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The Effects of Activity Based Learning on Sixth Grade Students' Achievement and Attitudes towards Mathematics Activities

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ABSTRACT

The aim of this study was to investigate the effects of activity based learning on sixth grade students' mathematics achievement in comparison to traditional learning, and determine their attitudes towards activities. Experimental research design with pretest-posttest control group was applied in the study. The participants, which included 78 sixth grade students, were previously divided into two groups by random assignment. One group received traditional learning and the other group received activity based learning. The study was carried out for four weeks on the mathematics subject of "integers". For collecting data the mathematics success test and the Likert type attitudes towards mathematics activities scale were used as pretest and posttest. As a result, the academic achievement for both groups were positive increased. On the other hand, while the attitudes towards activities of students' in the experiment group decreased significantly, they increased in the control group.

Keywords: academic achievement, attitude, activity based learning, mathematics activities

INTRODUCTION

The importance of mathematics to man has accounted for its inclusion in school curriculum as a compulsory subject for every child of school age to acquire the appropriate mathematical skills that will enable him cope with life challenges. With regards to this, mathematics should be taught as a core subject to all students at primary and secondary school level in order to give a sound basis for scientific and reflective thinking, and prepare them for the next level of education. The importance of mathematics does not only lie in its contributions to scientific and technological development but also in its utility in day-to-day interactions at the market places, transportations, business of all sorts by both literate and illiterate members of the society (Golji & Dangpe, 2016).

The use of traditional teacher-centered approaches in mathematics has been recognized as none inceptively for many students. According to studies has reported that students often view mathematics as a set of isolated procedures, failing to see real-life applications of their learning outside of the classroom. However, researchers have found that mathematics classrooms and the individualistic nature of mathematics, whereby students work independently, actually discourages learning. Therefore improving student enjoyment of mathematics is a key strategy to address subject disengagement. Innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' achievement in mathematics (Riley et al., 2017). In Turkey, radical curriculum changes were made in the field of mathematics by 2005. Instead of traditional approach, constructivist approach and teaching methods come to the fore. However most of teachers who conduct the teaching process may prefer to use traditional teaching methods which are still habits due to the crowded classes, limited time, material inadequacy and inadequate facilities. Constructivist education, which has recently been aimed to gain functionality, started to also appear in mathematics teaching. After the students receive this information, they are led to repeat these via questions related to the subject. Solution to the questions are created beforehand and they have only one answer. A student who provides or finds this answer is academically successful. In an environment of such an approach, students are passive receivers (Olkun & Uçar, 2014).

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Contribution of this paper to the literature

- This study aimed to investigate the effects of activity based learning on sixth grade students' mathematics achievement in comparison to traditional learning, and determine their attitudes towards activities.
- Activity based learning in mathematics may increase students' academic success in comparison to traditional education. On the other hand, while the attitudes towards activities of students' in the experiment group decreased significantly, they increased in the control group.
- Our study points out that the necessity of activities in integer numbers and suitability for objectives, to reach more positive student attitudes towards activity based implementation.

After the NTCM (National Council of Teachers of Mathematics) publication about mathematics education standards reflecting the constructivist approach, constructivist curricula were developed in many countries, and this theory's influence in the world of education grew. In 2005, nearly fifteen years after the NCTM's call, curricular reform began in Turkey. The Turkish education system tried to replace the traditional behaviorist teaching approach. This approach is centered on the teacher, and it renders students passive, since it supposes learning to occur by means of the teacher transferring knowledge to passively listening students (Doruk, 2014).

In the traditional approach of teaching, instead of methods that provide students with ability to interpret, reason, analyze and synthesize, the bundles of information divided into pieces that are far from entirety given to students lead them to memorize these pieces rather than making sense of mathematics and setting it on a basis. The roles of students and teachers in this traditional method used in Turkey can be described as students are mainly passive and do not responsible from their own learning, teachers are actively engaged in learning process and responsible from students' learning. During this teacher centered approach, teachers mainly use course books and solve ordinary problems as examples on board. One of the disadvantages of this practice is that it is almost impossible for one instructor to ensure each student with individualized attention or instruction (Ehrenberg, Brewer, Gamoran, & Willms, 2001). This kind of teaching approach could make challenge to the nature of mathematics, and while the abstract nature of the discipline of mathematics creates the idea that mathematics is difficult in the mind of the student, the passivity of the student in the process also makes mathematics even more complicated. In this approach, students do not have a role as individuals who listen, analyze questions and answer questions, but they have an active role as individuals who question, interpret, reason, wonder, not only solve the problem but also construct it, showing the initiative of a typical scientist and forming their own cognitive structures with the help of activities (Ayhan, 2011). The purpose of this curriculum is to bring the student into an active position as opposed to a passive position. While the student in a passive position is presented with bundles of information, the active student constructs a comprehensive structure by making sense of expression(s) and sets it on a basis instead of learning things in bunches. Hence, activity based teaching in mathematics education has gained importance. The student who receives information passively in the traditional learning approach, actively creates information with their interactions with peers and experiences in the activity based approach (Köstereliođlu, Bayar, & Köstereliođlu, 2014).

Effects of Attitudes on Learning

An information of observable facts and principles of learning is crucial role to our understanding of the behavior of people. As we learn a new notion by following any particular process of learning we can device a preferable education system that becomes self-sustainable. Learning is more or less a persistent change in behavior potential that occurs as a result of practice. It happens because our mind is exposed to our ever changing surrounding, owing to which it learns by observation. This means that learning refers to relative changes within the system (Malhotra et al., 2015). Considering that learning is an active process in activity based education, it is needed to prioritize activities in order to create education environments that lead students to learn by doing and experiencing. While monotonous education environments continue the passivity of students, the targeted was of constructivist education should not only contain a presentation method that activates the student, but it should also take a role in leading class environment and time slots to be supportive elements in students' participation. It is needed to save children from boring classroom environment and the limits of thinking in solid patterns, and take them to a multi-dimensional world, where processes such as imagination, perception and emotion are intertwined (Bahadır & Özdemir, 2013).

One of the obstacles against learning in mathematics teaching is the attitude of the student towards the class and factors that are related to the class. Factors such as course content, course presenter and readiness of the students, way of presentation, learning and teaching environment determine the students' attitudes. Continuity and change of the attitude are closely related to the state of the variables within the context of teaching/learning. Positive aspects affecting learning appear as a qualified learning feedback for the learner. An attitude is "a tendency that is attributed to a person which regularly constructs their thoughts, emotions and behaviors regarding a

psychological object." (Pehlivan, 2008). Attitudes emerge in students as an effect of learning environment, and are expressed as a shape of cognition, affect and behavior. Therefore, student attitude toward a learning environment is a critical factor, which determines the effectiveness of instruction and learning outcome, in designing lessons (Han & Carpenter, 2014). It is positively related to achievement in any engagement. For instance, attitude is principal to the dynamics of behavior and determines how far a student learns. Also, attitude has to do with the way one perceives, the opinion one holds as well as what one beliefs about a thing, people, activities, establishment, administrations and phenomena in general. Someone's attitude about an object, case, or group of people can also identify his achievement (Harbor-Peters, 2005).

Math anxiety and attitude have very substantial role in students' mathematics success. Math anxiety is a feeling of intense frustration or helplessness about one's ability to do mathematics. Students experience extreme discomfort and feelings of anxiety when thinking or doing mathematics and the term generally used to describe this state is mathematics anxiety. It can occur in all levels of education from primary school to higher education and, once established, can keep for life, interfering with daily activities involving numeracy and further learning of mathematics (Yenilmez, Girginer, & Uzun, 2007). Teachers' delivery technique may have an effect on students' mathematics anxiety. Mathematics has been based on a traditional delivery technique in many classrooms, with a focus on development of skills (Finlayson, 2014). Math classes using traditional curriculum which concentrates on basic skills, teacher lecture, seatwork, and whole class instruction are more likely to have students with math anxiety than math classes that utilize non-traditional curriculum which focuses on real-life applications and group work (Ruff & Boes, 2014). Overcoming math anxiety means that we need to examine the classroom environment, and how we teach mathematics in the classroom. Addressing anxiety and self-esteem of children, and improving their confidence and related attitudes to math are crucial. Especially important is making math relevant to real-life contexts, and linking to students' interests (Finlayson, 2014).

Attitude is another important concept about mathematics success. Attitude toward mathematics is a dispositions towards mathematics that have been acquired via beliefs and experiences, but which could be changed (Eshun, 2004). On the other hand, attitudes toward mathematics is an aggregated measure of liking or disliking of mathematics, a tendency to keep in or refrain from activities about mathematical, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless (Ma & Kishor, 1997). Attitudes are gained through time and they are hard to change. Therefore, students who develop a positive or a negative attitude towards mathematics may reflect it in their lives in the future. Teachers have significant responsibility for students to be able to develop a positive attitude towards any subject, but especially mathematics (Duru, Akgün, & Özdemir, 2005). Clear understanding of task definitions by the teachers will be reflected in the presentation of the mathematics class. This reflection will contribute to the employment of a student-centered education approach and achievement of positive attitudes. In order to support children's advancement in the field of mathematics, opportunities should be provided for them to do research, satisfy their curiosity, see cause-effect relationships and make estimations. This is possible by "mathematics activities" organized based on children's levels, where as many senses as possible will take part in the learning process. Attitude of students towards activity based learning is an important subject in education process because if the student is not positively disposed as well as liable to activity based learning, he/she would not achieve the purpose and its objectives of the lesson in school. The teacher should support students to be able to carry out activities and make subjects comprehensible.

Activity Based Learning

An activity is made up of least one actions the completion of which satisfies the initial goal. The all component of actions are always realized in specific contexts which determine to a large extent the conditions under which the actions can be realized and the initial motive can be satisfied (Su, 2017). Activity based education refers to learning where students physically and mentally explore subject by simulation of the work environment, manipulation of tools and materials associated with the world of work, or performance of a real work task. This learning method includes the desired activities in terms of knowledge, attitude and skill (Ravı & Xaviera, 2007). The student has the capacity to learn through individual actions and experience and start developing their ideas about world. They evaluate things according to their own thoughts and experiences. Activity based teaching helps them to construct their knowledge (Shah & Rahat, 2014). The interactivity amid the students is the key agent for successful learning. Interactive resources or environment are helpful to learners because these resources can be accessed at any time and as many times as the learner chooses. In short, interactivity is the base for activity based learning (Ravı & Xaviera, 2007). Likewise, activity based learning is an important method that teaches students to think in original ways against their own problems, makes it easier for them to find practical solutions, and provides self-esteem for students in their development period to learn (Öcal, 2012). This type of learning is a method of teaching that takes into accounts the outcomes and behaviors in the primary and secondary school mathematics curriculum and aims to simulate daily life problem situations (Camci, 2012).

Activity based learning is an interdisciplinary model and started to be applied by Diane Bricker et al. from Oregon University for the first time. Regarding the curricula that have been used since 2005, it may be seen that education is shaped with in-class and extracurricular activities. This is why activities have become an inseparable part of the classes (Öcal, 2012). Additionally, activity based learning is a range of pedagogical approaches to teaching. Its main concern is based upon the fact that learning should be based on doing some hands-on, minds-on or hearts-on experiments and activities. The idea of activity based learning strategy is said to be rooted in the common notion that children are active learners rather than passive recipients of information. Some of the advocates of activity based learning strategy are the Constructivists Psychologists as Dewey, Piaget, and Vygotsky etc. who believe in the common notion that children are active learners rather than passive recipients of information. Thus, if the learner is therefore provided with the opportunity to explore their environment and provided an optimum learning environment then the learning becomes joyful and long lasting. This learning strategy means reversing the traditional teacher-centered understanding of the learning process and putting students at the center of the learning process (Golji & Dangpe, 2016). The possibility of designing activity based learning in a way that is suitable for its purpose is undeniably related to what is understood from the concept of activity (Günay, 2013). Describing/understanding this concept of learning in an objective and comprehensive way, will lead it to become an element that will increase the efficiency of this learning method. Activities in learning are various tools used by individuals who take part in learning environments to materialize abstract concepts and carry out teaching in a more effective way (Gürbüz, Çatlıoğlu, Birgin, & Erdem, 2010).

There are different types of activities (research based activity, practical investigations, problem solving activity, project work etc.) which can become instrumental in the teaching and learning process. These activities help students build their knowledge of mathematics concepts and procedures. Activity based learning gives them an opportunity to explore their own self. It provides students with a smiler set of experiences so everyone can participate in discussion on a level of playing field, despite their socio-economic status. It compels student thinking by requiring understanding of the observed events, rather than memorizing the correct responses. It encourages questioning of the observed events and the resulting data. It promotes cause and effect thinking and diminish dependence upon authority (Malhotra et al., 2015). Also, usage of activities in learning environments puts the students into the center, provides richer learning opportunities, leads students to use and love mathematics, makes mathematics teaching fun, provides opportunities to take notes on and discuss mathematics, and leads to increases in encouragement of students (Gürbüz et al., 2010). As long as students find the content and method of teaching for the subjects fun and interesting, they actively take part in the learning experience. Therefore, usage of teaching activities during the processes in the classroom is significant in terms of learning. Activities used during classes may contribute to making the learning permanent, creating positive attitudes towards the class, and attracting interest for the class (Camci, 2012).

National and international literature contains various study results on the importance of activity based learning, and its effects on academic achievement and attitudes towards mathematics it is applied in. Ayhan (2011) investigated the effects of activity based learning on the success of 8th grade secondary school students. It was reported that they were able to reach the relationships between given models or data more easily and correctly as the activities progressed. As activities progressed, the students expressed the relationships that obtained from the models or problems given in the activities quickly and correctly. In some studies conducted with students, it was found that activity based teaching increased the students' success in comparison to traditional teaching (Camci, 2012; Küpçü, 2012), it increased students' skills of interpretation better and broke the negative attitudes towards mathematics (Camci, 2012). In a similar study, Gürbüz et al. (2010) compared activity based learning and traditional learning in terms of their effects on students' development regarding some concepts in the subject of probability. In the experimental study, it was determined that activity based learning affected the teaching of probability concepts positively. This learning approach in question not only made the process fun, but also made learning meaningful. Additionally, Günay (2013) investigated the success effects of different ways of organization of activity based learning content in secondary school mathematics. In the study, it was reported about the activities used for teaching that; activities where text and image were given as integrated (prepared based on the principle of physical integration) led the students to have higher posttest results in comparison to activities given in the form of text-only or image-only, and caused reduced amounts of cognitive effort required.

A study on secondary school students by Johnson (1970) examined the effects of tangible activities on success in teaching geometrical concepts. The study presented the significance of tangible activities in teaching geometrical concepts and concluded that tangible nature of activities will increase student success even more. Douglas and Joke (2016) found that activity based learning pedagogy may play an essential rule in increasing teachers' experiences and skills of integrating technology into teaching activities. Additionally, they reported that table-supported activity based teaching encouraged student-centered in-class practices and supported the arguments that it has a potential to improve mathematics success. In one study, Bassett, Martinez, and Martin (2014) investigated the effects of the method of activity based learning and teacher-guided learning in science teaching on student success. As a result of the experimental study, the success rate of the students in the classroom with teacher-guided

Table 1. Process of implementation of the experiment and control groups

Group	Before Implementation	Implementation	After Implementation
Experiment	Pretest (MST+MAAS)	Activity Based Learning (20 hours)	Posttest (MST+MAAS)
Control	Pretest (MST+MAAS)	Traditional Learning (continued)	Posttest (MST+MAAS)

education was found higher than those in the activity based teaching classroom. Additionally, they measured the attitudes of the students in both groups towards the relevant method of teaching, and determined that the attitudes of the students with the experience of activity based learning were lower than those with the experience of teacher-guided learning. In another study, Rubin, Marcelino, Mortel, and Lapinid (2014) analyzed the effect of various activities using models of integers. In the study, it was determined that that activities led to a greater increase in students' performance and conceptual understanding on related to integers topic.

The findings of relevant studies in the literatures show the importance of activity based learning on students' math achievement and their attitudes towards activities. However, there are no studies that investigate the effects of this learning approach on both the academic success levels of students and their attitudes towards mathematics activities. Therefore, there is a need for research on this subject. This study has significant in terms of satisfying this need in the literature. Considering the related findings in the literature, no study was found to investigate the attitudes towards conducting mathematics activities which is expected to predict student success in mathematics classes to a significant extent. The attitudinal description of the study will consist of determining the attitude changes in students in cases where the requirements of activity based learning are met, and prediction of these. This significance will contribute to interpreting the data obtained in relation to the study field and sharing them with stakeholders, reaching qualified learning in the area of mathematics teaching, and raising awareness about achieving permanent learnings.

This study is conducted to provide a framework analysis about how activity based learning approach enhance sixth grade students' math achievement for the subject of "integers" in comparison to traditional learning, and some information according to their attitudes. Specifically, this study aims at finding answers to the following questions:

1. Is there a difference between the posttest success scores of the experiment group which took activity based learning and the control group which took traditional learning, when their pretest success scores are controlled?
2. Is there a difference between the posttest attitude scores of the experiment group which took activity based learning and the control group which took traditional learning, when their pretest attitude scores are controlled?

METHODOLOGY

Research Design

An experimental research design with pretest posttest control group was used in the study. In this model, there are two groups formed by random assignment. One group is named the experiment group, while the other is named the control group. Measurements are made in both groups before and after the experiment (Karasar, 2007). In order to determine the effects of activity based learning on students' academic achievement and attitudes towards mathematics activities, the Mathematics Success Test (MST) and the Mathematics Activities Attitude Scale (MAAS) were applied on the experiment and control groups as pretest before the instruction process and posttest after the instruction process. **Table 1** shows the process of implementing the teaching methods in the experiment and control groups.

Participants

The participants of the study consisted of 78 students (44 female, 34 male) in two branch of 6th grade of a secondary school in the province of Siirt in the academic year of 2016-2017. The mean age of the students was 11.5 ± 0.6 years. The economic situation of the school where the school is located is medium. Any two 6th grade branches with equivalent academic achievement according to the information received from school administrators have been identified. These branch have mutual math teacher, equal number of students and similar mathematics grades for past year. The branches were randomly assigned as one control group and the other experiment group.

Table 2. Table of specifications for MST integers subject outcomes, activities and items

Outcomes (The student…)	Activities	Items
Interprets integers and shows them on the number line.	Learning Integers	1,2
Determines the absolute value of an integer and makes sense of it.	Symmetry Mirror	3,5
Compares and ranks integers.	Integer Comparison	3, 4, 6
Conducts addition and subtraction operations with integers, solves related problems.	Number Line Drawing	5, 6, 7, 8, 9, 10
Understands that subtraction operation in integers means addition with the negative sign of the subtracted number.	Counting Plates	10
Uses the properties of addition as strategies for fluent operation.	Stairs Drawing	5,7

Data Collection Tools

The study used MST and MAAS as data collection tools. *MST* was prepared by the researchers to determine the students' success in the mathematics subject of "integers." It was used as pretest to determine the readiness levels of the students before experimental implementations, and as posttest to measure their academic success after the implementations. While forming the test, a 15-question draft test was formed by considering the outcomes of the related subject. Multiple-choice questions in the 6th grade mathematics textbook at the end of the unit were utilized while preparing the questions (Turkish Ministry of National Education [MEB], 2016). In order to ensure the content validity of the test, opinions were received from a commission consisting of four people who are experts in the field (3 in mathematics education and 1 in measurement-assessment). Necessary adjustments were made in line with the feedback from the experts, and the draft test was applied on students in an upper grade (40 individuals) who previously studied the subject different from experimental and control group. Item analysis was then conducted, item discrimination and difficulty were checked, and the final test consisting of 10 questions was formed by taking the test items that provided the best results among those measuring the same information. Some of the questions in this test are as follows; how many integers between -7 and +4 are there? (-29) + (0) + (+13) which is the result of the following? A thermometer showed +2 in the evening. At night, the temperature was 6 less than the evening temperature. How many degrees centigrade is night temperature? Correct answers were scored 1 and incorrect answers were scored 0 in this test. KR-20 (Kuder-Richardson) coefficient were calculated for reliability. KR20 coefficient Equivalent to Cronbach's Alpha and used when items are scored dichotomously, i.e., 1 or 0 (Peers, 2006, p. 30). KR 20 reliability coefficient of the final test was calculated as 0.880. Thus, the maximum possible score that may be received from the test was 10, while the minimum was 0. The test was applied to both groups before and after the implementation. **Table 2** is the table of specifications for the course outcomes and activities of the primary and secondary school mathematics curriculum that were considered in development of MST, as well as the item numbers.

MAAS was developed by Ocak and Dönmez (2010) to measure the attitudes of students towards mathematics activities before and after implementation. There are 10 positive and 9 negative items in the 5-point Likert type scale. Some of the questions on this scale are as follows; "I think that math activities can do me a lot", "I am happy to do math activities", "I find math activities meaningless", "Mathematical activities mixes my mind" etc. The three factors in the scale explain 53.13% of the total variance. The Cronbach's alpha reliability coefficient of the scale was 0.919. In this study, the Cronbach's alpha value of the scale was calculated as 0.846. This value shows that the scale is reliably (Kayış, 2005, p. 405). The positive items of the scale are scored as 1 "absolutely disagree", 2 "disagree", 3 "undecided", 4 "agree" and 5 "absolutely agree", while the negative items were scored in reverse. The maximum possible score of the scale is 101, while the minimum is 21. High attitude scores show positive attitudes towards mathematics activities. The scale was applied to both groups before and after the implementation.

Process of Implementation

Integers subject were given through traditional learning in the control group. The steps were carried out for 20 hours in the classroom. Firstly, the students were given the success test and attitude scale as pretest under supervision of their teacher in the classroom. During the implementation in the classroom, techniques such as plain presentation, questions-answers, example provision, showing and practicing were used. In this process, the teacher solved example questions, and the students carried out relevant operations based on this given rule. In the last stage, exercises and problems that required these operations were solved. Meanwhile, during the implementation, techniques such as emphasizing important points, motivating students for the subject and making summarizations were frequently utilized. Same subject (integers) were given through activity based learning in 20 hours in the experiment group along 4 weeks by the teacher of the course. Two class hours were dedicated for each activity, 16 class hours were used for 8 activities, and the remaining 4 hours were used to solve the subject assessment questions. Therefore, integers subject were taught in more time in the experimental group than control group. A

Table 3. The mean pretest and posttest success scores, standard deviations and mean corrected posttest success scores of the groups

Groups	N	Pretest	Posttest	Mean Corrected Posttest Scores	
		$\bar{X}$±S	$\bar{X}$±S	$\bar{X}$	SH
Experiment	39	4.461±2.024	7.436±1.957	7.444	.340
Control	39	4.487±2.150	5.795±2.858	5.787	.340

Pretest / Posttest correlation r =.478** p=.000

week before starting the implementation, the students and the teacher were informed about the tests and activities to be carried out during the education process. After this, the students were given the success test and attitude scale as pretest in their own classrooms under supervision of their teachers. Then 8 activities (See Appendix) were prepared for the subject of integers found in the 6th grade textbooks of the MEB based on activity based learning and traditional learning methods. The activities to be carried out were designed to provide solutions to different types of problems that the students may face in their daily lives in relation to the subject. The students shared and discussed the solution methods for problems given in the activity, the activities they carried out and the results they reached with their peers. In achieving that the students are able to structure the information by themselves, the teacher carrying out the study only had a guiding role when help was requested.

Data Analysis

The analysis of covariance (ANCOVA) was used in the study to determine the difference between the mean success and attitude scores of the students in the experiment group with activity based learning and the students in the control group with traditional learning. In a design with pretest, posttest and a control group, if it is wanted to assess whether the experimental operation was effective or not, the most suitable statistical operation is the method of ANCOVA, where the pretest is controlled as the mutual variable (Büyüköztürk, 2016, p. 122). Related method is conducted with the aim of measuring group differences over an independent variable after statistically controlling for the effects of one or more covariants. Covariants are chosen as they are related to the dependent variable. ANCOVA provides a stronger insight into the relationship between the independent and dependent variable by keeping the error variance minimal. With this aspect, it is a stronger method of analysis than ANOVA (Tabachnick & Fidell, 2015). In the study, the students in the experiment and control groups were given the success test and attitude scale before the implementation, and the same tests were applied on both groups after the implementation as posttest. Thus, the effects of the implementations were analyzed by examining the difference between the posttest scores of the groups, and the difference between the start and the end of the implementation was analyzed by examining the difference between the pretest and posttest scores of each group. SPSS 21 package software was utilized in the analysis of the data. The level of significance was taken as .05 in all analyses.

Findings

In this section of the study that investigated the effects of activity based learning on the academic success and mathematical activity application attitudes of students' in comparison to the traditional method, the findings are given below.

ANCOVA results based on the mean corrected posttest success scores of the groups

The mean pretest and posttest success scores of the students in the experiment and control groups were calculated, in order to determine whether there is a significant difference between the scores of the experiment group students who received activity based education and those in the control group who received traditional education. Considering these scores, the means, standard deviations and mean corrected posttest scores of both groups were calculated. There were minor differences between the groups in terms of math success pre-test. The mean different were not significant ($t(76) = 0.054$; $p = .957$). In the meantime, as the posttest success scores were related to pretest success scores ($r(78) = .478$; $p < .001$), pretest success score was taken as the covariant. Levene test statistic was checked for the variance homogeneity assumption. The result was found for the mean posttest success scores ($F = .545$; $p=.463$), and thus, the assumption of variance homogeneity was satisfied for the success test. **Table 3** shows the data obtained.

In **Table 3**, the average scores of pretests and posttests for both groups were given. It was seen that the mean success scores increased in both groups when the pretest success scores were controlled. While the mean corrected posttest score increased to 7.44 in the experiment group, it decreased to 5.79 in the control group.

The difference between the mean corrected posttest success scores of the students in the experiment and control groups was 1.66. ANCOVA was used to determine whether this difference was significant. **Table 4** shows the results obtained.

Table 4. ANCOVA table related to the mean corrected posttest success scores of the students in the experiment and control groups after the mean pretest scores were controlled

Source of Variance	Sum of Squares	Sd	Mean Square	F	p	Partial η^2
Corrected model	169.667	2	84.834	18.780	.000	.375
Pretest	117.155	1	117.155	25.935	.000	.257
Teaching Method	53.491	1	53.491	11.841	.001	.136
Error	338.794	75	4.517			
Corrected Total	3922.000	78				

Table 5. The mean pretest and posttest attitude scores, standard deviations and mean corrected posttest attitude scores of the groups

Groups	N	Pretest	Posttest	Mean Corrected Posttest Scores	
		$\bar{X}$±S	$\bar{X}$±S	$\bar{X}$	SH
Experiment	39	3.174±0.367	3.087±.171	3.085	.031
Control	39	3.167±0.283	3.246±.401	3.248	.031

Pretest / Posttest correlation r =.753** p=.000

Table 6. Students in the experiment and control group attitude scores after the mean pretest scores were controlled

Source of Variance	Sum of Squares	Sd	Mean Square	F	p	Partial η^2
Corrected model	4.890	2	2.445	64.948	.000	.634
Pretest	4.404	1	4.404	116.978	.000	.609
Teaching Method	0.518	1	.518	13.750	.000	.155
Error	2.824	75	.038			
Corrected Total	789.874	78				

According to the ANCOVA results given in **Table 4**, there was a statistically significant difference between the mean success scores of the students in the experiment group who received activity based education and those in the control group who received traditional education, when the mean pretest scores were controlled [$F_{(1,75)}$=11.84, p=.001]. In other words, after controlling for pretest scores, the posttest success scores are related to the group variable. Accordingly, based on the results of the Bonferroni test between the corrected success scores of the groups, the mean success score of the experiment group (7.44) was higher than the mean success score of the control group (5.79). Based on this, the posttest success levels of the students in the experiment group were higher than those in the control group. Additionally, the pretest scores predicted the posttest scores (F=25.93; p<0.001). Partial eta squared values provided information on the effects of the Covariant (here, pretest) and the groups on posttest. The effect size of group on posttest was η^2=.136, meaning, the group variable explained 13.6% of the posttest variance. On the other hand, the effect size of the covariant (pretest) was even higher as η^2=.257, which means, 25.7% of the posttest variance was explained by pretest.

ANCOVA results based on the mean corrected posttest attitude scores of the groups

The mean pretest and posttest attitude scores of the students in the experiment and control groups were calculated, in order to determine whether there is a significant difference between the scores of the experiment group students who received activity based education and those in the control group who received traditional education. There were a small differences between the groups in terms of pretest attitude scores. The mean different were not significant (t(76) = 0.092; p = .927). In the meantime, as the posttest success scores were related to pretest success scores (r (78) = .753; p < .001), pretest attitude score was taken as the covariant. **Table 5** shows the data obtained.

According to **Table 5**, the mean pretest attitude score of the experiment group (3.174) was higher than the mean score in the control group (3.087). Based on the mean corrected posttest attitude scores after the operations, the mean attitude score in the experiment group decreased to 3.085, while this value increased to 3.248 in the control group. It may be seen that there is a difference in favor of the control group students in terms of the mean corrected posttest attitude scores. Levene test statistic was checked for variance homogeneity assumption. The result was found for the mean posttest attitude scores ($F_{(1, 75)}$ = 5.06; p = .027). It was seen that the assumption of variance homogeneity was violated by a small margin for the attitude test. Considering that the number of items in the experiment and control groups was the same, this margin was ignored.

ANCOVA was used to determine whether the difference between the experiment and control group students was significant in terms of the mean corrected posttest attitude scores. The results are given in **Table 6**.

According to **Table 6**, there was a significant difference between the students in the experiment and control groups in terms of the mean corrected posttest attitude scores, after controlling for the mean pretest scores [$F_{(1, 75)}$ =13.75, p<.001]. In other words, after the pretest scores were controlled, the posttest attitude scores were related to the group variable. Accordingly, the posttest attitudes of the students in the experiment group towards activity based education were lower than those in the control group. Based on the partial eta squared values, the effects of the pretest on the mean posttest attitude scores were much higher than the group effects. While the pretest effect was η^2=.609, the group effect was η^2=.155'dir. Thus, it may be stated that 60.9% of the posttest attitude variance was explained by the pretest, and 15.5% was explained by the group variable.

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

This study investigated the effects of activity based learning on sixth grade students' mathematics achievement in comparison to traditional learning, and determine their attitudes towards activities. Based on the findings obtained, both in-group and inter-group comparisons were made in the experiment group that received activity based education and the control group that received traditional education, relevant discussions were included, and recommendations were made.

Considering the pretest results of the experiment group students and traditionally taught control group students in teaching the subject of integers in the sixth grade of secondary school, a noticeable difference was found to be in favor of the experiment group students in terms of the posttest math academic success scores. In this study, it was found that the experiment group students were academically more successful in comparison to the control group students. Therefore, we can say that activity based education in mathematics teaching may increase the academic success of the students in comparison to traditional education. The reason for this may be that activities in mathematics classes provide opportunities to work with tangible materials and increase the motivation of the students this way. Additionally, it may be considered that the presentation and content of the activities made it easier to learn the subject and relate it to daily life. This result agrees with the results of other studies where activity based learning and traditional learning in mathematics courses were compared in terms of academic success (Ayhan, 2011; Batdı, 2014; Camcı, 2012; Case, Harris, & Graham, 1992). The studies mentioned above were conducted with different mathematics units and on different class levels. These studies reached the conclusion that activity based learning increased academic success. Considering the results of relevant studies, it may be considered that activity based learning will be an applicable approach in all class levels in secondary schools for increasing academic success. It was also seen that, in learning processes supported by activities, the subjects of learning were comprehended better (Köstereliođlu et al., 2014; Rubin et al., 2014), classes enriched with activities influenced student perceptions positively (Köstereliođlu & Yapıcı, 2016), and contributed to increased academic success by positively affecting the students' role in the learning process, performance in the assessment process, and their interest and attitude towards the class (Bahadır & Özdemir, 2013; Batdı, 2014; Hussain, Anwar, & Majoka, 2011). Additionally, in another study on the effectiveness of educational math activities related to embodied training of numerical concepts, it was found that these kind of activities improve students' estimation performance more strongly than the control group in the mentioned study (Link et al., 2013). Moreover, students who have exposure appropriate manipulatives to help them learn fractions subject, have significantly improved their achievements when compared with the students who do not have exposure to these manipulatives (Jordan, Miller, & Mercer, 1998). These studies show that the use of activities during classroom hours, improves students' both estimation performances and achievement in the subject of integers. In a different study, it was revealed that instruction with manipulatives was least effective for children, with very small and sometimes negative effects (Carbonneau, Marley, & Selig, 2013). Thus, it is imperative that educators think carefully about ways to effectively use mathematics manipulatives for learning and use research to guide them. The studies in Turkey on determining the perceptions of mathematics teachers regarding the concept of activity in mathematics are limited (Bozkurt, 2012). Before the implementation in this study, the teacher of the class was given a total of six hours of training on activity based teaching based on the subject of integers. However, as it was thought that this training was not sufficient in scope of this study, the duration of training may be increased and more activities may be included in further studies.

In this study that was conducted in the scope of teaching the mathematics subject of integers, a significant difference was found as opposed to expectations between the attitudes of the students in the activity based experiment group and the traditional control group in terms of their attitudes towards mathematics activities. In other words, while it was expected that the students who received activity based education would develop positive attitudes towards practicing mathematics activities, the result was the opposite. That is, the attitude scores of the students who received activity based education dropped, while those of the control group that received traditional education rose. Failure of the students/teachers to give up the habits they gained from traditional education or lack of satisfactory effects of the tools and scales used to measure attitudes (Suydam, & Higgins, 1977), and maybe, the possibility that the activities or materials related to the subject were not fun and interesting enough, may have prevented the attitude scores of the students who received activity based education from rising (Bassett, et al., 2014).

Additionally, some study results reported that prospective teachers provided opportunities for entertainment in the learning process, and they had a positive approach in terms of using activities in the learning process for making learning easier and supporting persistent learning (Kösterelioğlu, et al., 2014). Similarly, in another study, Batdı (2014) reported that activity based learning has effective and positive results in terms of increasing the interest and positive attitudes towards the course.

As a conclusion of this study, it was seen that activity based learning activities improve students' academic achievements and attitudes towards activities. This study also obtained results that demonstrated that activity based education may be utilized more than traditional education in teaching the mathematics subject of integers. However, the findings in the study were limited to the numbers of the students in the experiment and control groups, and the data collected by the success test and attitude scale applied to these students. This may be implemented on a larger sample with application of different tests and scales, data may be collected, and the effectiveness of the activity based learning approach on success and attitude may be investigated. In conclusion, it is expected that the activity based learning method will lead to positive results on the academic success levels of students in case of its implementation in the mathematics curriculum, and it is recommended that similar studies are conducted on different teaching-education levels and with different subjects and fields.

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APPENDIX

Activities carried out in the Experiment Group Regarding the Subject of Integers

Activity 1: Determining Integers

Let us choose a friend to work together with in the classroom. With your friend,

a) Find which numbers we need to use to express the following situations.

b) For each situation, find the integer in the opposite direction or value.

c) Find a daily life situation compatible with these numbers in the opposite direction or value.

- Eren owes my 170 TL.
- Ayşe is 5 floors above the ground floor of a shopping mall.
- The weather temperature in Erzurum tonight is negative 25 degrees.

Erzurum

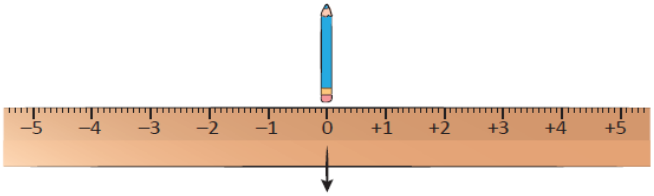
Uludağ

- Walking backwards from the start line in 4 steps.
  The altitude of Uludağ, which is the largest winter and nature sports center of Turkey is 2543 meters.
- Our submarine named Burak Reis on its course 50 meters below the sea level.

Activity 2: Absolute Values

Tools and materials: symmetry mirror, piece of wood, ruler and pencil.

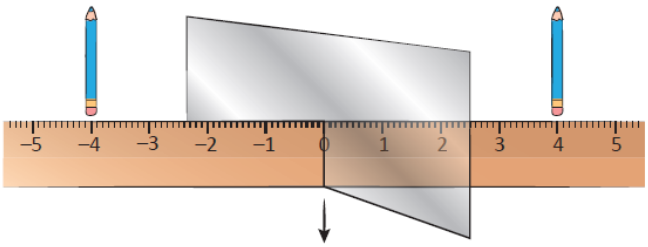
Let us build a number line model like below where integers are indicated with equal intervals.



Origin

Let us put our pencil onto the 0 (origin) point and move it to the right by 4 units.

Similarly, let us put our pencil onto the 0 point and move it to the left by 4 units.



Origin

Let us place the symmetry mirror perpendicularly to the origin of this number line and examine the distances of couples of numbers that are overlapped on the mirror from the 0 point. Are the distances equal? How do you think we may express this situation? Discuss.

Activity 3: Comparing Integers

Tools and materials: graph paper, ruler

Activity Steps:

- Form groups of two.
- Groups choose 5 integers that they are able to show on a number line, of which two are negative.
- Groups draw a number line on their graph paper with the help of the ruler. They show the integers they have chosen on the number line.
- Groups order these numbers from the greatest to the smallest by using the number line.
- Groups explain what they did to the classroom.
- The classroom decides on the accuracy of the steps.

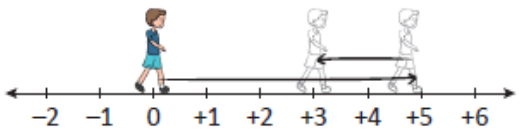
Activity 4: Drawing a Number Line

Let us draw a number line on the floor of the classroom in a way the students are able to see it. Pay attention to include positive and negative integers on this number line. One of the group members establishes an addition operation with two integers. The other group member tries to reach the result of this operation by walking forwards or backwards on the number line. They explain the reasons for these movements on the number line to the peers in the classroom. For example, let us look at the following implementation:

Ayşe and Mehmet have formed a group and Ayşe chose the operation "(+5) + (-2) =?"

Mehmet;

- Starts from the 0 point, facing right,
- Walks forwards by 5 units (+5),
- He does not change direction (addition),
- He walks backwards by 2 units (-2).



$(+5) + (-2) = (+3)$

Activity 5: Drawing a Number Line

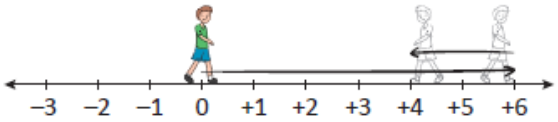
Let us draw a number line on the floor of the classroom in a way the students are able to see it. Pay attention to include positive and negative integers on this number line. One of the group members establishes a subtraction

operation with two integers. The other group member tries to reach the result of this operation by walking forwards or backwards on the number line. They explain the reasons for these movements on the number line to the peers in the classroom. For example, let us look at the following implementation:

Ali and Melike have formed a group and Melike chose the operation "(+6) – (+2) = ?"

Ali;

- Starts from the 0 point, facing right,
- Walks forwards by 6 units (+6),
- He changes direction (subtraction),
- He walks forwards by 2 units (+2).



$(+6) - (+2) = (+4)$

Activity 6: Drawing a Ladder

Activity Steps:

- The teacher draws a 10-step ladder on the boards as seen on the side.
- Imagine a friend of yours climbs 3 steps up first, and then climbs 4 more steps up.
- Write down the mathematical expression showing which step your friend reached by using integers.
- Imagine the same friend climbing 4 steps up first, and then 3 more steps up.

- Write down the mathematical expression showing which step the same friend reached by using integers.
- Compare the mathematical expressions you wrote down and declare the conclusion you have reached.

▣ ▣ ▣

- Imagine a friend of yours climbs 5 steps up first, followed by 3 more steps up, and then climbs down for 2 steps.
- Write down the mathematical expression showing which step your friend reached by using integers.
- Imagine the same friend climbing 3 steps up first, followed by 2 steps down, and finally 5 steps up.
- Write down the mathematical expression showing which step your friend reached by using integers.
- Compare the mathematical expressions you wrote down and declare the conclusion you have reached.

▣ ▣ ▣

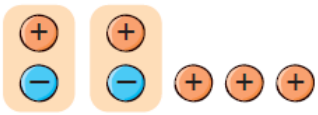
- Imagine a friend of yours climbs 8 steps up on the ladder first, and then climbs down for 8 steps.
- Write down the mathematical expression showing which step your friend reached by using integers.
- Declare the conclusion you have reached from the mathematical expression you wrote down.
- Imagine a friend of yours climbs 9 steps up on the ladder first, and then climbs up for 0 more steps.
- Write down the mathematical expression showing which step your friend reached by using integers.
- Declare the conclusion you have reached from the mathematical expression you wrote down.

Activity 7: Counting Plates

The teacher: Can you represent integers in different ways using counting plates? For example, how many different ways are there to represent the integer +3?

Student 2: As 1 blue and 1 orange counting plate amounts to zero, we can show +3 as

Student 3: Then, we can also show it as



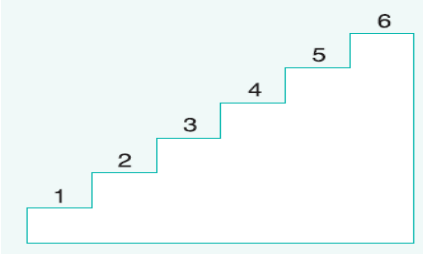
Can you find other ways to represent the integer +3?

Activity 8: Drawing a Staircase

Tools and materials: counting plates

Activity Steps:

- Your teacher draws a staircase on the board like shown on the side.



- Imagine a friend of yours;
  - ✓ First climbs up 2 steps and then climbs 3 more steps up.
  - ✓ First climbs up 6 steps and then climbs 2 steps down.
- Model the operations you considered using the counting plates.
- Write down the mathematical expressions for the operations you modelled.
- Explain the relationship between the operations of addition and subtraction in integers.