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The Effect of Feedback Timing on Mathematics Achievement

Geri Bildirim Verilme Zamanının Matematik Başarısına Etkisi

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Abstract. The aim of this study is to explore whether feedback time given to the students has an effect on mathematics achievement. In the experimental study, the experimental groups were given the feedback between the pre-test and the post-test at different times (e.g. just after the pre-test, one day later, one week later, just before the final test) while the control group was not given feedback. The study group consisted of 233 students studying at 8th grade Şehit Uğur Kutku Secondary School in Şahinbey District of Gaziantep. There were a total of six groups including, one control group and five experimental groups. The study was designed as 6x2 experimental pattern for three weeks, and pre-test and post-test were administered based on each week's pre-decided learning objectives. ANCOVA test was applied to compare the post-test achievements of the groups. According to the results of the analysis; it was found that there was no difference in the pre-test success of the groups. However, there was statistically significant difference between groups in the post-tests. As a result, it was seen that the mathematics achievement of the groups given feedback just before the post-test was higher. It is recommended that the feedback should be given regularly and right before the exams.

Keywords: Feedback, mathematics course, course achievement

Öz. Bu çalışmanın amacı geri bildirim verilme zamanın matematik başarısına etkisinin olup olmadığının belirlenmesidir. Deneysel tasarım kullanılan çalışmada deney gruplarına ön-test ve son-test arasında farklı zamanlarda (ön-testten hemen sonra, bir gün sonra, bir hafta sonra, son-testten hemen önce) deney grubuna geri bildirim verilirken kontrol grubunda geri bildirim verilmedi. Çalışma grubu olarak Gaziantep İli Şahinbey İlçesi Şehit Uğur Kutku Ortaokulu 8. Sınıflarda öğrenim gören 233 öğrenciden oluşmaktadır. Bir kontrol grubu ve beş deney grubu olmak üzere toplam altı grup bulunmaktadır. Çalışma üç haftalık 6x2'lik deneysel desen olarak tasarlanmış ve her hafta belirlenen kazanımlara ilişkin ön-test ve son-test uygulanmıştır. Grupların son-test başarılıları karşılaştırmak için ANCOVA testi uygulandı. Analiz sonuçlarına göre; grupların ön-test başarılarında farklılaşma olmadığı belirlenmiştir. Fakat son-test ve genel tekrar testlerinde gruplar arası farklılaşma istatistiksel anlamlılık düzeyindedir. Sonuç olarak, son-testten hemen önce geri bildirim verilen grupların matematik başarısının daha yüksek olduğu tespit edilmiştir. Düzenli ve uygulanacak testten kısa zaman önce verilen geri bildirimin matematik dersindeki başarı üzerinde olumlu etkisi olduğu görülmüştür.

Anahtar kelimeler: Geri bildirim, matematik dersi, ders başarısı

INTRODUCTION

The system is defined as a whole that consists of a number of interconnected and interdependent sub-parts and functions as part of larger systems (Bayrak, 2008). When we look at education from this framework of definition, it is a part of the learning system which consists of a number of sub-parts (educational institutions, educational levels, school diversity). The system contains input, process, output, and feedback components as a basis, regardless of simplicity or complexity. A similar situation is also present in the education system. When we consider middle school as a system, middle school students begin their education in 5th grade and graduate from 8th grade. The quality of this system is measured by feedback. In a sense, determining what are the problems

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encountered in this process, revealing their nature, depends on the effective functioning of the feedback component.

According to Sönmez (2001), the input can be defined as all the necessary information, human resources and materials which are taken from outside to perform the purpose of the system. As for the process, it is the part where the inputs in the system are formed, processed and rebuilt according to the specific purposes, i.e. made into the desired product. Outputs as a result of the processes, certain products emerge, and these products form the outputs of the system. The activities considered as feedback are those that are performed to determine whether the system is working and what are the non-performing sides by looking at the realization of the purpose of the system to what extent and performed to determine how to remove these sides.

Education system is accepted as an open system. Open systems are defined as the system that receives input from the environment to achieve at least one objective and obtains outputs by processing these inputs, and obtains feedback on these outputs (Bayrak, 2008). Elements such as inputs, processes, outputs, feedback that are available in the definition are the elements of an open system. Therefore, the elements of the education system are also these.

When considered in the context of education, the inputs of the system are teachers, knowledge, tools, investment and students (Baykul, 1992). When we consider educational institutions as a continuity, it is observed that the output of one system is the input of the other. For example, a student who graduated from primary school and start middle school is an input for middle school; while, an output for primary school. The process can be considered as education activities for the students to achieve the set goals. Finally, all these items are evaluated, and a result is obtained from the system. Evaluation results should be considered as feedback in a sense. In a sense, it is the determination of whether the set education goals have been achieved.

From whatever level or category, we look at the education system, the final goal is to ensure the student to achieve set learning objectives. Learning-teaching process is considered as the product of a number of activities to achieve set learning objectives (Küçükahmet, 2008). Students are expected to achieve a certain academic success as a result of these activities performed. Main purpose of the effort made and sources used for education is to ensure students to gain set objectives. Some of these learning objectives are in the affective domain, while the majority are in the cognitive domain. The success of schools and students is generally accepted as an academic success. As a result, it is among the basic goals of the educational institutions that students achieve sufficient level of academic achievement. In the following parts of the study, firstly the feedback is emphasized and then information about feedback in mathematics teaching is presented.

Feedback

When the related literature is examined, it is seen that different definitions are made regarding feedback. According to De Cecco (1968), feedback is providing information about a result by comparing the success of a student with a standard performance. According to Ilgen, Fisher and Taylor (1979), feedback is a communication process evaluating a behavior or circumstance and providing corrective information (cited in Peker, 1992). While Brinko (1990) defines feedback as a two-way communication process. When we consider the feedback as a communication process, the teacher's feedback to the student during education process is a sign of a communication process

between the student and the teacher. Examining the adequacy of examinations or performances of the student and providing feedback to the student.

Classification of Feedback

Feedback is classified according to way of providing, circumstances of target group, tools used and quality. Information on classifications are being classified according to correct/incorrect and inadequacy of the answers given by students. According to this perspective, there are four categories. First feedback (correct/incorrect) informs about whether the answers of students are correct or wrong (Arnett, 1985; Bumgarner, 1984). In this case, if the test item is answered incorrectly, no other information other than what the correct answer is given. A second type of feedback is corrective feedback. If the question is answered incorrectly, it shows what the correct answer is. In the third feedback type, students are ensured to continuously answer the questions until they are answered correctly. A fourth feedback type is explanatory feedback. In this type, detailed information regarding why certain question elements are answered correctly (Farragher & Szabo, 1986).

Another classification regarding feedback types is created by Hattie and Timperley (2007) by conceptualizing a feedback intervention model aiming to reduce the gap between the current and targeted performance. Third classification is related to Schimmel (1988) model which feedback into five types in terms of functions. These are verifier, corrective, explanatory, determinant, and expansive (articulation) feedbacks. Verifier feedback is providing information to student about the learning outcomes.

Another detailed classification regarding the feedback given by the teachers is developed by Tunstall and Gipps (1996). It is coded to form the rewarding, punishing, approving, disapproving, highlighting success, progress, explaining about success and improving way of the feedback given by teachers in the classroom. Then, it is categorized according to being negative and positive with this code.

The Effect of Feedback on Student Achievement

When the recent studies are looked at (Ezzat et al., 2017; Harks, Rakoczy, Hattie, Besser, & Klieme, 2014), feedback is related with the achievement of students. A recent study reveals the effect of feedback on the success of students (Boston, 2012). It is seen that the importance of the feedback from teachers and friends of primary school students is emphasized. Research made on the effect of feedback on the success of the student show that feedback potentially has an important effect on the learning of the students (Hattie & Timperley, 2007).

Students expect timely feedback from teachers to understand how good they are individually. Both the teachers and the middle school students consider the feedback of teachers as an important factor for the effectiveness of student's learning in the mathematics lesson (Law, Wong, & Lee, 2012). They stated that it was important to determine whether the work students had done was incorrect and their general mistakes by the teacher in the classroom, and as a result, making additional courses in order to complete their inadequacies at the end of the course was important (Voerman, Meijer, Korthagen, & Simons, 2012; Zhang et al., 2016).

Implementation of Feedback

For the feedback to serve set goals, sufficient care should be given in the implementation stage. Main factors to impact the implementation stage of feedback are timing, amount and implementation manner.

Timing of Feedback

Timing of feedback is one of the factors ensuring its effectiveness (Fyfe & Rittle-Johnson, 2015; Hattie & Timperley, 2007; Kulik & Kulik, 1988). The time between the answer given by the student and the feedback received is defined as the timing of the feedback. In terms of timing, feedback can be provided in three ways as instant, slightly delayed and delayed (Brinko, 1990). Some researchers define instant feedback as summary information given within the applied test, while some consider it as corrective information given individually in a lesson or at the end of education regarding the questions in the test. Often, the instant feedback definition of a researcher is delayed feedback for another (Kulik & Kulik, 1988). This irregularity in the definitions casts a shadow on the researches and makes generalization difficult, even impossible. One of the most studied issue about feedback is on the subject of comparing the effect of instant and delayed feedback. When researches on the timing of feedback examined the results and opinions obtained are quite contradictory (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Swift & Gooding, 1983). Some researchers argue that instant feedback is required to correct the mistakes before they are saved to memory; while others assert that delayed feedback allows forgetting the feedback made and saving the correct information to memory (Koçdar, 2006).

Timing is highly important in terms of both the provider and receiver of constructive feedback. Many researchers such as Brinko (1993) and Hathaway (1997) pointed out that feedback should be provided as soon as possible after the performance to make a healthy connection between feedback and performance against the likelihood of remembering the performance differently. Feedback given while the performance is still fresh in the memory will be understood better (Brinko, 1993; Hathaway, 1997). According to Kulik and Kulik (1988), the feedback given instantly in the applied but non-laboratory lessons is better than delayed feedback. It is concluded that if the feedback is delayed, it will not have enough effect on the performances of the individuals (Kantarcı, 2014).

Current results show that instant feedback supports remembering, most correct identifying of first answers, increase trust on answers and decreases repeating incorrect answers (Dihoff, Brosvic, & Epstein, 2003). Instant feedback method is more effective than delayed feedback method (Erbaş & Yücesoy, 2002). The main purpose of providing instant or slightly delayed feedback is students to consider and use it. Feedback should be given to student there and then, when his/her interest and performance in solving the subject, homework or problem is fresh. When it is considered that feedback is also a learning tool, it should be given while the mind of the student is still busy with the learning goal. That is, rather than for something already completed, it should be given while the student is still involved in the subject or homework.

Amount of Feedback

The most difficult part of making a decision about feedback is determining the amount. When determining the amount of feedback to be given, the following criteria should be taken into consideration in determining how much and how many points require detailed information:

a) The subject in general, learning goals or achievements in particular

b) Typical developmental learning progress for these subjects and goals

c) Students individually

Correct and effective identifying of this process requires knowing the students. For some students, simple explanation will be sufficient for targeted development,

however, other students may need more explanation. To understand the following concept, information and education experiences regarding the subject can be used.

Manner of Feedback

Teachers should consider whether the students understand the feedback given. Taking such decisions in education environment partially depends on opportunity. Talking with the student is usually the best because communication can be made by talking. However, finding time to talk everything with the student may not be possible. Therefore, written feedback would be easier and beneficial in some cases (Köğce & Baki, 2014). Also, deciding on whether the feedback will be individual or in groups is an issue to be decided in the manner of feedback. In cases of class being crowded or mistakes and inadequacies being in class general, teachers prefer to give feedback in groups. Individual feedbacks given in front of the group will also reduce the benefit of the feedback to the individual. Factors affecting implementation of feedback are given in Table 1. (Köğce & Baki, 2014).

Table 1. *Feedback implementation dimensions*

Implementation Factors	Manner	Type
Timing	When	Instant
	Frequency	Slightly delayed
		Delayed
Amount	Important Goals	Main adequacy
		Critical points
	Control points	Development status of student
		Explanation amount
Manner	Tool used	Verbal
		Written
		Visual
		Applied
	Individual/Group	Specific/general status of mistake
		Classroom being crowded

When given the information in Table 1 is taken into account, teachers can determine general principles by deciding on the timing, amount and manner during in-class feedback implementation. These criteria, despite changing by class, student and lesson, will provide a road map for teachers.

Mathematics Education and Feedback

It is expressed in many studies that mathematics is in every field of life and is the basis of many disciplines. It is also stated that it prepares the person for correct and efficient thinking and accurate decision making (Eraz, 2014). In addition, with the change in educational approach, student-centered new education programs and modern approaches are preferred, educating individuals who research, inquire, produce ideas, share ideas, solve problems, in short, who are mathematics literacy is aimed (Baki, 2008). Determining whether the students have reached these characteristics is important.

In studies focusing on the relationship between assessment and learning, it is recommended to make formative assessment to contribute to the learning of the students (Glover & Thomas, 1999; Higgins, Hartley, & Skelton, 2010). The important thing in the process of formative assessment is not only grading the student but also

form their skills by using the information obtained from their work and performances and enable them to be aware of their development (Tunstall & Gipps, 1996). Feedback has an important place in the formative assessment process. Today, as a concept commonly used in both the science and social sciences, feedback can be given in various ways.

The functioning of the education process must be carefully followed in order to make mathematical subjects that are perceived as abstract and difficult easier and understandable to students. In general, it is important that teachers interact with students in a complex way, give appropriate feedback, and take the necessary steps to ensure that students understand mathematical concepts and symbols from the beginning to the end of the teaching process. In this context, teachers giving feedback should find realistic solutions for teaching mathematics by determining where they are inadequate at. In mathematics, each student must have the ability to think and express his ideas using mathematical symbols. Therefore, the success of each student in mathematics is related to their ability to read, understand and apply mathematical symbols (Köğce, 2012).

In mathematics teaching, it is very important how the students react in terms of identifying and correcting the misconceptions that occur during the acquisition of mathematical concepts, mistakes in the process steps, completion of the process and the interpretation of the processes (Köğce & Baki, 2014; Köğce, Yıldız, Aydın, & Altındağ, 2009). Math teachers try to perfect the process with the feedback they use in the education process. It is not possible for a student to learn mathematics in a process that does not contain feedback, because feedback is the basis of mathematical thought, conceptualization and correction.

According to Santagata (2004), feedback from teachers regarding teaching mathematics can be grouped as correcting a student, giving clues, repeating questions, asking reasons, giving clues to a different student, asking an indirect question, choosing the right answer, having find the correct answer by making the students use the correct answer and answering attempts. During the teaching process, teachers can help students gain appropriate skills by identifying the mistakes made and finding the correct answer through these mistakes.

Feedback in the process of teaching mathematics helps students to understand their mathematics needs, read mathematical symbols and relate processes correctly (Çimer, Bütüner, & Yiğit, 2010). The effective use of the conceptualization process that forms the basis of mathematics teaching is something that directly affects the learning of the student. Teachers usually give feedback throughout this process. Correct use and correlation of mathematical symbols form the basis for students' understanding of mathematical content and cognitive development.

One of the main reasons that students do not like mathematics may be due to making careless mistakes in a long calculation or a series of steps. A small mistake can lead to incorrect answer in problem solving in mathematics. Instant feedback should be given to inform and correct mistakes in calculation process. However, it should be noted that instant feedback is not given during exams. Therefore students must develop skills also in identifying their own mistakes (Boston, 2012).

In the literature (Brinko, 1990; Hattie & Timperley, 2007; Higgins, 2000; Tunstall & Gipps, 1996) there are different suggestions in the timing of feedback. For example, according to Hattie and Timperley (2007), feedback must be given in a way to reveal the quality of the work during the work being done. As for Brinko (1990), feedback can be given instantly, slightly delayed or in a delayed manner. In some

studies, instant feedback is mentioned as to be more effective (Kulik & Kulik, 1988). In this study, data to enrich the discussion regarding timing of an effective feedback stated in the literature will be presented.

Although there are studies on the feedback having effect on the academic achievement (Aydın, 2011; Dökmen, 1982; Ezzat et al., 2017; Harks et al., 2014), the studies on feedback are limited. Various studies conducted revealed that feedback has important place in education. However, it could not be made clear yet which types of feedback are beneficial in which conditions and to what extent. Therefore, it is useful to contribute to know-how with a number of new studies (Dökmen, 1982). This study will contribute to the literature on feedback in this sense.

Math anxiety and mathematics achievement is a problem in almost all countries. In order to solve this problem, studies are being carried out in many areas of education as well as in mathematics teaching (Bakan Kalaycıoğlu, 2015; Escalera-Chávez, Moreno-García, García-Santillán, & Rojas-Kramer, 2017). One point of these studies is about making the learning process more effective (Merritt, Lee, Rillero, & Kinach, 2017). There are some studies which indicated that the effective feedback was effective in decreasing math anxiety (Núñez-Peña, Bono, & Suárez-Pellicioni, 2015; Wise, Plake, Eastman, Boettcher, & Lukin, 1986) and increasing mathematics success (Harks et al., 2014; Labuhn, Zimmerman, & Hasselhorn, 2010; Núñez-Peña et al., 2015).

This study is important in terms of examining the effect of feedback timing on the academic success. Moreover, as mentioned, despite the studies on the effect of feedback are common, due to studies on how the timing of the feedback should be are insufficient, this study will become an important source for the literature. However, the findings to be obtained as a result of the study will provide the data to practitioners on the timing of the feedback.

This study basically formed in the context of the question "Does the timing of feedback have an effect on mathematics success?" Within this framework, the answer to the question of the effect of feedback given according to different application times between pre-test and post-test on the mathematics success of students is sought. Answers to the following questions will be sought in the study:

1- Since pre-test1 is controlled, do post-test1 scores of students differ according to the timing of feedback they receive?
2- Since pre-test2 is controlled, do post-test2 scores of students differ according to the timing of feedback they receive?
3- Since pre-test3 is controlled, do post-test3 scores of students differ according to the timing of feedback they receive?
4- Since pre-test1, pre-test2 and pre-test3 are controlled, do final test scores of students differ according to the timing of feedback they receive?

METHOD

In this study, 6x2 experimental pattern was designed to examine the effect of change on one or more independent variable for the purpose of determining the cause-effect relationships. Experimental research model, being the most convenient research to form cause-effect relations between the variables under the control of the researcher, serve all purposes of science (Erkuş, 2013). In experimental researches, is changing of independent variable by the practitioner and comparison of scores of groups for the variable dependent on at least two conditions (Büyüköztürk, Kılıç Çakmak, Erkan Akgün, Karadeniz, & Demirel, 2013). The dependent variable of this study is the academic

success of the student in mathematics lesson while the independent variable is the timing of feedback given to students. Experimental design used in the study is given in Table 2.

Table 2. *Experimental manipulations*

Groups	Pre test	Manipulaiton	Post test
Control Group (CG)	$Pre_{1,2,3}$	-	$Post_{1,2,3,4}$
Experiment 1 (E1)	$Pre_{1,2,3}$	X_1	$Post_{1,2,3,4}$
Experiment 2 (E2)	$Pre_{1,2,3}$	X_2	$Post_{1,2,3,4}$
Experiment 3 (E3)	$Pre_{1,2,3}$	X_3	$Post_{1,2,3,4}$
Experiment 4 (E4)	$Pre_{1,2,3}$	X_4	$Post_{1,2,3,4}$
Experiment 5 (E5)	$Pre_{1,2,3}$	X_5	$Post_{1,2,3,4}$

$Pre_{1,2,3}$: Pre-test1, pre-test2 and pre-test3 applied on the groups

$Post_{1,2,3,4}$: Post-test1, post-test2, post-test3 and final test (contains all outcomes in the same unit) applied on the groups

$X_{1,2,3,4,5}$: Feedback given to groups on different times

According to Table 2, it was determined that there are the subject of algebraic expressions and inequalities in mathematics lesson and four learning objectives related. There was no specific purpose in the choice of subject. Which subject is stated in the working calendar is preferred. The study is planned as three weeks. I. Week Learning Objective1, II. Week Learning Objective 2 and III. Week Learning Objective 3 and 4 were decided.

Experimental Design and Study Group

Information regrading the weekly planning of the application is given in Table 3.

Table 3. *Experimental design timetable*

Group	1. Lesson (Instant)	One day later	One week later
Control	Pre test		Post test
E1	Pre test- Feedback- Post test		
E2	Pre test- Feedback	Post test	
E3	Pre test	Feedback- Post test	
E4	Pre test	Feedback	Post test
E5	Pre test		Feedback- Post test
E6	Pre test- Feedback		Post test

As presented in Table 3, different conditions were regarded as timing on feedback. The study group of this experimental research consists of 233 students in 8th grade of Şehit Uğur Kutku Middle School in Gaziantep, in the academic year 2017-2018 and mathematics teacher was the same for all groups.

First, pretest is applied on all groups. No feedback is given to control group. In E1, pretest is applied in first lesson, then feedback is given immediately afterwards and posttest is applied after the feedback. In E2, feedback is given right after pretest. Posttest is applied one day later. In E3, feedback is given one day later and posttest is applied afterwards. In E4, feedback is given 1 day later. Posttest is applied one week later. In E5, feedback and posttest is applied one week later. E6 group study was planned. But this group could not be included in the study due to insufficient classrooms in the school. E6 group could be selected from another school but this would jeopardize internal validity of experimental design. Parallel tests were used to control the carryover effect.

Data Collection Tools

Since the purpose of the experimental study is to determine the effect of feedback timing on the student's mathematics lesson success, achievement test was used for mathematics lesson algebraic expressions and identities. The achievement test mentioned is developed by the researcher.

The achievement tests used in the research measure the learning objectives of algebraic expressions and identities. In the tests used in the first and second week, "Understands simple algebraic expressions and writes in different formats" and "Multiples algebraic expression"; in the third week test includes two learning objectives: "Explain identities with models" and "Divides algebraic expressions into multipliers".

A total of 122 (23 for first learning objective, 26 for the second learning objective, 17 for the third learning objective, and 48 for the fourth learning objective) four-choice multiple-choice items were written by the researcher in consideration of these learning objectives. The written items were submitted to the mathematics education expert, assessment and evaluation expert and a mathematics teacher to examine measuring the related learning objective, whether they included scientific errors, their comprehensibility and their suitability to the level of the student. Considering the opinions and suggestions of the experts, some items were eliminated, and some corrections were made. At the end of this process, the items were divided into two equivalent tests (Form-A and Form-B), taking into account the difficulties encountered in the implementation of the remaining 80 items. These forms were randomly distributed to 485 9th grade students in two different high schools.

According to the analysis of the data obtained from the experimental application, it was seen that the item difficulty index ranged between .33 - .82 and the discrimination index ranged between .39 - .61. for Form -A and Form-B. Taking into account the learning objective, item difficulty index, and discrimination index and tests that will be applied within the same course hours after the lessons have been processed, equivalent forms (Form-A and Form-B) consisting of eight items have been obtained to be used as pre-test(Form-A) and post-test (Form-B) in different weeks.

Table 4. *Test* form and equivalent test form reliability analysis

	Test Form	**Equivalent Form**
Items	40	40
Split Half (odd-even) Correlation	0,639	0,725
Spearman-Brown internal consistency	0,780	0,841
KR20	0,726	0,816

As shown in Table 4, split-half reliability (0.639-0.725), KR-20 (Kuder Richardson) reliability (0.726-0.816), and internal consistency (Spearman Brown) coefficient (0.780-0.841) are calculated in the study. For both forms, 24 questions were selected to take into account item discrimination, difficulty level and gains. Examples of each objective are given in the appendix.

Implementation of Study

In the implementation, which was made on 13th Feb-9th March, 2018, 233 students participated in the control and experiment groups. After the determination of experiment and control groups, information regarding the implementation is given to the class teacher included in the study group. Design of the implementation process is presented in figure 2. Since the effect of feedback time on the success of algebraic expressions and identities was tried to be determined, the students took lesson on this subject. In order to

provide a similar education process, the teacher was interviewed before the education and asked to study at the same class hours in order to follow the same process in their class and to avoid any inadequacies. The study is planned as three weeks. These are determined by taking objectives into consideration.

The experimental study was carried out at the end of the course so that to minimize the learning losses of the students and there was no differentiation. Same process was followed for each outcome. First, pretest prepared based on the outcomes is applied on all the groups. Then feedback is given. After the feedback, posttest is applied.

The mathematics test prepared, after the first outcome of the algebraic and identities is studied by the teacher, pretest is conducted on the experiment and control groups by the researcher. The students are given feedback within framework of specified experimental design timetable (Table 4) and then post tests are conducted. Feedback process is applied by the researcher. No feedback is given to control group. All of the 225 students who took the test answered 8 items in 15 minutes. Thus, pre and post test applications are conducted within experimental design as 1 week per learning objectives, to the experimental and control group students. Finally, a final test is conducted from all learning objectives.

In all groups, feedback was given by the researcher. Giving feedback; before feedback giving process to give similar feedback researcher the solution of questions and taking into consideration the mistakes encountered during trial application feedback process is planned. Firstly, the students were told how many correct and incorrect answers they did. Then how they should solve the questions and what are the points to take care during solution are emphasized by the researcher to students. And the solution ways are told in the class in a similar way. Considering the class population being high, collective feedback is preferred. Studies in the literature on the feedback process (Arnett, 1985; Bumgarner, 1984; Farragher & Szabo, 1986; Hattie & Timperley, 2007; Schimmel, 1988; Tunstall & Gipps, 1996) were examined. The study of Trunstall and Gipps (1996) was not preferred due to being based on examination of in-class teacher behavior with qualitative observation. Because the study of Schimmel (1988) is more inclusive and broader in classification, these feedback types were taken as basis in this study.

Table 5. *Feedback types implemented*

Feedback	Definition	Procedure
Verifier	Providing information to student about the learning outcomes.	Pretest results are given to students.
Corrective	Providing the correct answer after specifying the answer is correct or incorrect.	Which questions were answered correctly or incorrectly is informed.
Explanatory	The student is provided with the explanation of why the correct answer is correct and why the incorrect answer is incorrect when informing about the learning outcomes.	The incorrect answers were individually explained in the class.
Determinant	It is feedback that includes information about how and what the student should work to correct the incorrect answer.	How they should solve the questions and what are the points to take care during solution are emphasized by the researcher to students.

The feedback types, definitions and procedures performed in the class are given in Table 5. Because it was not addressed when giving feedback how it will be related with the next subject, expansion-oriented feedback type was not used.

Data Analysis

In the mathematics achievement test used in the research as pre and posttest, multiple choice items were scored as correct-incorrect (1-0). Quantitative data obtained in implementation of success test as pre and post tests were analyzed by using SPSS (Statistical Package for Social Sciences) for Windows 22.0 program. The mean, standard deviation, ANCOVA and independent ANOVA tests were used for the evaluation of the data. ANCOVA provides statistical control of the variables associated with the dependent variable, with the exception of a factor or factors of which the impact is tested in a study (Büyüköztürk, 2015). In this study, ANCOVA test was used to statistically control the effect of pre-tests in the comparison of post-tests. Before conducting ANCOVA, homogeneity of regression slopes assumption was checked and this assumption was held for all comparisons. When there is a differentiation, the Bonferroni post hoc test was used to determine between which groups differ. First, it was determined whether the assumptions of ANCOVA test were met. In order to determine whether the groups had normal distribution, all students and group kurtosis and skewness values were examined. It was decided to have normal distribution due to values being between -3 and +3 (DeCarlo, 1997; Hopkins & Weeks, 1990). In the calculation of the effect size, the partial eta-squared size calculation was used.

FINDINGS

In this section, the findings and interpretations of the application weeks for the study plan are given. Firstly, the findings of each week are given and then a general evaluation is made.

Findings on Week I

Firstly, the data on whether there is a differentiation between the pre-test1 scores of groups (ANOVA) is given. Then, adjusted mean and information on ANCOVA test are given for post-test1.

Table 6. *Descriptive statistics for Pre-test1 and Post-test1*

	N	Pre-test1		Post-test1		
		Mean	S. deviation	Mean	S. deviation	A. Mean
CG	37	3.84	2.60	4.08	2.16	4.16
E1	36	4.03	1.90	5.44	1.89	5.44
E2	40	4.15	1.58	4.95	1.80	4.87
E3	39	4.23	2.40	5.21	2.19	5.07
E4	34	3.91	1.96	4.42	2.15	4.50
E5	39	3.92	1.81	5.29	1.52	5.38

According to Table 6, sample means vary between 3.84 and 4.23. To determine whether the differentiation occurring in pre-test1 is statistically significant, One Way ANOVA test is applied and information regarding this are given in table 6.

Table 7. *ANOVA results for Pretest 1 scores*

	Sum of Squares	df	Mean Squares	F	p
Between groups	4.402	5	.880	.206	.960
Within Group	937.527	219	4.281		
Total	941.929	224			

The difference between the mean scores of the groups in the pre-test1 is not statistically significant as it is p>0.05 according to Table 7. That is to say, the pre-test1 successes of the groups can be considered the same. ANCOVA test is made to compare posttest-1 means by adjusting for pre-tests-1 (Table 8).

Table 8. *ANCOVA results of Post-test1 scores corrected for Pre-test1 scores*

	Sum of Squares	df	Mean Squares	F	p	η^2
Group	45.542	5	9.108	4.619	.001	097
Pre-test1	405.813	1	405.813	205.797	.000	.489
Error	423.961	215	1.972			
Total	6243.000	222				

According to Table 8, it was found that there was a statistically significant difference between the post-test1 mean scores corrected for pre-test1 scores of the students receiving feedback at different times (F(5,215)=4,619; p<0,05). That is to say, post-test1 scores of the students are related with the feedback timing. According to the results of the Bonferroni test conducted between the corrected post-test1 scores of the groups, E1 and E5 group differentiation by control group is statistically significant. Means of E1 and E5 groups are higher compared to control group. That is to say, mathematics success of E1 and 5 groups is better than control group. In both groups, feedback is given before post-test. Differentiation between other groups is not significant. Also, partial eta value is calculated as 0.097. When this value is examined, it is seen to have a medium level effect size.

Findings on Week II

Firstly, the data on whether there is a differentiation between the pre-test1 scores of groups (ANOVA) is given. Then, adjusted mean and information on ANCOVA test are given for post-test2.

Table 9. *Descriptive statistics for Pre-test2 and Post-test2*

Groups	N	Pre-test2		Post-test2		
		Mean	S. deviation	Mean	Standard deviation	A. Mean
CG	35	3.94	1.86	4.29	2.16	4.44
E1	38	4.24	1.73	5.74	2.23	5.70
E2	36	4.08	2.26	4.44	2.21	4.54
E3	32	4.34	2.06	5.39	2.12	5.25
E4	36	4.19	2.15	4.62	2.05	4.60
E5	37	4.35	1.95	5.61	1.66	5.53

When the mean of groups given in Table 9 are examined, the lowest mean was CG's again. To determine whether the differentiation occurring in pre-test2 is statistically significant, One Way ANOVA test is applied. Information regarding this are given in table 10.

Table 10. *ANOVA results for Pretest 2 scores*

	Sum of Squares	df	Mean Squares	F	p
Between groups	4.351	5	.870	.216	.955
Within Group	836.794	208	4.023		
Total	841.145	213			

The difference between the average scores of the groups in the pre-test2 is not statistically significant as it is p>0.05 according to Table 10. That is to say, the pre-test2 successes of the groups can be considered the same.

Table 11. *ANCOVA results of Post-test2 scores by groups corrected for Pre-test2 scores*

	Sum of Squares	df	Mean Squares	F	p	η^2
Group	53.888	5	10.778	4.449	.001	.100
Pre-test2	349.943	1	349.943	144.465	.000	.418
Error	486.890	201	2.422			
Total	6159.000	208				

According to Table 11, it was found that there was a statistically significant difference between the post-test2 mean scores corrected for pre-test2 scores of the students receiving feedback at different times (F(5,201)=10,778; p<0,05). That is to say, post-test2 scores of the students are related with the feedback timing. According to the results of the Bonferroni test conducted between the corrected post-test1 scores of the groups, the differentiation between E1 and CG, E2 and E4 is statistically significant. Means of group is higher compared to control, E2 and E4 groups. That is to say, mathematics success of students in E1 group is better than the students in this group. In E1 group, pre-test, feedback and post-test is applied in the same lesson. In E2 and 4 groups, feedback is given far from post-test. It is not as effective as the feedback given close to post-test. Differentiation between other groups is not statistically significant. Also, partial eta value is calculated as 0.100. According to effect size examination, it is seen to have a medium level effect size.

Findings on Week III

Firstly, the data on whether there is a differentiation between the pre-test3 scores of groups (ANOVA) is given. Then, adjusted mean and information on ANCOVA test are given for post-test3.

Table 12. *Averages on Pre-test3 and Post-test3*

	Pre-test 3			Post-test3		
	N	Mean	S. Deviation	Mean	S. Deviation	A. Mean
CG	38	4.24	1.324	4.34	1.23	4.44
E1	35	4.43	1.770	5.94	1.73	5.93
E2	37	4.30	1.561	4.74	1.54	4.80
E3	32	4.53	1.849	5.39	2.45	5.28
E4	35	4.40	1.666	4.62	1.91	4.60
E5	37	4.49	1.325	5.78	1.69	5.74
Total	214	4.39	1.570	5.12	1.86	

When the means of groups given in Table 12 are examined, the lowest mean was CG's. The ranking of experiment groups is E2, E4, E1, E5 and E3. According to adjusted means, the ranking is E1, E5, E2, E4 and CG. To determine whether the differentiation occurring in pre-test3 is statistically significant, One Way ANOVA test is applied. Data regarding this are given in table 12.

Table 13. *ANOVA results for Pretest 3 scores*

	Sum of Squares	df	Mean Squares	F	p
Between groups	2.246	5	.449	.179	.970
Within Group	522.782	208	2.513		
Total	525.028	213			

The difference between the average scores of the groups in the pre-test3 is not statistically significant as it is p>0.05 according to Table 13. That is to say, the pre-test3 successes of the groups can be considered the same.

Table 14. *ANCOVA results of Post-test3 scores by groups corrected for Pre-test3 scores*

Source	Sum of Squares	df	Mean Squares	F	p	*Partial η²*
group	67.695	5	13.539	6.027	.000	.130
pre3total	186.944	1	186.944	83.217	.000	.292
Error	453.787	202	2.246			
Total	6207.000	209				

According to Table 14, it was found that there was a statistically significant difference between the post-test2 average scores corrected for pre-test2 scores of the students receiving feedback at different times (F(5,202)=13,539; p<0,05). That is to say, post-test3 scores of the students are related with the feedback timing. According to the results of the Bonferroni test conducted between the corrected post-test1 scores of the groups, control group and E1 with E5 differentiation is statistically significant. Also, differentiation between E1 and CG, E2 and E4, and also E5 and control and E4 is statistically significant. Averages of E1 and 5 groups are higher compared to other groups. That is to say, mathematics success of students in E1 and E5 groups is better than the students in control group. Differentiation between other groups is not statistically significant. In E1 and E5, feedback is right before the post-test. Also, partial eta value is calculated as 0.130. According to effect size result, it has medium level effect size.

Findings on Final Test

After the three-week process according to the experimental design plan was completed, the students were given a 12-question final test that contains all four outcomes. Firstly, final test scores and descriptive statistics on adjusted means are given in Table 14. Information on previously made ANCOVA test are presented.

Table 15. *Descriptive statistics of final test scores by groups*

group	N	Mean	S. Deviation	A. Mean
CG	34	5.82	2.02	5.91
E1	33	9.18	1.75	9.19
E2	33	6.70	2.31	6.78
E3	27	7.67	2.47	7.54
E4	32	6.75	2.43	6.72
E5	33	8.15	1.91	8.11

According to adjusted final test means scores, it is seen that the highest is E1 group, the lowest is control group (Ex1>E5>E3>E2>E4>CG). To determine whether the difference observed between the adjusted post-test mean scores of groups is significant, ANCOVA test is made. Data regarding this are given in Table 16.

Table16. *ANCOVA results of final scores by groups corrected for Pre-test1, Pre-test2 and Pre-test 3 scores*

	Sum of Squares	df	Mean Squares	F	p	*Partial* η^2
Group	224.919	5	44.984	12.929	.000	.261
Pre-test1	23.394	1	23.394	6.724	.010	.035
Pre-test2	12.157	1	12.157	3.494	.063	.019
Pre-test3	55.825	1	55.825	16.045	.000	.081
Error	636.732	183	3.479			
Total	1082.479	191				

According to Table 16, it was found that there was a statistically significant difference between the final scores corrected for pre-test1, pre-test2 and pre-test3 scores of the students receiving feedback at different times (F(5,5183)=12,929; p<0,05). That is to say, final scores of the students are related with the feedback timing. According to the results of the Bonferroni test conducted between the corrected final scores of the groups, the differentiation between E1 and CG, E3 and E5 is statistically significant. Also, the differentiation between E1 and CG, E2, E3 and E4 is significant. Also, the differentiation between E5 and CG and E4 is significant. Averages of E1, E3 and E5 groups are higher compared to control group. That is to say, mathematics success of students in E1, E3 and E5 groups is better than the students in control group. In E1, E3 and E5 groups, feedback is given right before the post-test. That is to say, giving feedback before post-test affects mathematics success positively. Also, partial eta value is calculated as 0.261. According to effect size, it has large effect size.

Conclusion and Discussion

In the study to determine the effect of feedback time on mathematics success, mathematics test is developed to measure mathematics success. In the experiment groups of the study, feedbacks are given in different times between pre and post-tests. Post-test scores of the groups are compared. In the analysis results, information on the differentiation between groups are given in table 16.

Table 17. *Differentiation of groups by weeks*

Week I	**Week II**	**Week III**	**Final Test**
E1 > CG	E1> CG	E1> CG	E1> CG
E5 > CG	E1> E2	E1> E2	E1> E2
	E1> E4	E1> E4	E1> E3
		E5> CG	E1> E4
		E5> E4	E3> CG
			E5> CG

According to Table 17, the students in E1 group are more successful in mathematics lesson than CG students in each week and in final test. In E1 group, pre-test, feedback and post-test given to students in the same lesson. This is in parallel with the data in the literature regarding that feedback should be given immediately (Brinko, 1993; Erbaş & Yücesoy, 2002; Hathaway, 1997; Kulik & Kulik, 1988). According to Erbaş and Yücesoy (2002), immediate feedback method is effective in increasing success. Similarly, in the meta-analysis study conducted by Kulik and Kulik (1988), it is stated that the research results are significant in favor of the immediate feedback. At the same time, E5 group is successful compared to CG in first, third and final test. When both

findings are considered together, it is seen that feedback is given right before post-test. Corresponds with the findings stated in the literature and on feedback having effect on remembering (Aydın, 2011). Students entering post-test were more successful compared to other groups because they remembered general mistakes and correct solutions in the pre-test. This judgement will be verified when remembering and understanding level of post-test questions are considered. These results show that the timing of feedback plays an important role in providing the expected results from the feedback.

E3 group differentiates only from CG in the final test. In E3 group, feedback is given right before the post-test. It wasn't as successful as E5 group, which was given feedback right before post-test. Students in the E5 group studied for 1 week until the post-test was applied, while students in E3 group did not study. Also, the students in E5 group having extracurricular studying may be effective in achieving this success. The fact that the students in the E5 group were repeating the subject in some way may have been effective in increasing the success.

Also, E2 group did not differentiate in any stage. So, it can be said that performances of E2 and CG were similar. E2 group is one of the groups which feedback is farthest to post test. Also, again E4 group did not differentiate in any stage. So, it can be said that performances of E4 and CG were similar. E4 group is the group which feedback is farthest to pre and post-test. As stated by Erbaş and Yücesoy (2002) and Kantarcı (2014), delaying feedback does not provide sufficient effect on the performance. The reason why students could not perform successful enough may be the feedback being post-test. The feedback given close to the post-test had a reminding effect on the expected behaviors. In the studies (Li, Zhu, & Ellis, 2016; Opitz, Ferdinand, & Mecklinger, 2011) conducted in the field of language teaching, it was determined that the feedback given by effective timing had a recall effect.

When evaluated in general, study groups which feedback is far from post-test could not obtain any differentiation compared to CG. Feedback given far from post-test had no statistical effect. In conclusion, mathematical success of groups which were given feedback right before post-test was higher.

The limitation of the study was that the experimental groups of the study could not be formed and lasted for 3 weeks. Therefore, the study results should be taken into account when generalizing.

Recommendations

To researchers; this study is conducted on the subjects of mathematics lesson algebraic expressions and identities. It is recommended to conduct on different subject and lessons. Also, 8th grades in public schools were determined as the study group. It is recommended to conduct studies in different grades and school types. Feedback right after pre-test and applying post-test one week later could not be done in experimental design due to insufficiency of number of classes. It is recommended to conduct studies including all probabilities. In this study, the effect of feedback timing to academic success was investigated: However, it should be looked at whether feedback types have any effect.

To practitioners who want to use the data of this study; academic success of students increases when the feedback is given before post-test according to study results. Teachers giving feedback to students before examinations will increase their success. In this context, it is recommended to mention this in the pre-training faculty and pedagogical formation processes in order to ensure that teachers are informed

about feedback timing because it affects the student success. At the same time, for informing the task to the teacher, in-service trainings are recommended to plan.

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Appendix

Example Question from Form-A and Form-B

<table>
<tr>
<td>Sabit terimi: 5
Kat sayılarının toplamı: 8
Terim Sayısı: 3

Yukarıdaki özellikleri sağlayan cebirsel ifade aşağıdakilerden hangisidir?

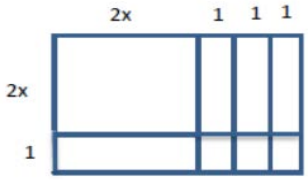
A) 3xy-3x+5
B) 4x+3y-5
C) 6xy-3y+5
D) 3x-y-5</td>
<td>$4x^2-2x+3y-5$

Cebirsel ifadesi için verilerden numaralanmış bilgilerden hangileri doğrudur?

I. Katsayıları: 4, -2, 3,-5'tir
II. Sabit terimi -3'tür
III. Katsayıların toplamı 2'dir.
IV. 5 terimden oluşmaktadır

A) Yalnız I B) II ve III
C) I ve III D) II ve IV</td>
</tr>
<tr>
<td>I. $3x.4x=7x^2$
II. $-5x.3x^2=-15x^3$
III. $3x.-3xy=-9x^2y$
IV. $4x.5xy=20x^2y$

Yukarıdaki eşitliklerden kaç tanesi doğrudur?

A) 4 B) 3
C) 2 D) 1</td>
<td> 
Cebir karolarıyla modellenen ifadenin özdeşi aşağıdakilerden hangisidir?

A) $2x^2+4x+3$
B) $4x^2+8x+3$
C) $2x^2+8x+3$
D) $4x^2+4x+3$</td>
</tr>
</table>