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| Research Article / Araştırma Makalesi |

# Effects of Using Web 2.0 Tools in Mathematics Instruction on Academic Achievement and Attitude and Examination of Relevant Teacher-Student Views

# Matematik Öğretiminde Web 2.0 Araçlarının Kullanımının Akademik Başarı ile Tutuma Etkisi ve Sürece İlişkin Öğretmen-Öğrenci Görüşlerinin İncelenmesi

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**Keywords**

1. Web 2.0 tools
2. Mathematics Instruction
3. Attitude
4. Academic achievement
5. Teacher-Student Views

**Anahtar Kelimeler**

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2. Matematik Öğretimi
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## Abstract

*Purpose:* The research mainly aimed to identify the effect of mathematics courses performed with Web 2.0 tools on secondary school students' mathematical achievements and attitudes towards mathematics and to examine teacher-student views on the process.

*Design/Methodology/Approach:* The research was designed according to the mixed-method research approach. First, how mathematics courses performed with Web 2.0 tools (Plickers, Kahoot, and Edmodo) affected fifth- and eighth-grade students' mathematical academic achievements and attitudes towards mathematics was examined, thereafter semi-structured interviews were conducted with the teacher and student views were collected using a written view form. The participants of the study is a mathematics teacher working in a secondary school located in the center of a city in Turkey and 133 students of this teacher.

*Findings:* Consequently, while mathematics courses using Web 2.0 tools were found to have a positive effect on fifth-grade students' relevant achievements and attitudes, eighth-grades' achievements and attitudes did not differ. Moreover it has been determined that teacher and students have generally positive opinions about the process.

*Highlights:* Future studies can investigate the effectiveness of different Web 2.0 tools in other courses in the long run. In addition, different variables such as attitude towards technology and digital literacy can be investigated. Web 2.0 tools can be introduced to teachers, and preservice teachers, and training can be provided to them.

## Öz

*Çalışmanın amacı:* Araştırmanın amacı, Web 2.0 araçları kullanılarak gerçekleştirilen matematik derslerinin ortaokul öğrencilerin akademik başarıları ile matematiğe yönelik tutumlarına etkisini belirlemek ve sürece ilişkin öğretmen-öğrenci görüşlerini incelemektir.

*Materyal ve Yöntem:* Bu araştırmada karma araştırma yöntemi kullanılmıştır. İlk olarak Web 2.0 araçları (Plickers, Kahoot ve Edmodo) ile işlenen matematik derslerinin beşinci ve sekizinci sınıf öğrencilerinin akademik başarılarını ve matematiğe yönelik tutumlarını nasıl etkilediği incelenmiş, ardından öğretmen görüşleri yarı-yapılandırılmış görüşmeler aracılığıyla ve öğrencilerin görüşleri hazırlanan yazılı görüş formları kullanılarak alınmıştır. Çalışmanın katılımcılarını Türkiye'deki bir şehrin merkezinde bulunan bir ortaokulda görev yapmakta olan bir matematik öğretmeni ile bu öğretmenin 133 öğrencisi oluşturmaktadır.

*Bulgular:* Sonuç olarak Web 2.0 araçları kullanılarak gerçekleştirilen matematik derslerinin beşinci sınıf öğrencilerinin başarı ve matematiğe yönelik tutumları üzerinde olumlu etkisi saptanırken, sekizinci sınıf öğrencilerinin başarı ve tutumları üzerinde etkili olmadığı belirlenmiştir. Ek olarak, sürece yönelik öğretmenlerin ve öğrencilerin genellikle olumlu görüşte oldukları tespit edilmiştir.

*Önemli Vurgular:* Araştırma sonuçlarına dayanarak, ileriki çalışmalarda Web 2.0 araçlarının etkililiği diğer dersler için de uzun süreli araştırılabilir. Ayrıca teknolojiye yönelik tutum ve dijital okuryazarlık gibi farklı değişkenler de incelenebilir. Öğretmenlere ve geleceğin öğretmeni olacak olan öğretmen adaylarına Web 2.0 araçları tanıtılıp etkili kullanımlarına yönelik eğitimler verilebilir.

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## INTRODUCTION

Mathematics is one of the most important courses that every student must take. However, it is a critical problem that students in secondary school and high school education are not on the expected levels in mathematics achievement both on the national and international levels. Therefore, it is important to consider the factors that affect the success of students, especially in abstract courses such as mathematics (Aydın, 2018). Thus, it is aimed in education to improve affective properties such as attitude that play a central role in mathematics learning aside from improving the cognitive properties (McLeod, 1992; Ministry of National Education [MoNE], 2009). Neale (1969) defined attitude towards mathematic as "*a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless*" (p.632, as cited in Ma & Kishor, 1997). Students' experiences about mathematics are effective in the development of negative or positive attitude towards mathematics.

Given that attitudes have the power and importance which guide the behavior, one can mention about a relationship between attitudes towards mathematics and mathematics achievement. There are several studies in the literature which have concluded a positive relationship between attitudes towards mathematics and mathematics achievement (Aiken, 1970; Barkatsas, Kasimatis & Gialamas, 2009; Eyyam & Yaratan, 2014). Another important factor that affects students' attitude towards the course is their teachers. Students usually believe that they will be more successful when they like the mathematics course, and they learn more effectively when they are interested in what they have learned (Ma & Kishor, 1997). Hence, when designing the instructional settings, teachers need to use appropriate methods which will contribute to students' liking of the course and attract their attention.

The transformation led by technological development in the society has also reflected on education. New information and technologies have been constantly changing the ways to perform mathematics and establish communication from past to present. Indeed, learning styles of teachers who were trained in the environments rather using written sources differ from the learning processes and information processing among members of the digital generation. It is important to make certain inferences about learning behaviors of the digital members of this age. To this end, it is now obligatory to take the digital steps of instructional designs in consideration of educational requirement for this digital generation. Today, technology is advancing at an immense speed and creating new means for meaningful mathematics instruction. As a result of constant advancement in computer technologies, instructional software increase both in quality and quantity, and there are more and more alternatives each day (MoNE, 2009).

Determining the efficacy of instructional activities for mathematics is undoubtedly one of the important points in the teaching-learning process. With the extensive use of information and communication technologies in the learning and teaching process, use of effective and suitable technological tools have also gained currency in this process (MoNE, 2013; National Council of Teachers of Mathematics [NCTM], 1989, 2000). In the cases where feedback in the tools used is fast, clear and explicit, students can have the chance to correct their wrongs and make meaning of their learning (Freeman & Tashner, 2015). There are several new technologies, and therefore, software helping teachers use formative assessment which improves learning and assessment-evaluation in the instructional process. With the advancing technology, web applications have also evolved, and Web 2.0 applications that can be used at many steps of instruction have become an element of educational technology. There are several software (e.g. Plickers, Kahoot, and Edmodo) within the scope of these applications. Other than being low-cost, main attributes of these software are that they help teachers transform the learning environment effectively from being teacher-centered into being student-centered and assess knowledge and skills of their students efficiently and productively (Elmahdi, Al-Hattami & Fawzi, 2018).

Although mathematics course is one of the basic courses in primary education, from the secondary school years, reasons such as abstraction of mathematical subjects from daily life and courses being intense and boring lead to negative thoughts about mathematics and cause mathematical achievement to decrease (Sezgin Memnun & Akkaya, 2010). Thus, in meeting the expectations of digital individuals, it is necessary to benefit from Web 2.0 tools for its features that make things fun, contribute to retentive learning, assist peer teaching and offer equal opportunities and to maximize this benefit. In the literature, there are several studies performed on the software such as Plickers and Kahoot (Borst, 2017; Demirkan, Gürışık & Akın, 2017; Elmahdi, Al-Hattami & Fawzi, 2018; Freeman & Tashner, 2015; Layden, 2018; McCargo, 2017; Wood, Brown & Grayson, 2017; Wuttiprom et al., 2017; Zengin, Bars & Şimşek, 2017) and Edmodo (Al-Said, 2015; Çankaya, Durak & Yünkül, 2013; Ekici, 2017). However, these studies have not been conducted in mathematics courses of secondary school students but mostly addressed courses instructed in the company of a software. In line with these considerations, this research mainly aimed to identify the effect of mathematics courses performed with Web 2.0 tools on secondary school students' mathematical academic achievements and attitudes towards mathematics and to examine teacher-student views on this process. Therefore, sub-problems of the study were decided as follows:

1. Do courses performed with Web 2.0 tools have any effect on fifth- and eighth-grade students' academic achievement in mathematics course?
2. Do courses performed with Web 2.0 tools have any effect on fifth- and eighth-grade students' attitudes towards mathematics?
3. What are teacher and students views on mathematics courses performed with Web 2.0 tools?

## METHOD/MATERIALS

### Research design

The research was designed according to the mixed-method research approach, in which quantitative and qualitative research methods are used together. In the research, explanatory sequential design, one of the mixed methods, was used. In the explanatory sequential design, firstly, quantitative data are collected and analyzed, then qualitative data are collected and analyzed to explain the quantitative results (Creswell, 1999). First, how mathematics courses performed with Web 2.0 tools (Plickers, Kahoot, and Edmodo) affected fifth- and eighth-grade students' mathematical academic achievements and attitudes towards mathematics was examined; thereafter semi-structured interviews were conducted with teacher, and written view forms were conducted with students.

### Study Group

Participants of this study is a teacher working in a secondary school in the central district of a city in Turkey and 133 students of his. Table 1 shows demographic information on teacher and his level of using computer, Internet and mobile devices.

**Table 1. Information on teacher**

| Gender | Professional seniority (years) | Level of Internet Usage | Level of Computer Usage | Level of Mobile Device Usage | Competence of Technology Usage in Instructional Process |
|---|---|---|---|---|---|
| Male | 15 | Somewhat Competent | Somewhat Competent | Somewhat Competent | Somewhat Competent |

According to Table 1, the teacher is male, and his professional seniority is 15 years. To describe the students, the students were handed a form about their chance to use Internet, smartphone and computer/tablet before the procedure. It was seen that all students had the chance to access at least one smartphone or computer, and none of them had problem with accessing Internet.

### Measures

Measures used in the study are Mathematics Course Achievement Tests, Mathematics Attitude Scale, and interviews. These measures are described below.

### Mathematics Course Achievement Tests (MCAT):

The Mathematics Course Achievement Test developed by Abalı Öztürk (2014) for fifth-graders was used in the study. Mean difficulty of the 33-item test was found to be .502, and its Spearman-Brown reliability coefficient of .82 indicates its reliability. The Mathematics Course Achievement Test which consists of 14 items and applied to the eighth-graders was developed by Özpınar, Gökçe and Aydoğan Yenmez (2017). Test's Cronbach-α reliability coefficient was found to be .906. It was decided to use the tests with the mathematics teacher upon the examination of test questions in consideration of the program.

### Mathematics Attitude Scale (MAS):

The 20-item and 5-point Likert-type Mathematics Attitude Scale developed by Aşkar (1986) was used to measure students' attitudes towards mathematics course. The scale is composed of ten positive and ten negative items. Reliability coefficient (Cronbach's Alpha) of the scale was found to be .89.

### Interviews:

Teacher views on the mathematics courses performed with Web 2.0 tools were collected with semi-structured interviews whereas student views were collected using a written view form (WVF) which were prepared by researcher.

### Procedure

First, the teacher was met and informed of the usage of Web 2.0 tools; exemplary applications were discussed, and questions were answered in a three-week period. Teacher's accounts were created together with him, and training was provided about how to use necessary information and questions, shapes, videos, etc. and features and scopes of Web 2.0 tools (Plickers, Kahoot, and Edmodo). Students were trained by the teacher about the software they would use. In this stage, brief information on Web 2.0 tools to be used in the application was provided to the students, and questions from students were answered. Teacher conducted the applications in his classrooms for eight weeks.

The study was performed to examine and compare the effects of the applications made with Web 2.0 tools of fifth and eighth grade students on their success and attitudes. For this purpose, MCAT and MAS were applied to both the experimental and control groups before and after the study in the classrooms of the teacher who was teaching mathematics in the fifth and eighth grades. Research design is presented in Table 2.

**Table 2. Design of the research**

| Groups | Pretests | Procedures | Posttests |
|---|---|---|---|
| Experimental Group 5th-Grade | MCAT<br>MAS | Applications that can be performed with Web 2.0 tools | MCAT<br>MAS<br>WVF |
| Control Group 5th-Grade | MCAT<br>MAS | Teaching according to the methods predicted by the curriculum | MCAT<br>MAS |
| Experimental Group 8th-Grade | MCAT<br>MAS | Applications that can be performed with Web 2.0 tools | MCAT<br>MAS<br>WVF |
| Control Group 8th-Grade | MCAT<br>MAS | Teaching according to the methods predicted by the curriculum | MCAT<br>MAS |

Students who took the courses with Web 2.0 tools were included in the experimental group while others consisted of the control group. The courses in the experimental and control groups were instructed by the same teacher. Experimental group students performed their activities individually on Plickers, both individually and in groups on Kahoot and Edmodo. Activities in the control group were performed in compliance with the constructivism and in line with textbooks. In experimental group of the study, the activities about relevant subjects in the textbook were transformed into applications that can be performed with Web 2.0 tools. The teacher ensured that the time and effort spent on the activities were the same in the experimental and control groups. It was seen that all students knew how to use a tablet, they had at least one tablet or smartphone at home which they could use, and they did not have difficulty entering the software.

At the end of the application, teacher views were obtained through semi-structured interview, and the views of the experimental group students were collected through WVFs in order to support and explain the quantitative data.

## Data Analysis

Research data were subjected to both qualitative and quantitative analyses. The SPSS software package was used in the study to analyze the quantitative data. T-test were utilized in the analysis of quantitative data whereas qualitative data were interpreted with frequency.

Highest possible score in MCAT applied to fifth-graders is 100 points. Given the highest possible score and the 5-point grading system, achievement groups were determined to be 0-20 (very low), 21-40 (low), 41-60 (moderate), 61-90 (high), and 81-100 (very high). In the pretest and posttest assessments of MCAT questions applied to the eight-graders, answers were examined in four categories of totally correct (2 points), partly correct (1 point), incorrect (0 point), and unanswered (0 point). The achievement grade of students in MCAT was calculated so as to be 0 being the lowest and 28 being the highest.

Depending on what kind of attitudes the feelings, thoughts and behaviors mentioned in the items of MAS did stir in the individual, the scale used five-point Likert grading. Accordingly, range coefficient calculated for the four ranges in the five-point Likert scale (5-1=4) is 4/5=0.80. For the positive items, the ranges are 1.00-1.79 (strongly not applicable), 1.80-2.59 (not applicable), 2.60-3.39 (neutral), 3.40-4.19 (applicable), and 4.20-5.00 (strongly applicable). Negative items are reverse-scored, and the total score was considered students' attitude score for mathematics course.

The qualitative data were subjected to a content analysis. The main purpose of the content analysis is to reach concepts and relationships that can explain the collected data. With content analysis, it is attempted to define data and explore the truths that might be implicit within data (Yıldırım & Şimşek, 2006). Coding achieved from the semi-structured interviews and WVFs of the research was reviewed by two experts, disagreed items were discussed to make the necessary adjustments, and the inter-rater reliability's percentage agreement index was found to be 88%. Since the index was above 70%, it was considered acceptable for the present research (Miles & Huberman, 1994). The study included the opinions supportive of the content analysis findings for the WVFs completed by all students about the mathematics course using Web 2.0 tools and the findings achieved from the teacher interview.

## FINDINGS

Findings of the research are presented under three headings in line with the sub-problems.

## Findings concerning the First Sub-problem of the Research

Students' pretest and posttest scores of MCAT were compared to examine whether the mathematics courses performed with Web 2.0 tools affected academic achievement, and the analysis results are provided below.

**Table 3. Results concerning the MCAT pretest and posttest scores of 5th-grade experimental and control groups**

| | | N | $\overline{X}$ | S | sd | t | p |
|---|---|---|---|---|---|---|---|
| Pretest | Experimental Group | 32 | 41.38 | 20.27 | 60 | .52 | .606 |
| | Control Group | 30 | 39.05 | 14.94 | | | |
| Posttest | Experimental Group | 32 | 55.20 | 17.71 | 60 | 2.27 | .027* |
| | Control Group | 30 | 45.55 | 15.54 | | | |

*Significant at .05

As seen in Table 3, according to the pretest results, no significant difference was found between the mean MCAT scores of the experimental and control groups at a significance level of .05 (p=.606). This finding indicates that there was no difference between the groups by academic achievement before the procedure.

As for the posttest results, an important difference was found between the mean posttest scores of the experimental and control groups [t(60)=2.27, p<.05]. The experimental group had higher posttest scores ($\overline{X}$ =55.20) than the control group ($\overline{X}$ =45.55). Hence, one can argue that courses using the Web 2.0 tools were more effective in fifth grade students' academic achievement.

**Table 4. Results concerning the MCAT pretest and posttest scores of 8th-grade experimental and control groups**

| | | N | $\overline{X}$ | S | sd | t | p |
|---|---|---|---|---|---|---|---|
| Pretest | Experimental Group | 36 | 7.53 | 2.58 | 69 | .39 | .695 |
| | Control Group | 35 | 7.28 | 2.61 | | | |
| Posttest | Experimental Group | 36 | 17.03 | 4.74 | 69 | 1.26 | .213 |
| | Control Group | 35 | 15.66 | 4.44 | | | |

No significant difference was found between achievement pretest scores of the eight-graders by the groups [t(69)=.39, p>.05]. According to Table 4, the experimental group's mean score of achievement pretest was $\overline{X}$ =7.53 whereas the control group's mean score was $\overline{X}$ =7.28. This finding indicates that there was no difference between the groups by academic achievement before the procedure.

No significant difference was observed between the achievement posttest scores of the eight-graders by the groups [t(69)=.1.26, p>.05]. It is seen in Table 4 that the experimental group's mean score of the achievement posttest was $\overline{X}$ =17.03 while the control group's mean score was $\overline{X}$ =15.66. As indicated by this finding, whereas there was no statistically significant difference between the groups by academic achievement, the experimental group students had higher mean scores than the control group students.

## Findings concerning the Second Sub-problem of the Research

Students' pretest and posttest scores of MAS were compared, and whether the software used had any effect on the attitude was examined with independent samples t-test. Analyses on the attitudes of the fifth- and eighth-grade experimental and control groups are presented below.

**Table 5. Results concerning the MAS pretest and posttest scores of 5th-grade experimental and control groups**

| | | N | $\overline{X}$ | S | sd | t | p |
|---|---|---|---|---|---|---|---|
| Pretest | Experimental Group | 32 | 3.15 | .22 | 60 | 1.13 | .261 |
| | Control Group | 30 | 3.09 | .19 | | | |
| Posttest | Experimental Group | 32 | 3.83 | .38 | 60 | 10.11 | .000* |
| | Control Group | 30 | 3.05 | .20 | | | |

*Significant at .05

Table 5 shows the experimental and control groups' levels of attitude towards mathematics course. According to the pretest analysis, there was no significant difference between the experimental and control groups' attitudes towards mathematics course ([t(60)=1.13, p>.05]. This finding indicates that there was no difference between the groups by attitude before the procedure.

However, a significant difference was observed between the posttest scores of groups ([t(60)=10.11, p<.05]. Given the analysis results, the experimental group had an arithmetic mean of $\overline{X}$ =3.83 for the posttest scores, the control group's arithmetic mean of the posttest scores was $\overline{X}$ =3.05.

As indicated by Table 5, experimental group students' attitude scores increased in the posttest whereas a decrease was observed in the control group, albeit low. Consequently, one can argue that the courses instructed with Web 2.0 tools had a positive effect on attitudes towards mathematics.

**Table 6. Results concerning the MAS pretest and posttest scores of 8th-grade experimental and control groups**

| | | N | $\overline{X}$ | S | sd | t | p |
|---|---|---|---|---|---|---|---|
| Pretest | Experimental Group | 36 | 2.80 | .81 | 69 | 1.36 | .178 |
| | Control Group | 35 | 3.01 | .37 | | | |
| Posttest | Experimental Group | 36 | 2.93 | .76 | 69 | .828 | .411 |
| | Control Group | 35 | 3.06 | .47 | | | |

As seen in Table 6, according to the pretest results, no significant difference was found between the mean MAS scores of the experimental and control groups at a significance level of .05 (p=.178). This finding indicates that there was no difference between the groups by attitude before the procedure.

No significant difference was observed between the achievement posttest scores of the eight-graders by the groups [t(69)=.828, p>.05]. It is seen in Table 6 that the experimental group's mean score of the achievement posttest was $\overline{X}$ =2.93 while the control group's mean score was $\overline{X}$ =3.06.

## Findings concerning the Third Sub-problem of the Research

In this section, findings on the teacher and student views are provided respectively. Semi-structured interview and WVFs were used to support the findings obtained from the quantitative data with qualitative data. First, the teacher was asked for his view on the applications with Web 2.0 tools in mathematics teaching. When teacher opinions were examined, it was determined that the teacher mostly emphasized the advantages and disadvantages of applications performed with Web 2.0 tools. Themes concluded from the analysis on the advantages of applications using Web 2.0 tools as reported by teacher and the relevant codes are shown in Table 7.

**Table 7. Themes and codes regarding the advantages of applications implemented with Web 2.0 tools**

| Themes | Codes |
|---|---|
| In terms of educator | Opportunity to receive instant feedback |
| | Effective instruction thanks to participation to the process |
| | Increased course efficiency |
| | Diversified purpose of usage (homework, course document, announcement, discussion, survey, evaluating questions, etc.) |
| In terms of learner | Opportunity to see deficiencies and mistakes |
| | Making the course fun |
| | Supporting the learning |
| | Making the course liked |
| | Increased motivation and interest |
| In terms of the software | Opportunity to perform off-course activities |
| | Low cost |
| | Being very practical to use and easy to apply |
| | Saving time on reviewing exam papers in crowded classes |
| | Allowing parent-student-teacher communication |
| | Property to archive questions and results |

As can be seen in Table 7, three themes (in terms of educator, in terms of learner and in terms of software) emerged regarding the advantages of applications realized with Web 2.0 tools. Teacher's views on the advantages of the process and software were as follows:

*"It is very nice that feedback is instant and collective in Plickers; it also ensures the right use of time. It is a positive software also for the ability to be applied to all students at the same time, motivation, learning, and energy. [...] Kahoot was quite positive for supporting the questions with visuals or videos. They are easy to use; their archiving features are nice. [...] Edmodo is a useful tool that can be used for every stage of the course since we can send students individual messages, open up discussions on the classroom panel, send course documents, and it gives the chance to do homework and activities. [...] It makes mathematics instruction easier both inside and outside the classroom with features such as following up student's progress, saving on time, being intriguing with ability to ask questions that encourage to research, ensuring a constant student-teacher communication, keeping courses from monotony and making them fun, and offering attention-grabbing environments."*

According to the teacher views, he notably stated that he could use Web 2.0 tools at every stage of mathematics course. The teacher also mentioned about the adversities and limitations they experienced in the process. Views of teacher on disadvantages of software and procedure are provided below.

*"At the beginning, the greatest problem with Plickers was that kids focused on the paper (QR code), software and how their names appeared on the program, and they were curious about its operation. Therefore, they had problem with focusing on the questions. Achievement of the goal was delayed. But it contributes greatly to motivation and learning when they get accustomed over time. […] The greatest problem with using Kahoot is that a tablet or phone is required for each student, and Internet for software. When you do not pay attention in group activities, some of the students in the group may remain in the background, or the competitive environment may offend students and lead to lack of confidence. […]"*

The teacher was asked whether he considered himself competent at using Web 2.0 tools and the planned to continue these applications in his future courses. The teacher stated that he would utilize the software when required since he used them for a long time during the procedure and they were not complex to use, and the students liked them, and the software supported their learning. He provided his view as follows: *"Of course I will apply them. Kids like them. […] I will use such software actively and when necessary for supporting and assessing the subjects and gains, not instead of assessments performed to grade students, that is, the actual exams.*"

The secondary school students were asked about their views on the applications using Web 2.0 tools. When the responses of the students were examined, it was determined that they focused on the advantages and disadvantages of the application process in parallel with the opinions of their teacher. Themes and codes achieved from the analysis of students' views on the procedure and software are given in the table below.

**Table 8. Themes and codes achieved from students' views on the advantages of Web 2.0 tools and procedure**

| Theme | Codes | 5 | 8 | Total |
|---|---|---|---|---|
| | | f | f | f |
| Advantages about learning | Assisting the learning | 19 | 12 | 31 |
| | Receiving instant feedback | 2 | 9 | 11 |
| | Novel (different) applications | 2 | 7 | 9 |
| | Enabling the learning in cooperation with peers | 7 | - | 7 |
| | Assisting the reinforcement of the learning | 3 | 3 | 6 |
| | Increased participation in the course | - | 5 | 5 |
| | Increased retention | 1 | 3 | 4 |
| | Increased achievement | 2 | 1 | 3 |
| | Rapid and flexible learning | 2 | 1 | 3 |
| | Reducing the noise during course | - | 1 | 1 |
| Advantages about affective properties | Ensuring learning by fun | 28 | 28 | 56 |
| | Being attention-grabbing | 22 | 23 | 45 |
| | Ensuring the liking of mathematics | 9 | - | 9 |
| | Adding excitement to the course | 5 | - | 5 |
| | Reducing the test stress | 1 | 1 | 2 |
| | Increasing the desire to learn | - | 1 | 1 |
| Advantages about the software | Effective and nice | 13 | 10 | 23 |
| | Being necessary | - | 5 | 5 |
| | Easy and applicable | 2 | - | 2 |
| | Embellishing teacher's instruction | 1 | - | 1 |
| | Being practical | - | 1 | 1 |
| | Opportunity to rehearse and reinforce the past subjects | 1 | - | 1 |

According to Table 8, three themes were derived from the student views. In the theme *advantages about learning*, the most emphasized codes were found to be "assisting the learning" and "receiving instant feedback". Relevant student views are given below.

*"It contributes to our learning. Because we find out about what we do right or wrong immediately."* (Fifth-grade S4)

*"[…] I wish all courses were like that. We would understand better, then. For example, I understood mathematics more in Plickers and Edmodo applications."* (Fifth-grade S29)

Under the theme *advantages about affective properties*, the most stated codes were "ensuring learning by fun", and "being attention-grabbing". Students provided the following statements:

*"I think the software are very nice. They were fun and different. That is why they intrigued me. […] It contributed to the course instruction. Because I used to get so bored in mathematics courses, and I had so much fun with them."* (Fifth-grade S15)

*"It made me learn more easily. […] I liked the course. Now I love it."* (Fifth-grade S23)

*"I would like very much if the mathematics courses were to continue like that. Because a boring and unenjoyable course like mathematics became fun. It was very good."* (Eighth-grade S17)

Frequently repeated codes under the theme *advantages about the software* was "effective and nice", and "being necessary".

According to the student views on adversities and limitations of mathematics courses performed with Web 2.0 tools, in line with teacher views, they emphasized that these software required technical infrastructure and Internet. 8 students stated that lack of Internet quota was among general problems. Students who did not have a computer/tablet but a smartphone stated that small screen size was an obstacle (f=5) and that storage capacity of their mobile devices was not sufficient when downloading the learning materials (f=2). In addition, 3 students from fifth-grade and 5 students from eighth-grade reported that they did not like Kahoot and Edmodo, respectively, and 5 eighth-grade students found Plickers boring.

When asked about whether they would like Web 2.0 tools to be used in future mathematics courses, majority of the students stated that they would whereas some of the students added that it would be effective to use them in other courses, too. Relevant student views are given below:

*"I would like the courses to continue like that. Because some of us used to find mathematics course boring. But our teachers can continue these applications to make the course nice. All courses would be more enjoyable and fun like so."* (Fifth-grade S5)

*"I think courses should continue like that. Because both mathematics being fun and technology are my interest. […]*" (Fifth-grade S17)

*"[…] Because it is more fun. It should be applied not only in mathematics, but also in other courses. […] And according to a research I have read, kids comprehend things better when having fun. I want such activities to continue so we can understand better."* (Eighth-grade S1)

*"Yes, because technology should be everywhere now. These software attract our attention. These applications are so much fun."* (Eigth-grade S27)

According to the students' views, some students did not want the courses to continue using Web 2.0 tools. While 18 eighth-grade students stated that they did not want the courses to continue using Web 2.0 tools because they considered them a waste of time as they were preparing for the High School Entrance Exam (HSEE), generally they notably emphasized that the applications were fun and enhanced the learning. In parallel with this view, one student stated that the mathematics courses should be performed with papers and pencils, and therefore, such usage of technology was not suitable for mathematics courses as they would take the HSEE in years to come.

## CONCLUSION, DISCUSSION AND RECOMMENDATIONS

Technology is one of the most important factors affecting human life since the early ages and it has changed our methods and habits in meeting our needs and solving our problems in all areas of our lives. Along with the developing technology, Web applications have also developed and Web 2.0 tools that can be used in many stages of education have become an element of educational technology. In this study Plickers, Kahoot and Edmodo were used, and effects of using these software on secondary school students' academic achievement in mathematics, attitudes towards mathematics and relevant teacher and students views were examined.

In the study using the mixed-method research design, as for the academic achievement, experimental and control group's mean pretest and posttest scores of MCAT were compared, and while a significant difference was observed between the fifth-grade groups, no significant difference was observed between the eighth-grade groups; however, experimental group students were found to have higher mean scores than control group students. It is thought that the increase in the posttest achievement scores of the experimental groups resulted from the applications performed using Web 2.0 tools. This finding also indicates that Web 2.0 tools are effective in supporting the learning and increasing the achievement. There are studies in the literature that coincide (Deniz, 2019; Gürleroğlu, 2019; Güzeller & Akın, 2012; Maguire et al., 2010; Tuncer & Şimşek, 2019; Wuttiprom et al., 2017) and do not coincide (Bennett et al., 2008; Korkmaz et al., 2019; Layden, 2018) with these results of the study. Gürleroğlu (2019) concluded that science instruction using the Web 2.0 tools had a positive impact on students' academic achievement. A similar result was achieved by Tuncer and Şimşek (2019). The study conducted by these researchers with fifth-grade students found Plickers to have affected the achievement in mathematics course. Like the study results regarding the eight-grade students, the study performed by Batıbay (2019) with seventh-grade students to examine the effect of Kahoot as a Web 2.0 tool on achievement in the Turkish course could not observe any significant relationship between the pretest and posttest achievement scores. Among the reasons why there was no significant difference in the achievements of eighth-grade students in this study, the following points which are also mentioned in the literature may be effective: Students are more focused on technology than the content of the subject, and some of the applications are carried out as group work (Kantar, 2022; Özyalçın, 2020), or they encounter problems caused by software (Kantar, 2022; Öner, 2009). As a matter of fact, the teacher also stated that the students' focus on software affects the application.

Compared to the MAS mean pretest and posttest scores of the fifth- and eighth-grade experimental and control groups, a significant difference was found between the fifth-grade groups while no significant difference was observed between the eighth-grade groups. This result may be due to the fact that eighth-grade students are preparing for the HSEE and some students see the applications as a waste of time. There are studies which concluded important effect of technology-assisted instruction on student attitudes in the literature (Deniz, 2019; Güzeller & Akın, 2012; Hangül & Üzel, 2010; Pilli & Aksu, 2013; Wuttiprom et al., 2017).

Several research studies have concluded attitude towards mathematics to be an important factor in explaining students' mathematics achievements (Eyyam & Yaratan, 2014; Ma, 1997; Reyes, 1984). Similarly, a statistically significant increase was observed in both achievements and mathematical attitudes of the fifth-grade experimental group students, and an increase was found in both achievements and mathematical attitudes of the eighth-grade experimental group students, albeit statistically non-significant. This relationship found in the study has some similarities with other study results in the literature (Barkatsas, Kasimatis & Gialamas, 2009; Eyyam & Yaratan, 2014; Fabian, Topping & Barron, 2016). Negative prejudice among students in mathematics instruction should be eliminated, and individuals who have developed a positive attitude towards mathematics should be raised (Hangül &Üzel, 2010). To this end, student-centered learning such as Web 2.0 tools that make courses fun should be preferred. Hence, features of these software such as making learner responsible for their learning, supporting the retentive learning, ensuring active participating, and assisting the peer teaching should be utilized at maximum to satisfy such expectations of learners.

Considering the usage of Web 2.0 tools in mathematics courses and the views on these software, it was observed that both teacher and students had positive views on the application and the software. There are studies in the literature that coincide with this result of the study (Al-Said, 2015; Çankaya, Durak & Yünkül, 2013; Demirkan, Gürışık & Akın, 2017; Elmahdi, Al-Hattami & Fawzi, 2018; Enriquez, 2014; Gürışık, 2018; Gürleroğlu, 2019; Ningsih & Mulyano, 2019; Wood, Brown & Grayson, 2017; Zengin, Bars & Şimşek, 2017). The teacher made evaluations in terms of educator, learner, and software in consideration of the advantages and disadvantages. The points emphasized in regard to the advantages coincide with the evaluations made by teacher on applications which he performed in different levels and various courses with Web 2.0 tools. Both in this study and in the literature, the teacher emphasized that software have the ability to provide instant feedback, give the chance to see and correct mistakes thanks to individual feedbacks, and support the learning (Demirkan, Gürışık & Akın, 2017; Elmahdi, Al-Hattami & Fawzi, 2018; Freeman & Tashner, 2015; Gürışık, 2018; Zengin, Bars & Şimşek, 2017), have the ability to archive questions and results (Elmahdi, Al-Hattami & Fawzi, 2018; Gürışık, 2018; Özpınar, 2020), make the courses fun (Özpınar, 2020; Zengin, Bars & Şimşek, 2017), and effective instruction (Demirkan, Gürışık & Akın, 2017; Elmahdi, Al-Hattami & Fawzi, 2018; Gürışık, 2018; McCabe, 2006; VandeWalle, 2016).

Another point emphasized by the teacher was about the disadvantages of Web 2.0 tools used in the procedure. The limitation stated by the teacher was requirement of technical infrastructure and Internet. Other emphasized limitations included problem with class management in crowded classrooms and student focus on software. This result is in parallel with the results of other studies in the literature (Çankaya, Durak & Yünkül, 2013; Demirkan, Gürışık & Akın, 2017; Ekici, 2017; Gürışık, 2018; Gürleroğlu, 2019; Kantar, 2022; Ningsih & Mulyano, 2019; Özpınar, 2020; Saleem, 2011).

Teacher added what purposes he would use the Web 2.0 tools for and stated that it would be more appropriate to use these software for assisting the learning rather than for judging the students and for exams conducted to grade students. Indeed, Bloom (1969, p. 48) states that formative assessment should be discriminated from grading as judging and classifying functions and should mainly assist the teaching so that it can be more efficient. In addition, in parallel with the finding of the present study, participants in the studies performed by Çankaya, Durak and Yünkül (2013), and Ekici (2017) also stated that they would use Web 2.0 tools in their future instructions.

Regarding the student views, the most emphasized points were that courses performed with Web 2.0 tools helped them learn, ensured that they learned by fun and were attention-grabbing. Similar findings are observed in the literature (Borst, 2017; Gürışık, 2018; Gürleroğlu, 2019; VandeWalle, 2016). Other advantages of the mathematics courses performed with the Web 2.0 tools and the relevant software, which are 'being easy to apply and increased achievement' (Al-Said, 2015; Borst, 2017; Gürışık, 2018), 'opportunity to receive instant feedback' (Al-Said, 2015; Elmahdi, Al-Hattami & Fawzi, 2018; Gürışık, 2018; Enriquez, 2014), 'ensuring the liking of mathematics and affecting the attitude positively, increased retention, and opportunity to rehearse and reinforce the past subjects' (Gürleroğlu, 2019; Wuttiprom et al., 2017), and 'being nice learning software' (Enriquez, 2014; Gürışık, 2018) show parallelism with the studies conducted with students in the literature.

As indicated by the students, the adversities and limitations of the mathematics courses performed with the Web 2.0 tools included requirement of technical infrastructure and Internet, small screen size for students who did not have a computer/tablet but a smartphone, and low storage capacity for the applications. This result coincides with the results achieved by Gürışık (2018) and the result 'technical challenges of mobile learning' as achieved by Saleem (2011).

Students' achievement in mathematics is influenced by several factors. It is necessary in education to focus not only on what is learned and how it is learned, but also on the feedbacks to enhance mathematics achievement of students (Köğce & Baki, 2014). In this study, fifth- and eighth-grade students of the experimental groups were found to have higher increases in their achievement in mathematics course than the control group. It was also notably observed that both teacher and students stressed out the feedback, contribution to learning and students stressed achievement aspects of the Web 2.0 tools. The teacher addressed the

contribution of Web 2.0 tools to achievement through instant feedback, and students having the opportunity to see and overcome their deficiencies. The students emphasized the contribution of these software as assisting the learning, ability to receive instant feedback, and increased achievement. Based on these findings, one can argue that feedbacks provided in every stage of the mathematics instruction using the Web 2.0 tools were effective.

When asked about whether they would like Web 2.0 tools to be used in future mathematics courses, majority of the students stated that they would whereas some of them would like them to be used in other courses, too. These results are in parallel with the results of the applications performed by Wuttiprom et al. (2017) using Plickers with undergraduates. Similarly, Wood, Brown and Grayson (2017) concluded that the participants recommended that courses should continue with Plickers applications and these applications should be utilized in other courses. On the other hand, Gürışık (2018) achieved a different result. At the end of the three courses instructed with Plickers applications in the relevant study, the secondary school students stated that these applications could be utilized in courses other than mathematics and science courses. They justified this suggestion by stating that science courses require paper-pencil. In parallel with this result of the study carried out by Gürışık (2018), some of the eighth-grade students reported that they would not want the courses to continue using Web 2.0 technologies; however, they emphasized that these applications were fun and enhanced the learning. This might have been due to the anxiety caused by HSEE which secondary school students would take at the end of the eighth grade. Indeed, a student argued that mathematics course should be only taken with paper-pencil as they would take the HSEE. Similarly, Wood Brown and Grayson (2017) observed that 9% of the students would rather paper-pencil or other electronic exams than Plickers applications.

Consequently, while mathematics courses using Web 2.0 tools were found to have an effect on fifth-grade students' relevant achievements and attitudes, eighth-grade students' achievements and attitudes did not differ. Moreover, the teacher and students were observed to have positive views on the process in general. This study addressed the variables of academic achievement and attitude within the context of mathematics course. Future studies can investigate the effectiveness of Web 2.0 tools in other courses in the long run. In addition, different variables such as attitude towards technology and digital literacy can be investigated. Web 2.0 tools can be introduced to teachers, and preservice teachers as the future teachers, and training can be provided to them in aplication and effective usage of software.

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## Statements of publication ethics

I hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

## Researchers' contribution rate

The study was conducted and reported by the corresponding author, who is the single researcher in the study.

## Ethics Committee Approval Information

Ethical approval was obtained from Nigde Omer Halisdemir University Scientific Research and Publication Ethics Committee, with document no E-86837521-050.99-58115.

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