathematical literacy achievement levels and awareness were examined in the context of a design-based application. This section includes the interpretation of the study findings by comparing them with the literature.

4.1. Discussion Regarding ML Achievement Level

When the ML achievement levels of secondary school students were examined, it was concluded that the students had a low average in the preliminary achievement test. This result is similar to many studies. Fointuna, Kaluge, Fernandez (2020) stated that secondary school students generally have low MOs; Narimo, Anif, Prayitno, Sari and Adnan (2020) concluded that 81.25% of secondary school students were at the 1st level of ML. Altun, Gümüş, Akkaya, Bozkurt, Ülger (2018) examined the ML skill levels of 8th grade students; Uysal and Yenilmez (2011) also examined 8th grade students and concluded that their ML scores were below the 3rd level. While Purwanti, Sukestiyarno, and Waluya (2020) stated that 5th grade students' ML was not yet established and was at the 1st level, Yeğit (2019) concluded that 95% of 5th grade students had medium and low levels of ML. In Çoban's (2018) study, they found that there were no students at the 5th and 6th levels and Uysal (2009) concluded that there were no students at the 6th level and that the students were at the 2nd level and below. İlbağı (2012) examined MOs in the 15-year-old group and stated that they were more successful in middle-lower level questions, while they could not answer the higher level questions correctly. When Aykurtlu (2019) examined students' problem solving and problem posing skills, 9th graders' problem solving success was better than 10th graders; He found that the problem posing success of 10th graders was better than that of 9th graders. The reason for the low ML achievement levels of secondary school students can be that they have not previously encountered ML questions in the classroom environment and textbooks, and that there are few/limited studies in this field. The reason for the students' low averages in the pretest is parallel to their performance in solving PISA-style problems. It is thought that the reason why most students cannot solve ML questions is that they do not understand the questions. Similarly, in Yıldız's 2019 study on the difficulties faced by 7th grade students in solving ML problems, it was observed that those at low levels had comprehension problems and those at medium levels had problems with mathematical expression. Dewantara, Zulkardi & Darmawijoyo (2015) stated that they created and developed MA to produce PISA-like mathematics activities and that they were not familiar with such problems. Ekawati, Susanti, Chen (2020) concluded in their study that students' having more PISA-like problem solving opportunities positively affects their learning and solving ML problems.

In the achievement test given to students at different times; It is seen that the scores they received from the intermediate, final and retention tests increased compared to the preliminary achievement test. As a result of an effective application, there was an increase in students' success in ML questions. Giving students the opportunity to develop their high-level skills through ML activities may be the reason for this increase. Malasari, Herman, and Jupri (2020) drew similar results in their study and found that students' ML increased by using teaching activities (MO problems). It was concluded that Şaban (2019) 8th grade and Korkmaz (2016) 6th grade students developed ML in their post-tests with an effective study. In 7 studies, Fırat (2019) found that mathematical literacy positively affected academic success, and in 3 studies, mathematical literacy and mathematics education were positively affected.

Students were asked to solve MO questions every week in mathematics classes. At the end of this process, an increase was observed in the students' problem understanding and problem solving skills. Husin (2020) concluded that the 5th grade ML problem solving learning result improved. In the study of Firdaus and Wahyudin (2017), it was observed that direct instruction of problem-based learning was more effective in the mathematical literacy of secondary school students and an increase in mathematical literacy was observed. Wood (2007) found a positive relationship between students' mathematical literacy and problem-solving performance. Güzel (2017) concluded that when the 6th grade mathematics course curriculum was enriched with mathematical literacy, ML scores increased. It has been observed that students are more interested in mathematics lessons enriched with different materials, which makes learning easier. Gellert (2004) concluded that the use of instructional materials has a significant relationship with students' mathematical literacy. Kurtoğlu Çolak (2006) concluded that different materials and equipment positively affect mathematical literacy.

It was observed that students who were familiar with ML questions established daily life relationships more easily at the end of the process. This established relationship has increased practicality. Mardiana, Sa'dijah, Qohar and Anwar (2020) supported this view with their study: They saw that secondary school students' ML skills could be improved and practicalized with GÖ activities and materials. Nuurjannah & Sayoga (2020) concluded that secondary school students acquired and developed ML skills with a contextual approach. Oktingrum and Wardhani (2020) show that giving mathematics tasks as a context is effective in evaluating ML. Akın and Kabael (2017) concluded that teaching quantitative reasoning to 8th grade students increased their ML performance by at least one level. Kükey (2013) applied a mathematics achievement test with the ML test in the 8th grade and concluded that ML has a great impact on mathematics achievement and ML levels increase, and that the mathematics course should be associated with daily life. In parallel, Kaiser & Willander (2005) stated that real-life problems showed great progress in students with low mathematical literacy. Dickerson (1999) and Turhan & Güven (2014) problem-based mathematics teaching increases problem solving. When examining the reflection of secondary school students' daily life experiences on contextual problem solving, Dündar & Ezentaş (2020) found that focusing only on mathematical operations distances the student from daily life knowledge, and that daily life knowledge cannot be transferred to the solution of the problem, and misperceptions such as lack of prediction skills and requiring a definitive and single answer make it difficult to solve the contextual problem. came to the conclusion. At the end of the process, it was seen that the biggest deficiency was the lack of ML questions in the students' textbooks and the students' unfamiliarity with such questions. If students are given the chance to solve ML questions through proper study, their ML success will increase.

5. CONCLUSION AND RECOMMENDATIONS

This research was conducted to improve secondary school students' mathematical literacy success levels and awareness. In this section, the results obtained in line with the research findings and suggestions regarding the results are included.

This research was conducted to improve secondary school students' mathematical literacy success levels and mathematical literacy awareness levels. In the first step of the application, a preliminary mathematics achievement test / MOÖYÖ was used to determine the ML achievement levels and ML awareness of sixth grade students. Subsequently, a total of 28 hours of mathematical literacy training over 16 weeks was implemented for sixth grade students, based on understanding PISA questions and logic, context, content, competency set sub-dimensions, evaluation process and question writing skills. Intermediate mathematics achievement test / MOÖYÖ was conducted. Then, after completing the four activities together, they were asked to write PISA questions. After the last mathematics achievement test / MOÖYÖ was administered, question writing continued. The opinions of the students were taken after the last retention mathematics achievement test / MOÖYÖ was applied. The results obtained in this direction are as follows:
Results obtained from students' mathematics achievement test findings; It was concluded that the students had lower average scores in the ML pre-mathematics achievement test and that their retention, final and intermediate mathematics achievement tests increased compared to the pre-mathematics achievement test.

Results obtained from students' MOÖYÖ findings; It was concluded that while the pre-mathematics MOÖÖS was positive, this positive attitude in the intermediate, final and permanence MOÖÖS gradually increased.

This section contains recommendations for researchers and educators based on the data obtained from the study. In this study, while the students had lower averages in the preliminary achievement test, their permanence, final and intermediate achievement test averages increased; It was concluded that while the pre-literacy scale was positive, the intermediate, post-literacy and permanence literacy scale scores gradually increased. In this direction:

In order to be successful in problem solving, such questions can be provided more space in textbooks. These activities can be expanded in the classroom environment. In this way, effective communication and cooperation will occur between them. With these activities, students can be helped to make healthy decisions and guide their friends correctly. This research was conducted with students with very high mathematics achievement. Such studies can also be carried out with students at other success levels.

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