The Effect of Mathematical Worksheets Based on Multiple Intelligences Theory on the Academic Achievement of the Students in the 4th Grade Primary School

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Abstract The aim of this research is to examine the effect of Math worksheets based on the Multiple Intelligences Theory on the academic achievement of students in the 4th grade primary school. The sample of the research consists of 64 (32 experimental and 32 control) students who are studying in the 4th grade in a primary school affiliated to the Ministry of National Education in the province of Bağlar, Diyarbakır in the academic year of 2016-2017. Experimental design with pre-test and post-test control group was used in the study. The obtained pre-test and post-test data were analyzed with SPSS 22.00 package program. Content analysis of interview data was conducted. According to the results of the research, it is shown that Math worksheets prepared on the basis of the Multiple Intelligences Theory has increased the academic achievements of the students in general. According to these results, it can be said that the preparation of Math worksheets according to students' different intelligence fields can positively influence the academic achievement of the students.

Keywords Multiple Intelligence Theory, Worksheets, Academic Achievement

1. Introduction

In the developing and changing world, it has become important for children to learn ways to obtain information instead of memorizing information because of the rapid obsolescence of information. This change and development in the world has also brought the change and development in the field of education. Traditional approach-based learning and teaching models which aim students to memorize the information are abandoned; concurrently construction-based learning and teaching models which are student-centred and provide access to the existing knowledge have been adopted. Recently, with these developments in the field of education, new learning and teaching approaches have emerged. Some of the approaches are: Life-long Learning, Collaborative Learning, Project-based Learning, Problem-based Learning, Mastery Learning, Discovery Learning Technique, Reflective Learning, Brain-based Learning, Active Learning and Multiple Intelligence Theory. Amongst these approaches multiple intelligence theory, was put forward by Howard Gardner in 1983. According to his theory, Gardner argues that individuals have no single intelligence component, that there are eight independent intelligence components that are independent of each other, and that these intelligence components that exist in the individual can be improved at a certain rate [8].

Gardner asserts that the traditional intelligence approach is advantageous in terms of convenience created by a common measure of student learning but is not helpful in discovering the student's strengths and weaknesses and suggests that intelligence has eight components which function independently from each other [3]. Gardner's [9,10] eight elements of intelligence that are mentioned in the multiple intelligence theory are; verbal-linguistic intelligence, logical-mathematical intelligence, visual-spatial intelligence, bodily-kinesthetic intelligence, musical-rythmic intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence. In recent years Gardner identified the "existentialist intelligence" as the ninth intelligence type; however Gardner, has not given approval because of the absence of evidence in the nervous system. This is because according to Gardner, one of the criteria of intelligence is there are evidences in the brain [16].

Learning and teaching environments based on

mathematical and verbal intelligence were predominantly used in traditional approach-based learning and teaching models with the aim of memorizing the information that existed in the students. However, verbal and mathematical intelligence areas are not dominant in every student. Apart from verbal and mathematical intelligence areas, some students have different dominant fields of intelligence such as physical, musical, visual, and social. Additionally, learning styles differ from each other just because students' intelligence areas are different from each other. Teachers should take into account individual differences among learners as they organize the learning and teaching environment. Thus, the learning and teaching environment should be considered and established in such a way that each student may have a different learning style and the field of intelligence [13].

While handling a unit, teachers should include activities that are appropriate for each intelligence field. However, it should never be tried to prepare activities for all the fields of intelligence in the same lesson. Already, this is not possible in practice. Rather, activities for different kinds of intelligence can be distributed among the following lessons. Gardner states that it is enough to include two activities of intelligence in one lesson [4]. Campbell notes that there have been a great deal of work on the Multiple Intelligences Theory on classroom practices; but the best of them cannot be determined; he also emphasizes that the teachers should choose appropriate methods by looking at the classroom environment, aims and the society.

Some educators advocate to use intelligence areas in educational processes that will provide many starting points; some others advocate to determine the strong or dominant fields of intelligences of every student since nursery school [6].

With the help of improved intelligence areas, it is possible for students to love mathematics and make them understand concepts better [12]. From this perspective, it is very important to apply the theory of Multiple Intelligence in teaching. With the activities, according to their intelligence areas, the lessons can be loved by the students. For example; a student with a high level of visual intelligence can love a math class with visual symbols. Likewise, a person with a high level of social-interpersonal intelligence can love mathematics by doing group work in mathematics. Classroom activities have a very important place in contemporary education concept; just because it is necessary to establish the democratic classroom environments in which the students are active in the contemporary education understanding and activities in which the students develop creative thinking directions. In other words, this understanding necessitates the use of materials that will be prepared in the direction of strategies, methods and techniques to ensure permanent learning [5]. One of these teaching materials is worksheets. Worksheets are written materials containing explanations that provide guidance on activities that students will take in the course of teaching any

topic [15]. According to Aydoğdu and Kesercioğlu [2] worksheets are important materials that enable students to organize their knowledge, including the steps of what the students need to do, and which ensure participation in the activity of the whole class at the same time. Mortensen and Smartt [14] identify worksheets as a strategy that allows them to control their own learning because it allows them to decide how and where to use the assigned tasks.

In an understanding of teaching that students are responsible for their own learning; it is important for the teachers to not to leave the students alone but to provide instructional environments that will give students the chance to test their experiences so that they can create their own knowledge and the guidance materials that they can use in these environments In this direction, teachers need guidance materials prepared by researchers or experts. These materials may be prepared around a unit or a concept, or may be prepared to cover all topics in the curriculum in a particular discipline, which relate to each other [1]. In addition, if teachers can analyze students' individual characteristics well and train their learners more versatilely, they can offer plans and rich options considering these features. To develop students' diverse learning experiences in order to be multi-faceted and creative, it is important to create a friendly and loving classroom atmosphere that can meet their emotional needs and to have positive and high expectations about them [11].

In this research, we tried to find answers to the following questions:

1. The effect of mathematical worksheets prepared according to the Multiple Intelligences Theory on the academic success of students;
2. Whether mathematical worksheets facilitate students' learning or not;
3. Whether the students want to do math worksheets or at home;
4. Investigate what kind of activities students want to have on mathematical worksheets

2. Methodology

2.1. Model of the Research

In this study, semi-experimental method was used as experimental method. Experimental method is used to investigate any event, case, object, subject and effect in the research, to reveal cause-effect relationships between variables and to compare and measure these results. To do this the research situation or environment is created. This environment usually happens to be an artificial one. The main reason for the need for this method is to measure the effectiveness of any " thing ", and if the result of the measurement is positive, to make proposes with the help of the results [7].

2.2. Sample of Research

The sample of the research consists of 64 students who are studying in the 4th grade in a primary school affiliated to the Ministry of National Education in Bağlar - district of Diyarbakır province - in the academic year of 2016-2017. 32 of these students are in the experiment and 32 of them are in the control group. Experimental and control groups have ensued as two classes, one for each class. 10 students in the experiment group were applied in the interview.

2.3. Data Collection Tool

The "Achievement Test" developed by the researcher was used to collect the data of the research. The achievement test consists of 20 questions and validity and reliability studies were conducted. For the reliability of the test, Kuder-Richardson 20 formula was used and the test was found to be reliable at the level of 0.891. For the validity, expert opinions were taken. The semi-structured interview form prepared by the researcher was used to gather interview data. The data collection tool consists of three open ended questions. There were no limitations on the answers of the students. The interview was recorded by taking permission from the students. The questions asked by the students during the interview were clear and understandable and were examined by two experts on the validity aspect.

2.4. Analysis of Data

In the analysis of the obtained data, scores obtained from pre-test and post-test were transferred to SPSS 22.0 package program and analyzed with using t-test. Content analysis was used in analyzing the data obtained from the interviews. With the aim of providing coding consistency two different researchers in the field coded it and the consistency was found 87 %. During the analysis, codes were created reflecting the views expressed by the students towards the questions. After coding, pairing process was conducted. In the pairing process, the codes are merged to create sub-themes and each sub-theme is placed under themes.

Implementation Steps of the Study: The implementation process of the study was carried out according to the following steps:

First Phase

In the first phase of the study, a mathematical worksheet based on the Theory of Multiple Intelligences was prepared in the direction of expert opinions on comprehension of the Fractions Unit. The worksheet prepared in this way was piloted with 8 students in a different class than experimental and control group. Thus, it was aimed to determine and solve the problems that can occur in the content and during the use of the prepared mathematical worksheets.

Second Phase

An "achievement test" consisting of 20 multiple-choice questions from the Fractions Unit was prepared. The 4th grade course and activity books were used while the achievement test was being prepared. The validity of the achievement test has been examined by experts in the field. The KR-20 reliability coefficient was taken into account in the reliability tests and as a result of the analyses the KR-20 reliability factor of the success test was calculated as 0.891.

Third Phase

Before the implementation at the stated school; one of two classes determined as an experiment and the other was determined as a control group by the appropriate sampling method. Before the expression of the topic at the pre-test implementations process, achievement test was conducted to both control and experiment group. Then the Fractions Unit was taught using the traditional method to the control group and the mathematical worksheet based on the Multiple Intelligence Theory to the experimental group. While the activities were being conducted, two students were provided with one worksheet so that students could work together. In the post-test process held after the expression of the topic, achievement test was conducted to each student at both groups and the findings were compared with the first findings.

Fourth Phase

In the study, the scores of the students in the experimental and control groups on the success test applied before and after the activities were analyzed using the SPSS 22.0 package program. In evaluation process of the obtained data; the mean values of the students' achievement tests and independent groups benefited from the t-test.

3. Findings

Findings and interpretations of mathematical worksheets based on the Multiple Intelligence Theory in the 4th grade of primary school in relation to the academic achievement of students.

The results of comparing the pre-test scores of the experimental and control groups with the independent t-test are given in Table 1.

Table 1. Comparison of the pre-test scores of the "Fractions Unit" of the experimental and control groups with the independent t-test

Groups	N	Average	Ss	Sd	t	p
Experiment	32	7.28	0.73	62	0.84	0.403
Control	32	7.09	1.03			

As seen in Table 1, there was no significant difference between the groups according to the pre-test results applied to compare the achievements of the experimental and control groups before implementation [$t_{(62)}$= 0.84; p>0.05]. Pre-test score averages of groups $X_{experiment}$ = 7.28 and $X_{control}$ = 7.09

The comparison of the end-test scores of the experimental and control groups with the independent t-test is given in Table 2.

Table 2. Comparison of the "Fractions Unit" end-test scores of the experimental and control groups with the independent t-test

Groups	N	Average	Ss	Sd	t	p
Experiment	32	13.53	2.12	62	8.12	0.00
Control	32	10.25	0.84			

As seen in Table 2, there was a significant difference in favor of the experimental group among the groups according to the post-test scores applied to compare the achievement of the experimental and control groups after the administration [$t_{(62)}$= 8,12; p<0.05]. When the post-test scores of experimental and control groups are examined; ($X_{experiment}$ = 13.53; $X_{control}$ = 10.25) The experimental group seems to be more successful.

Table 3 compares the pre-test and post-test scores of the control group with the dependent t-test.

Table 3. Comparison of pre-test and post-test scores of the "Fractions Unit" of the control group with the dependent t-test

Groups	N	Average	Ss	Sd	t	p
Pre- test	32	7.09	1.03	31	-11.86	0.00
Post-test	32	10.25	0.84			

As shown in Table 3, there was a significant difference between the pre-test and post-test success scores applied to the control group in favor of the post-test [$t_{(31)}$= -11,86, p <0.05].

Table 4 compares the pre-test and post-test scores of the experimental group with the dependent t-test.

Table 4. Comparing the pre-test and post-test scores of the "Fractions Unit" of the experimental group with the dependent t-test

Groups	N	Average	Ss	Sd	t	p
Pre- test	32	7.28	0.73	31	-18.53	0.00
Post-test	32	13.53	2.12			

As shown in Table 4, there was a significant difference between the pre-test and post-test success scores of the test group in favor of the post-test [$t_{(31)}$= -18,53, p<0.05].

Findings and interpretations obtained from the research's interview technique

Research's "Does the Maths worksheets given to you make it easier for you to learn? Can you explain why with reasons?" questions were accepted as the main theme. The themes obtained from the analyzes are shown in Table 5.

Table 5. Comments on whether mathematical worksheets of students in primary 4th grade make it easier for students to learn (N=10)

Themes	Sub-Themes	Frequency
It makes it easier	Interesting and attention-grabbing	7
	Having visual content	6
	Its being based on collaboration	6
It doesn't make it easier	Its being difficult	1

When Table 5 is examined, it is seen that the sub-theme with the highest frequency is "interesting and attention-grabbing" according to the opinions of the students in the 4th grade of primary school, whether the mathematical worksheets facilitate students' learning. This is followed by sub-theme "having visual content". Subsequently, it is followed by sub-theme "being based on co-operation" and "being difficult" respectively. Some students' responses to this question are as the following;

I understand better when I work with Emre (Student 8). I cannot solve the questions on this sheet very hard, I do not want to do it when I cannot solve it (Student 5). There are plenty of pictures on these leaves and I love the pictures. I understand better when there is a picture (Student 2).

Research's "Do you want to do sheet in the classroom or at home? Can you explain why with the reasons?" questions were accepted as the main theme. The themes obtained from the analyzes are shown in Table 6.

Table 6. Opinions on whether primary school students in grade 4 want to do their Math worksheet in the class or at home (N=10)

Themes	Sub-themes	Frequency
In the Class	I want to play at home	8
	I want to work with a group	6
At Home	I feel more comfortable	2
	I have more time	2

When Table 6 is examined, it is seen that the sub-theme with the highest frequency is "I want to play at home" according to the opinions of the students in Primary 4th grade who want to do math works or class at home. It's followed by the sub-theme "I want to do it with a group". These are followed by the sub-themes "I feel more comfortable" and "I have more time". Some students' responses to this question are as following;

I want to do it in the class. Because I want to play games at home and watch TV (Student 3). I want to do it in the class. When I go home, I want to play games with my friend Sinan. My dad does not allow me to play games when I have my homework (Student 1). I want to do it at home. My other friends in school are doing faster than me. I cannot keep up with them. But I can do it slowly at home. (Student 6).

The question "What kind of activities do you prefer in the math worksheets you are given?" has been accepted as the main theme of the research. The themes obtained from the analyzes are shown in Table 7.

Table 7. Opinions on what kind of activities do the 4th grade primary school students want to have on Math worksheets (N=10)

Themes	Frekans
Being interesting and attention-grabbing	7
Having visual content	6
Involves group work	6
Having more questions	3

When Table 7 is examined, it is seen that the theme with the highest frequency is "interesting and attention-grabbing"

according to the opinions of the 4th grade primary school students about what kind of activities do they want on their Math worksheets. This is followed by "having visual content". Subsequently, it is followed by "involving group work" and "the number of questions" themes. Some students' responses to this question are as following;

> I would like to have more pictures on these sheets. I paint those sheets afterwards (Student 8).
> Emre and I solve the questions together. Emre is more hardworking than me. He's helping me when I cannot figure it out. (Student 7)
> I want to have more questions on these sheets. I quickly finish doing it; I would like it to last longer. (Student 10))

4. Conclusion, Discussion and Recommendations

4.1. Conclusion and Discussion

When the Fragmentation Unit success test results are examined, statistical analysis results show that there is no significant difference $[t_{(62)}= 0.84; p>0.05]$ between the pre-test scores. When the pre-test success scores of the Fractions of the students of the experimental and control groups were taken into account, it was determined that the average scores ($X_{experiment} = 7.28$; $X_{control} = 7.09$) of the students in the two groups were very close to each other The fact that the scores of the two groups do not show a significant difference according to the results of the t-test at the Fractional Unit indicates that the students have similar preliminary knowledge about the subject. When the post-test scores of the groups were examined, it was seen that there was a significant difference $[t_{(62)}= 8.12; p<0.05]$ in favor of the experimental group. It is observed that the average of the students in the experiment and control group at the Fractions Unit increased after the implementations. The average scores of the students in the experimental group after the implementation at the Fractions Unit are increased from 7.28 to 13.53; while the control group's average scores are increased from 7.09 to 10.25. A statistically significant difference was found in favor of the experimental group between the control and the experimental group's post-test scores. Accordingly, it can be said that teaching with Math worksheets based on the Theory of Multiple Intelligence in the experimental group is more successful than traditional teaching in the control group.

It can be said that; group-work based activities in the Math worksheet which are based on the Theory of Multiple Intelligence eased students' learning processes who has social-interpersonal intelligence; also the shapes, symbols, graphics, etc. helped students who has visual-spatial intelligence and lastly; expressing the subject in an explanatory way with verbal expressions facilitates the learning of students who has verbal-linguistic intelligence.

It has been seen that the students have stated that the implementations of the worksheets should be in the classroom environment but should not be given as homework. According to this result, it can be said that students do not want to do homework after school hours, but they want to do more physical activities like the students at their age should do

4.2. Suggestions

1. The activities on the worksheets can be prepared taking into account the different intelligences of the students.
2. Worksheets may include activities involving group work. In this way, students can benefit from peer education.
3. Worksheets may not be given as homework but may be applied in the classroom environment in the presence of teachers.

4.3. Proposals for Further Research

1. This research can be conducted using different research methods and samples.
2. The effect of the worksheets based on the Theory of Multiple Intelligence on other (Turkish, Science et.) lessons can be researched

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