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IMPLEMENTATION AND EVALUATION OF REALISTIC MATHEMATICS EDUCATION ACTIVITIES USING ELECTRONIC PORTFOLIO[i]

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Abstract:
In the study, the mathematics activities prepared by taking expert opinions within the framework of Realistic Mathematics Education (RME), which contains real life examples, focuses on angles, and requires to do design or research, have been applied to the students. The study was conducted in a secondary school in Istanbul in the academic year of 2017-2018 and proceeded for a total of 8 weeks. The target group of the study consisted of 60 7th grade students. The research is designed as an intervention research which is one of the qualitative research methods. In this study, the activities prepared within the RME framework were conducted for 8 weeks using the electronic portfolio which is one of the alternative assessment and evaluation methods in the experimental group and the activity worksheets in the other group. Students' answers were evaluated according to the specific criteria formed by taking expert opinion and subjected to qualitative analysis. Although it is seen that e-portfolio has positive effects on students' ability to do a research, to model and to design creative products, it has been found that it did not contribute to their mathematical literacy and to their expressing their mathematical ideas clearly in the expected level.

Keywords: realistic mathematics education, e-portfolio, portfolio, real life math questions

1. Introduction

Developments in science and technology has made the change in curriculums inevitable. As it is known, the new curriculums resulting from these changes are based

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on approaches that help to raise individuals who are responsible for their own learning, have problem solving and critical thinking skills, can use technology, are investigative and productive (Sağlam, Arslan, Avcı & İyibil, 2008). In the new world order, educational institutions should create a productive education environment, so to do this, they should generate programs that will provide a successful transition from school to business life and to introduce children and young people to the real life from the primary school stage (Yaylacı 2007).

These developments taking place in the world along with the transition to a information society, are reflected in the education field in Turkey as wells as in many fields. The Turkish education system was restructured and education programs for raising the type of human being suitable for the requirements of the age have been renewed since 2005 with the transition to student-centered education (Yıldırım & Karakoç Öztürk, 2009). As a student-centered education approach, a constructivist approach that requires active participation of students, which is sensitive to individual differences of students and aims to develop their individual skills and talents, has been adopted (MOE, 2005).

The Realistic Mathematics Education approach developed by Hans Freudenthal and developed by the Freudenthal Institute has similarities with the constructivist approach. Freudanthal argues that mathematics should not be separated from real life, it should be a part of real life and it should be learned by being experienced. The biggest difference between Realistic Mathematics Education and constructivist theory is the fact that the constructivist approach is a theory of information on its basis and explains how knowledge should be acquired, but Realistic Mathematics Education is a theory of teaching. According to the RME, theoretical information cannot be given independently of the applications, whereas in the constructivist approach there is no such requirement (Panhuizen 2001).

Realistic Mathematics Education is based on the aspect of *"Mathematics is a human activity."* (Freudenthal, 1991; Zulkardi, 2000). According to this approach, as most teachers do, giving the definitions and the formulas to the students firstly and then asking them to solve the problems using these formulas is an anti-didactic, non-instructive method. In the Realistic Mathematics Education, the teaching aspect does not start from formal knowledge, but starts from informal knowledge, uses the modeling to form a bridge while reaching the formal knowledge, and adapts the problems from real life (Altun 2006). Freudenthal argues that throughout the history, mathematics evolved out of real-life problems experienced by people and those people mathematized real life through these problems, and then they reached formal mathematics (Freudenthal 1968). The key word in this education process is to mathematize. Mathematicalization is not only a mathematician's job, but an action that can be done by every human being (Treffers 1987).

The evaluation of student success in traditional methods is usually handled in a way that is different from the teaching process and focuses more on the product. For this purpose, written and oral exams with multi-choice and short answer tests are considered important. In the constructivist learning approach, assesment and evaluation is part of the teaching process and takes place at every important point throughout the whole learning process -not only at the beginning or end of learning. Since it also consantrates on the process, it requires many assestment tools and methods to create an alternative to the old approach (Gelbal & Kelecioğlu, 2007). Similarly, since constructivist approach and RME are similar in many respects, it is thought that the use of alternative assesment and evaluation methods will be more effective in the curriculums created by adopting the RME approach. These methods can be exemplified as concept maps, performance and project assignments, portfolio, e-portfolio (electronic portfolio), self-evaluation, peer evaluation and check lists.

One of the popular alternative assessment techniques used to evaluate the performance of a student as a person and a group in the learning process in recent years is the portfolio that means individual development file (Birgin, 2002; Kaptan, 2000; Aschbacher, 1995; Grace, 1992; Arter et al., 1995). Since the definition of the portfolio changes in terms of the purpose and usage types of the users, a single definition cannot be given. In general terms, the portfolio is a collection of the examples of a student's works which show the effort, progress or success of him/her. Simon & Forgette-Giroux (2000) define the portfolio as "*a cumulative and systematic collection of studies chosen and recommended by students, teachers or their colleagues to assess the development of an ability of the student*" (p.85). In addition, Birgin (2002) defines the portfolio as "*evaluation of the evidences obtained cumulatively and systematically by gathering the skills, actions or behaviors of a student in one or more fields in a certain process according to predetermined criteria*".

Electronic portfolios, also known as web-portfolios, multi-media portfolios or e-portfolios, may contain the same works with the traditional portfolios, but according to Kilbane & Milman (2003), the main difference between them is that the content is shown in a digital environment. In general, e-portfolios have been defined as a collection aimed at showing the potential progress and achievements of students' works in an electronic environment (Weigle, 2007). According to Abrami and Barrett, the electronic portfolio is "*a digital container that can store visual and audio content such as text, image, video and sound*" (p. 2, 19). Butler (2006) and Gunawardena (2010) state that it is a series of digital works which consist of student's ideas, reflections and learning outcomes (Butler 2006; Gunawardena et al., 2010). Researches on e-portfolio are generally gathered around two main headings. First one is student opinions on the use of e-portfolio and second is the effect of e-portfolio usage on students' academic successes.

In a study conducted by Barrot J. (2016), the effect of using Facebook as an e-portfolio platform in English writing lessons on student opinions was investigated and it was observed that electronic portfolios had a positive effect on students because of their many advantages that offered to students. In a study by Saarinen A., Seitamaa-Hakkarainen P, and Hakkarainen K. (2017), the effect of e-portfolio on student opinions was investigated by using an iPad application named Book Creator in secondary school students in handcraft lessons in Finland. It was seen that the e-portfolio was a viable method in craft education. Denton D. and Wicks D. (2013) examined the effect of using WordPress application as an electronic portfolio on students' perceptions and found that students perceived electronic portfolios as a proper method for organizing the data that changed over time.

Wanchid & Charoensu, (2015) investigated whether there was a significant difference between the effects of paper-based portfolios and e-portfolios on English writing skills and observed that there was no significant difference between them. However, they stated that the use of e-portfolio had more positive results for language learning and evaluation. Bryant & Chittum (2013) analyzed the impact of the e-portfolio on student outcomes and explained that the e-portfolio can contribute to student learning in a reasonable manner when properly applied. Khales (2016) analyzed whether the e-portfolio could influence the education of prospective teachers and how communication between them developed through e-portfolios within the professional communities of prospective teachers. The findings revealed that the use of e-portfolios enabled the participants to work together more closely and helped the teaching strategies to be developed. Based on the literature review, the present content suggests that the e-portfolio can make a major contribution to student learning when properly applied. However, although e-portfolio research is gradually becoming significant in the literature, there is a need for a transition towards empirical evaluation of the effects on student outcomes.

Finally, this study aims to explain the theoretical basis of RME, to apply the activities prepared within the RME framework by using an electronic portfolio in a sample and a portfolio in another sample, to compare the two samples with each other and to evaluate the results of the activities on the basis of certain criteria.

2. Material and Methods

This section consists of the study model, the study group, the data collection tool and the stages of the study, the collection of the data and the analysis of the data. The research is designed as an intervention research which is one of the qualitative research methods. This method is a type of research in which the participants are active and the generalization is not considered. It is a type of research which requires the people who are directly or indirectly related to the research as a researcher. It is focused on improvement and enhancement. The answers of the participants to the activities were analyzed with sub-headings based on expert opinion and descriptive analysis which was one of the qualitative research methods was done.

2.1 Study group

The study was carried out in Mehmetçik Imam Hatip Secondary School in Güngören district of Istanbul in 2017-2018 academic year and conducted in a total of 8 weeks in March and April. The target group of the study consisted of 60 7th grade students. However, since the study was based on the volunteer participation, the number of students participating in each activity varied and the study was conducted with 36 students. Participants were selected by convenience sampling method. In the study, the participants were applied the mathematics activities that contained real life samples, focused on angles, were expected to do design or research and were prepared by taking expert opinions within the framework of Realistic Mathematics Education (RME).

2.2 Data Collection Tool and Stages of Study

In the research, activities were prepared by taking expert opinion as data collection tool. These activities were prepared within the framework of Realistic Mathematics Education (RME) and were applied to the students for 8 weeks as one activity each week. In the 1st activity, students were asked to design a game using angles. Angry Birds game was introduced as an example to the students and they were asked whether they had previously realized the angles in the game. Most of the students stated that they did not realize that mathematics was used in a game. Thus, the application of the study was started by showing that mathematics was used in real life and students' interests were drawn to real life mathematics. In the 2nd activity, students were asked how the position and length of our shadows changed. Then the students were asked to make a sundial after they realized that our shadows changed as the angles of the rays coming from the sun changed. The students were in contact with their classmates while they were making their sundials and found the opportunity to get help from each other. In the 3rd activity, a commercial film in which the subject of angles was used and students were asked to design another commercial film by using the subject of angles, again. Many different commercial film ideas emerged from students. Each response from the students was analyzed under sub-headings as in other activities. In the 4th activity, the students were shown two hand fans which were standing in different angles and asked which one would blow more winds and what the reasons could be. In addition, students were asked to create their own hand fans to observe this situation by themselves. Thus, the students not only learned a mathematical subject, but also reflected it on their own lives. In the 5th activity, the students were asked to watch the video of Michael Jackson's Smooth Criminal and to search how he bowed doing an acute angle without using a computer effect. After that, it was examined if the students were able to do a good research to reach the answer according to the sub-headings. The students were expected to do some researches in the 6th and 7th activities. In the 6th one, they were asked to investigate Scoliosis disease and to find other diseases that impaire our postural angle. In the 7th activity, the students were informed about the leaning tower of Pisa and asked to find how many degrees the Pisa tower leaned and if there were any other skew towers in the world. In the 8th and last activity, the students were asked to create tangram shapes and then to create other puzzles by using geometrical shapes. As it is seen, during all these activities, students were directed to do some research and design some products.

2.3 Data Collection

Edmodo program, which was chosen as the online class in the classroom determined as experimental group, was used in the application of activities and collection of feedbacks. In Edmodo online platform, students have the opportunity to communicate with their researcher and classmates off-school hours. Thus, the development of their social skills has been ensured, as well. In the other class, which was determined as a control group, the researcher was not in direct contact with the students and distributed the printed activities on the paper to the students and gave feedback to them through the classroom teachers.

2.4 Data Analysis

The answers of the participants to the activities were analyzed by sub-headings based on expert opinion and descriptive analysis, which was one of the qualitative research methods, was used. The number of sub-headings varied for each activity and they were evaluated according to yes-no answers and high-medium-low levels. The answers were categorized as 'yes' 4 points, 'no' 0 point, 'high' 4 points, 'medium' 3 points and 'low' 2 points. Thus, the score was determined as 100 points in total as ' Angry Birds' activity was 16 points, 'sundial' activity was 12 points, 'Van Damme' activity was 12 points, 'hand fan' activity was 12 points, 'Michael Jackson' activity was 8 points, 'scoliosis' activity was 12 points, 'Pisa' activity was 12 points, and 'tangram' activity was 16 points.

3. Findings and Comments

This section consists of the findings obtained from the analysis of the activities prepared within the framework of Realistic Mathematics Education according to certain main and sub-headings, the views of the students and the comments made in the light of this information. As shown in Table 1, the activity was analyzed under 5 sub-headings. It was seen that a large majority (95%) of the 57 students participating in the activity were able to plan and build the games. It is thought that the control group had a higher rate in game building because that the experimental group used Edmodo program for the first time and had difficulty of getting used to it. However, it is seen that the students who were expected to build games by using angles

Table 1: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Angry Birds Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
1.1. Designing the game	Yes	20	%91	34	%97	54	%95
	No	2	%9	1	%3	3	%5
1.2. Clearly determining the rules of the game	High	7	%35	7	%21	14	%26
	Medium	4	%20	11	%32	15	%28
	Low	9	%45	16	%47	25	%46
1.3. Correct use of the mathematical elements required in the designs	High	7	%35	6	%18	13	%24
	Medium	7	%35	11	%32	18	%33
	Low	6	%30	17	%50	23	%43
1.4. Explaining the game well by drawing or modeling	High	10	%50	21	%62	31	%57
	Medium	4	%20	8	%23	12	%22
	Low	6	%30	5	%15	11	%20
1.5. Creativity level	High	8	%40	10	%29	18	%33
	Medium	5	%25	13	%38	18	%33
	Low	7	%35	11	%32	18	%33

As shown in Table 1, the activity was analyzed under 5 sub-headings. It was seen that a large majority (95%) of the 57 students participating in the activity were able to plan and build the games. It is thought that the control group had a higher rate in game building because that the experimental group used Edmodo program for the first time and had difficulty of getting used to it. However, it is seen that the students who were expected to build games by using angles could clearly determine the rules of the game and the majority of the both groups (45% - 47%) could determine the rules at a low level. In the Angry Birds activity, students were expected to present their designs by writing or drawing, however the majority of them preferred to draw their designs. For this reason, it is thought that students could not determine the rules of the game clearly owing to have focused on drawing much more. Considering the sub-heading of 'correct use of the mathematical elements required in the designs', the students were expected to use the angles effectively for this activity. When the students' designs were analyzed, it was seen that the designs of the experimental group were distributed in similar rates as high-medium-low levels and half of the control group was at the low level. When considered the sub-heading of 'did the participant explain the game well by drawing or modeling?', it was found that both groups (50% - 62%) were clearly at the high level. Finally, for the Angry Birds activity, students' creativity levels were analyzed and the total number of them was observed to have been distributed at close rates to high-medium-low levels.

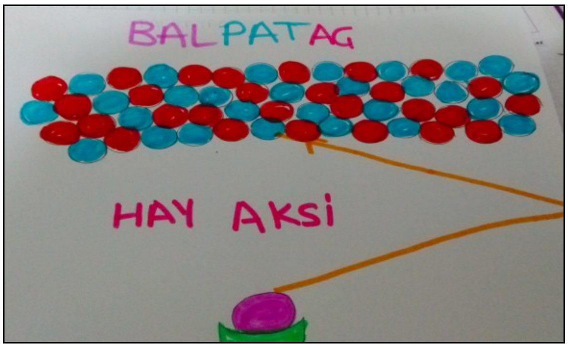

Figure 1. One of those students' game design for this activity

In the 2nd activity, students were asked to find the answers to the questions on the worksheets and in the second part of the activity, students were asked to make their own sunsdials. As can be seen in Table 2, the activities of the students were analyzed under three sub-headings: students' ability to make a sundial, students' answering questions correctly and students' ability to solve the research question.

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Table 2: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Sundial Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
2.1. Ability to make a sundial	Yes	16	%80	31	%94	47	%89
	No	4	%20	2	%6	6	%11
2.2. Answering questions correctly	High	6	%30	6	%18	12	%24
	Medium	10	%50	12	%36	22	%44
	Low	1	%5	15	%45	16	%32
2.3. Students' ability to solve the research question	High	9	%45	0	%0	9	%18
	Medium	5	%25	10	%30	15	%30
	Low	3	%15	23	%70	26	%52

For making a sundial, the control group (94%) had a higher rate of participation than the experimental group (80%). When the level of answering the questions correctly was analyzed, it was observed that the majority of the control group (45%) was found at low level, while half of the experimental group was found at medium level. It is thought that the reason why the experimental group had a better level of research than the control group is that the experimental group may have received more activity through the online platform and may be more intertwined with the internet. Finally, when the reseearch skills of students were analyzed, half of the experimental group (45%) was observed to have a high level of research skills while the majority of the control group (70%) was observed at the low level.

Figure 2: One of those students' sundial for this activity

Table 3: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Van Damme Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
3.1. Designing a commercial	Yes	15	%100	29	%100	44	%100
	No	0	%0	0	%0	0	%0
3.2. Level of creativity	High	11	%73	15	%52	26	%59
	Medium	2	%13	9	%31	11	%25
	Low	2	%13	5	%17	7	%16
3.3. Correct use of the mathematical elements	High	10	%66	12	%41	22	%50
	Medium	5	%33	11	%38	16	%36
	Low	0	%0	6	%21	6	%14
3.4. Expressing their ideas clearly about making a commercial film	High	8	%53	5	%17	13	%30
	Medium	4	%27	14	%48	18	%41
	Low	3	%20	10	%34	13	%30

In the 3rd activity, students were asked to watch the commercial film by Van Damme who is a famous film star. After watching this commercial, students were expected to make a commercial film by using the subject of angles. As seen in Table 3, this activity was analyzed under four sub-headings. 15 students from the experimental group and 29 students from the control group participated in the study. The majority of the experimental group (73%) showed a high level of creativity and approximately half of the control group (52%) showed a high level of creativity. When the correct use of the mathematical elements was analyzed, it can be seen that two thirds of the experimental group could use the mathematical concepts at the high level and the one third of them could use the mathematical concepts at the medium level. In the control group, the students were found to be close to the high and medium levels (41% -38%). As in activity 1, the correct use of mathematical elements in this activity was higher in the experimental group than in the control group. Considering the level of expressing their ideas about making a commercial film, more than half of the experimental group (53%) was at the high level, while about half of the control group (48%) was at the medium level.

Figure 3: One of those students' commercial idea for this activity.
"No matter what age you are, you are like this"

Table 4: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Fan Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
4.1. Making their own hand fans	Yes	19	%100	9	%31	28	%58
	No	0	%0	20	%69	20	%42
4.2. Explaining the reason which fan make more wind	High	5	%26	14	%48	19	%40
	Medium	7	%36	5	%17	12	%25
	Low	7	%36	10	%34	17	%35
4.3. Giving correct examples with their hand fans to show angle types	High	8	%42	1	%3	9	%19
	Medium	6	%31	20	%69	26	%54
	Low	5	%26	8	%28	13	%27

In the 4th activity, the students were expected to answer the questions on the worksheets and then complete their second part of the activity by making their own hand fans. As seen in Table 4, 19 students who participated in the activity in the experimental group made their own hand fans, while only 9 (31%) of 29 students who participated in the activity in the control group made their own hand fans. The answers of the experimental group to the reasoning question on the worksheet were concentrated equally in the medium and low levels. The answers of the control group were mostly at the high level. In the last part of the activity, students were asked to take their hand fans' photographs in different ways showing the angle types or to draw a model by looking at their fans. When the accuracy of their models or drawings were analyzed, it was seen that the majority of the experimental group (42%) was at the high level and the majority of the control group (69%) was at the medium level.

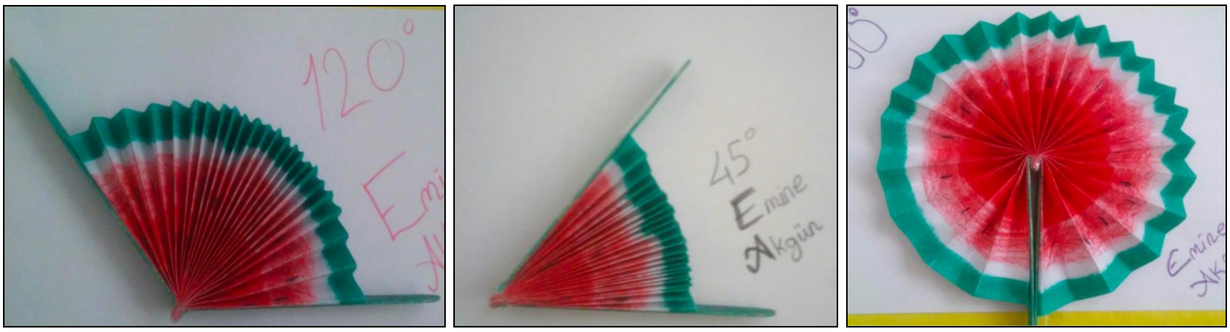

Figure 4: One of those students' hand fan to give examples for some angles

Table 5: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Michael Jackson Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
5.1. Did they reach the correct answer?	Yes	17	%94	10	%33	27	%56
	No	1	%6	20	%66	21	%44
5.2. How much research they did to find the answer?	High	15	%83	8	%27	23	%48
	Medium	3	%17	16	%53	19	%40
	Low	0	%0	6	%20	6	%13

In the 5th activity, the students were asked to watch Michael Jackson's Smooth Criminal dance and search how Michael Jackson did the bending movement without using a computer effect. As it is seen in Table 5, it was analyzed whether the students were able to reach the correct answer and how much research they did to find the answer. A large majority of the students in the experimental group (94%) reached the correct answer, while more than half of the control group (66%) did not reach the correct answer. When the levels of their researches were analyzed, it was seen that the experimental group was at the high level (83%) and approximately half of the control group (53%) was at the medium level. The experimental group's participating in the activities using Edmodo program and their using internet effectively gave them the opportunity to do better researches than the control group. This, as in the sundial activity, moved the research levels of the experimental group up to a better level.

Figure 5: One of those students' answer to explain how Micheal Jackson does his dance figure.
"You may watch in this video more detailed, and this picture explains most things."

Table 6: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Scoliosis Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
6.1. Did they reach the correct answer?	Yes	5	%26	15	%52	20	%42
	No	14	%74	14	%48	28	%58
6.2. Giving correct examples similar to scoliosis	Yes	12	%63	27	%93	39	%81
	No	7	%37	2	%7	9	%19
6.3. How much research they did to find the answer?	High	2	%11	3	%10	5	%10
	Medium	13	%68	22	%76	35	%73
	Low	4	%21	4	%14	8	%17

Scoliosis is a type of disease that results from spinal curvature and leads to posture disorder. The students were also asked to search this disease in the context of the 6th activity and to find other diseases in our body that are similar to this condition, resulting from posture angle disorder. In the first part of the activity, the students were asked after what degree the scoliosis became critical. As can be seen in Table 6, a large majority (74%) of the experimental group did not reach the correct answer, but approximately half of the control group (52%) found the correct answer. When that the students were able to find the right examples was analyzed, it was observed that the both groups concentrated at the high level (63-93%). It is thought that the reason why the control group reached the correct answers at such a high level is the fact that the students helped each other in the classroom and then answered the questions. When their levels of research to reach the answer were analyzed, it is seen that both groups concentrated at the medium level (68- 76%).

Table 7: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Pisa Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
7.1. Did they reach the correct answer?	Yes	16	%76	25	%76	41	%76
	No	5	%24	8	%24	13	%24
7.2. Did they find similar examples ?	Yes	15	%71	26	%79	41	%76
	No	6	%29	7	%21	13	%24
7.3. How much research they did to find the answer?	High	8	%38	15	%45	23	%43
	Medium	7	%33	7	%21	14	%26
	Low	6	%29	11	%33	17	%31

In the 7th activity, the Pisa Tower, which is located in Italy, was told to the students. In the first part of the activity, the students were asked to search how many degrees the Pisa tower was leaning. In the second part of the activity, they were asked whether there were other similar structures in the world and they were asked to give examples if any. As can be seen in Table 7, the activity of Pisa was analyzed under three sub-headings. When the correct answers were analyzed, it was seen that both groups reached an equal ratio (76% -78%). In another sub-heading, it was observed that a significant majority of students in both groups could find the right examples. When the level of doing research to reach the answer was analyzed, the experimental group was distributed at close to high-medium- low levels, while almost half of the control group (45%) concentrated at a high level.

Table 8: Frequency Distribution and Percentages of Experimental and Control Groups According to Sub Headings of Tangram Activity

Sub Headings	Categories	Frequency (Experimental Group)	Percentage (Experimental Group)	Frequency (Control Group)	Percentage (Control Group)	Frequency (Total)	Percentage (Total)
8.1. Did they design a puzzle?	Yes	12	%75	15	%75	27	%75
	No	4	%25	5	%25	9	%25
8.2. Formation level of the given tangram shapes	High	0	%0	14	%70	14	%41
	Medium	7	%50	4	%20	11	%32
	Low	7	%50	2	%10	9	%26
8.3. Level of determining the rules of the puzzle	High	2	%17	1	%7	3	%11
	Medium	3	%25	3	%20	6	%22
	Low	7	%58	11	%73	18	%67

8.4. Correct use of the given mathematical elements	High	2	%17	0	%0	2	%7
	Medium	7	%58	10	%67	17	%63
	Low	3	%25	5	%33	8	%30

In the 8th activity, students were informed about what tangram was and asked to do some research to get more information and then asked to form the given tangram shapes. In the last part of the activity, students were asked to create their own puzzles using geometric objects. The activity was analyzed under four sub-headings as seen in Table 8. When the puzzle design rates are examined, it is seen that the experimental and control groups have an equal success rate (75%). In the formation of the given tangram shapes, the experimental group showed an equal distribution at the medium and low levels, while the majority of the control group (70%) was concentrated at the high level. When the levels of determining the rules of the puzzle are analyzed, it is observed that both groups concentrated at the low level (% 58-% 73). It is thought that the students could not determine the rules clearly, because they preferred to show their puzzles by drawing rather than writing. When the correct use of the given mathematical elements is analyzed, it is seen that more than half of the students (58- 67%) concentrated at the medium level in both groups.

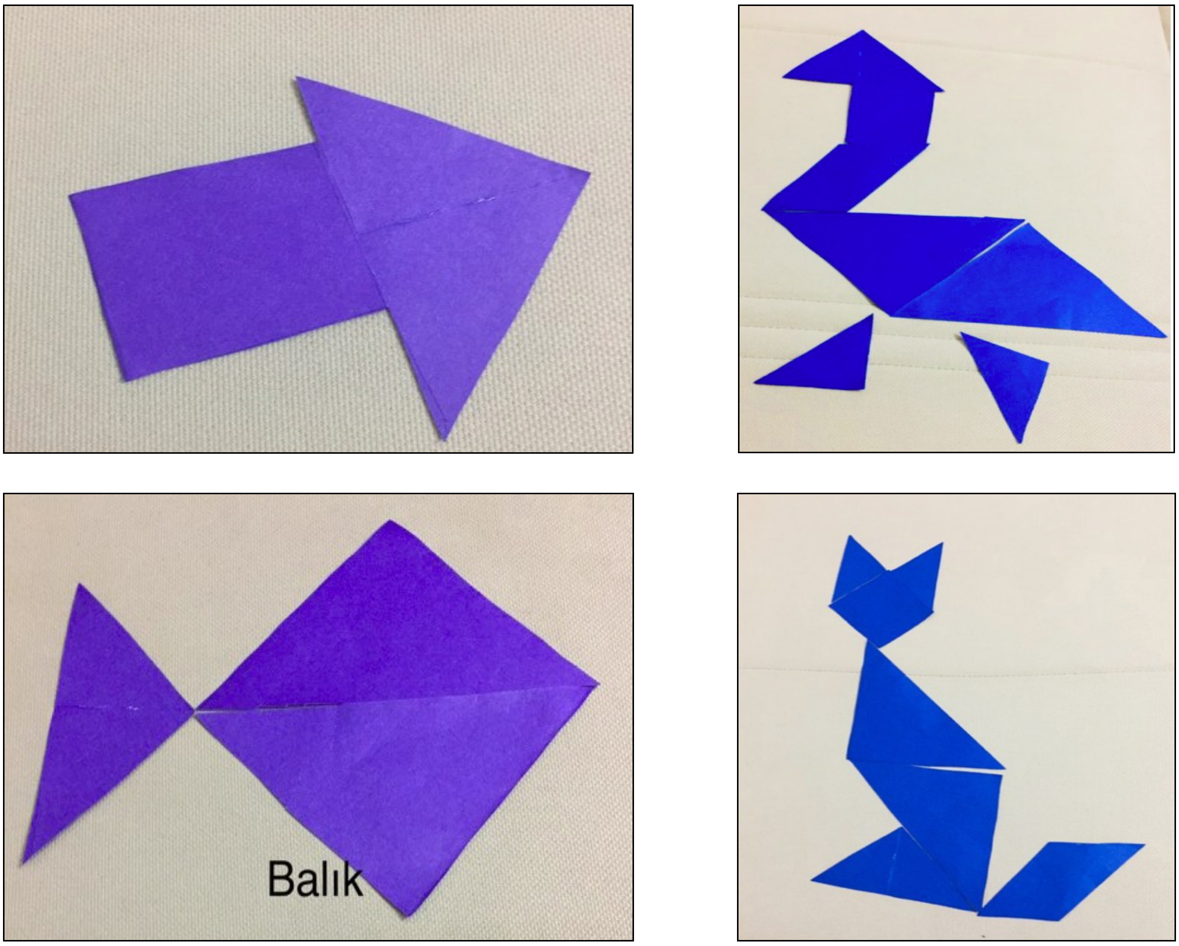

Figure 6: One of those students' tangram shapes for this activity

4. Discussion

In this section, discussions and suggestions about the results of the analysis of the study according to sub-headings are given. Activities prepared within the framework of Realistic Mathematics Education have been applied to the students for 8 weeks as one activity per week. These 8 different activities were analyzed according to the determined criteria. However, these sub-headings were categorized under 5 main headings. These headings are; to be able to design a product, to be able to express mathematical ideas clearly, to be able to do a research, to be able to use mathematical knowledge and creativity. While the creativity levels of the students could only be analyzed with 2 activities, the use of mathematical knowledge could be analyzed in all activities.

We believe that the reason why control group had a higher success rate in game design section in which we wanted students to use their mathematical knowledge is because they had not used e-portfolio platform before. In addition, it was observed that the majority of the both groups were able to determine the rules at a low level. Students were expected to use angles effectively in their plans. It is also seen that the mathematical literacy of both groups were not at the desired level. The ability of students to model the games they planned was significantly higher in both groups. It has been observed that the creativity elements in their games were distributed at close to high-medium-low levels.

For making a sundial, the control group (94%) had a higher rate of participation than the experimental group (80%). When the level of answering the questions correctly was analyzed, it was observed that the majority of the control group (45%) was found at low level, while half of the experimental group was found at medium level. It is thought that the reason why the experimental group had a better level of research than the control group is that the experimental group may have received more activity through the online platform and may be more intertwined with the internet. Finally, when the reseearch skills of students were analyzed, half of the experimental group (45%) was observed to have a high level of research skills while the majority of the control group (70%) was observed at the low level.

It can be said that the use of e-portfolio contributes positively to the students' accessing information by using technology in an online platform. This finding is parallel to the studies on technology literacy. (Morgil et al., 2004) There are some findings that indicate that students' building high quality relationship with technology and use online platforms make them more effective in technology literacy. The students were also expected to design a commercial film using angles. 15 students from the experimental group and 29 students from the control group participated in the study. The majority of the experimental group (73%) showed a high level of creativity and approximately half of the control group (52%) showed a high level of creativity. When the correct use of the mathematical elements was analyzed, it can be seen that two thirds of the experimental group could use the mathematical concepts at the high level and the one third of them could use the mathematical concepts at the medium level. In the control group, the students were found to be close to the high and medium levels (41% -38%). As in activity 1, the correct use of mathematical elements in this activity was higher in the experimental group than in the control group. Considering the level of expressing their ideas about making a commercial film, more than half of the experimental group (53%) was at the high level, while about half of the control group (48%) was at the medium level.

As a result of the findings of this sub-problem, e-portfolio application is a process that students enjoy to participate. Although the students had some hesitations at the beginning of the application, developing original products, improving their ability to use information technologies and undergoing a process that did not have passing grade anxiety led to a positive change in students' opinions towards application. The fact that e-portfolio application is a student-centered method was another benefit. At the end of the application of this process, which has a supporting role in the traditional education method, it was observed that the students were satisfied with their works, the display of the products they made and the evaluation by their friends. This is similar to other studies that have reached the conclusions that e-portfolio products improve the students' learning experiences (Luchoomun, McLuckie, & Wesel, 2010).

In the 4th activity, the students were expected to answer the questions on the worksheets and then complete their second part of the activity by making their own hand fans. In this activity, it was expected by the researchers to reflect the gains of angles on their products.19 students who participated in the activity in the experimental group made their own hand fans, while only 9 (31%) of 29 students who participated in the activity in the control group made their own hand fans..

The high participation rates of the students using e-portfolio are in parallel with the studies that indicate that the e-portfolio increases the student motivation (Dağ, 2012). For the reasoning question on the worksheet, the experimental group was equally distributed at the medium and low levels, and the half of the control group (48%) was concentrated at a high level. This finding contradicts the findings of other studies, which have reached the conclusion that the e-portfolio increases student success (Luchoomun, McLuckie, & Wesel, 2010).

In the last part of the activity, students were asked to take their hand fans' photographs in different ways showing the angle types or to draw a model by looking at their fans. When the accuracy of their models or drawings were analyzed, it was seen that the majority of the experimental group (42%) was at the high level and the majority of the control group (69%) was at the medium level.

The fact that the students' modeling rates are high in the control group using e-portfolio suggests that they had the opportunity to collaborate on the online platform and that they found the opportunity to analyze the works of their other friends. This situation emphasizes the positive contribution of cooperative work to the creativity and modeling skills as well as motivation.

Students were asked to do a research about how Michael Jackson did his leaning movement while dancing without using a computer effect and how many degrees the Pisa tower was leaning. It was found that the control group conducted their researches at the high level in both tasks.

In the Tangram activity, students were asked to do a research again and it was focused on students' designing their own puzzles by using geometrical objects. When the puzzle design rates are examined, it is seen that the experimental and control groups have an equal success rate (75%). In the formation of the given tangram shapes, the experimental group showed an equal distribution at the medium and low levels, while the majority of the control group (70%) was concentrated at the high level. When the levels of determining the rules of the puzzle are analyzed, it is observed that both groups concentrated at the low level (% 58-% 73). It is thought that the students could not determine the rules clearly, because they preferred to show their puzzles by drawing rather than writing. When the correct use of the given mathematical elements is analyzed, it is seen that more than half of the students (58- 67%) concentrated at the medium level in both groups.

Even though this situation verified the contribution of the e-portfolio process to the level of doing a research, it did not contribute to mathematics literacy. The activities prepared within the framework of RME has been motivating and enjoyable for students, so they have participated in the activities. This finding is expected to be encountered in the application of Realistic Mathematics Education (Freudenthal, 1991; Zulkardi, 2000). However, it is observed that activities prepared within the framework of RME and integrated with e-portfolio platform did not contribute to the students' mathematical literacy and their expressing their mathematical ideas clearly in the desired level. As a result of the findings, it was thought that 8 weeks were not enough for these skills to develop. Additionally, any studies were not found analyzing the relationship between these skills and e-portfolio in the literature. However, in the study conducted for 8 weeks, it is seen that e-portfolio has positive effects on students' skills of doing a research, modelling and designing creative products. This situation is in parallel with the studies in the literature (Nguyen, Hsieh & Allen, 2006; Gömleksiz, & Ayhan, 2010; Dağ, 2012).

Lımıtatıons

- Since participation in application is voluntary, the number of participants was low, but since the study is a qualitative study, the aim of generalization is not intended.
- Because the experimental group used the electronic portfolio software called Edmodo, it was more difficult to adapt to the study than the control group.

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