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The Effect of Using Web 2.0 Tools in Geometry Instruction on the Academic Performance of 3rd Grade Primary School Students[1]

Geometri Öğretiminde Web 2.0 Araçlarının İlkokul 3. Sınıf Öğrencilerin Akademik Performansına Etkisi

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Abstract: The aim of this study is to determine the effect of Web 2.0 tools on academic performance in the 3rd-grade primary school mathematics course. A mixed-method research design was employed, integrating both quantitative and qualitative data. Quantitative data were collected through an achievement test, while qualitative data were gathered via a semi-structured interview. The study group consisted of 35 third-grade students enrolled in a private school in Eskişehir during the 2020-2021 academic year. The qualitative component of the research included nine students selected based on their pretest and posttest academic performance in the experimental group, as well as the teacher of the experimental group. Quantitative data were analyzed using t-tests, whereas qualitative data were examined through content analysis. According to the achievement test results, the findings indicate that although students in both the experimental and control groups successfully learned the geometry concepts outlined in the third-grade Mathematics Curriculum, the impact of Web 2.0 tools did not produce a significant difference in overall academic performance between the groups.

Key Words: Web 2.0 tools, mathematics education, geometry education, primary school, technology integration

Özet: Bu araştırmanın amacı, ilkokul 3. sınıf matematik dersinde Web 2.0 araçlarının akademik performansa etkisini belirlemektir. Araştırmada, nicel ve nitel verilerin beraber kullanıldığı karma araştırma yönteminden faydalanılmıştır. Araştırmadaki nicel veriler, başarı testinden; nitel veriler ise yarı yapılandırılmış görüşme formu aracılığıyla elde edilmiştir. Araştırmanın çalışma grubunu 2020-2021 eğitim-öğretim yılında Eskişehir ili Tepebaşı ilçesinde bulunan özel bir okulda öğrenim gören 3. sınıf seviyesinde 35 öğrenci oluşturmaktadır. Araştırmanın nitel bölümünü ise deney grubundaki ön test ve son test akademik başarılarına göre seçilen 9 öğrenci ve deney grubu öğrencilerinin sınıf öğretmeni oluşturmaktadır. Araştırmanın nicel verileri t-testleri, nitel verileri ise içerik analiz yöntemi ile analiz edilmiştir. Araştırma sonucunda, araştırmanın başarı testine göre deney ve kontrol grubundaki öğrenciler Matematik Öğretim Program'ındaki 3. sınıf seviyesinde belirlenen geometri kazanımlarını kavradıkları tespit edilmiştir. Deney grubundaki öğrencilerin derslerde Web 2.0 gibi teknoloji entegrasyonu konusunda olumlu görüş bildirmişler ve bu uygulamaların ders materyali olarak kabul edilebileceği sonucuna ulaşılmıştır. Derslerde öğrencilere Web 2.0 araçlarını keşfedebilme imkanının verilmesi gerektiği ve teknoloji entegrasyonunun sınıflarda daha fazla deneyimlenmesi gerektiği düşünülmektedir.

Anahtar Kelimeler: Web 2.0 araçları, matematik eğitimi, geometri eğitimi, ilkokul, teknoloji entegrasyonu

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Introduction

Education is a multifaceted process that enables individuals to realize their potential formally and informally. It can be structured according to specific curricula, systematic progression, and predefined goals, or it can occur through self-directed exploration and environmental learning (Eshach, 2007; Falk et al., 2019). Teachers, peers, the social environment outside school, books, learning resources, and the increasing role of technology in daily life all contribute significantly to the learning process. The importance of these factors is determined by the individual's needs and the value they attribute to each. As individuals progress through Maslow's hierarchy of needs by fulfilling basic requirements, students advance when their fundamental educational needs are met (Aydın, 2022).

Technology plays a critical role in shaping individuals' emotional, academic, and economic lives (Akgün et al., 2014; Bal & Çavdar, 2023; Çalaman & Demirbaş, 2024; Kalip & Çöl, 2020; Öztop & Toptaş, 2019). Its pervasive influence has made it an indispensable part of children's lives, not just that of adults (Aksoy, 2021; Yıldız & Akyel, 2024; Ergül Sönmez & Çakır, 2021). Consequently, investigating the purposes and effectiveness of technology use in education is essential. When used correctly and effectively, technology can provide accessible, independent, and experiential learning opportunities. Therefore, it is crucial to integrate technology into education, ensuring that teachers possess the necessary technological skills, understand its advantages and disadvantages, and develop the ability to evaluate its use critically. However, rapid technological advancements also present challenges. For instance, excessive dependence on technology can lead to addiction, thereby increasing reliance on digital tools (Dinç, 2015; Koca & Tunca, 2019). Additionally, the unfiltered use of digital materials, prolonged screen time, and the tendency to rely on digital resources as primary references can contribute to academic complacency (Köde & Çoklar, 2020). Given these challenges, teachers, as the architects of future societies, must stay ahead of technological trends and continuously support students in making informed and balanced use of digital tools.

The evolution of teaching materials continues, yet the need for diverse instructional resources to capture students' attention and facilitate learning remains constant. Teaching materials can be classified as digital and non-digital. While traditional non-digital materials have historically been predominant in learning environments, the increasing role of technology in daily life has led to a growing emphasis on digital materials (Köde & Çoklar, 2020). Digital materials encompass various technological tools such as computers, projectors, and internet-based resources, forming a technological infrastructure that enhances the learning experience (Howell & O'Donnell, 2017). The integration of digital materials into various subjects enriches the learning process. Studies in the literature highlight the advantages of digital materials in education, including their ability to capture attention, support multimedia learning, and offer cost-effective solutions (Köde & Çoklar, 2020).

Mathematics is a "science or discipline that examines the structures, properties, and relationships between shapes, numbers, and multiplicities through logical reasoning" (Yenilmez et al., 2010, p. 2). Research indicates that both digital and non-digital materials significantly impact learning (Köde & Çoklar, 2020; Kurt et al., 2023). In mathematics education, these materials are crucial in engaging students' senses, making abstract concepts more tangible, and facilitating comprehension (Moyer, 2001). The 2018 Primary School Mathematics Curriculum encompasses four learning domains: numbers and operations, geometry, measurement, and data (MEB [Ministry of National Education], 2018). In 2024, the Ministry of National Education introduced a revised curriculum featuring five core themes: Numbers and Quantities, Operations to Algebraic Thinking, Geometry of Objects, Data-Based Investigation, and Probability of Events and Data-Based Investigation (the latter being unique to the fourth grade).

The digital material explored in this study comprises Web 2.0 tools, second-generation internet technologies designed to support students' developmental needs. These are interactive, user-driven internet applications —such as blogs, wikis, and collaborative platforms, that enable learners to actively create, share, and engage with digital content rather than merely consume it (Greenhow et al., 2009; O'Reilly, 2005). A literature review reveals that Web 2.0 tools are predominantly utilized at the middle, high, and university levels. However, research focusing on the integration of Web 2.0 tools into primary education, particularly in mathematics, remains limited, with even fewer studies addressing their role in supporting geometry learning (Alakoç, 2003; Azid et al., 2020; Çelebi & Satırlı, 2021). This study investigates the impact of Web 2.0 tools on third-grade students' geometry learning outcomes, addressing a gap in digital pedagogy research within primary education. The primary objective is to evaluate how these tools influence students' achievement and perceptions in this subject. In line with this objective, the study seeks to answer the following questions:

- Do pretest scores differ significantly between the experimental and control groups?
- Do pretest and posttest scores differ significantly in the experimental group?
- Do pretest and posttest scores differ significantly in the control group?
- Do posttest scores differ significantly between the experimental and control groups?
- What are the opinions of experimental group students on using Web 2.0 tools in geometry education?

Method

This study aimed to examine the effect of Web 2.0 tools on the geometry learning of third-grade primary school students within the context of technology integration. A mixed-methods research design was employed, specifically an integrative mixed-methods design that combines qualitative and quantitative approaches (Balcı, 2018). For this purpose, a quasi-experimental design was implemented. The study group consisted of students from two different classes, assigned as paired groups. During the implementation process, these paired groups completed the achievement tests simultaneously. The group engaged in learning with technology integration constituted the experimental group.

Within the research purpose, achievement pretest and posttest were administered to collect quantitative data, and a quasi-experimental design with a control group was used. To gather qualitative data, nine students from the experimental group were selected based on their achievement pretest and posttest results, representing high, average, and low achievers (coded as S1, S2, S3,….S9). Semi-structured interviews were conducted with nine students from the experimental group. Additionally, the teacher responsible for the experimental group provided feedback through a semi-structured interview form, which was incorporated as qualitative data. This study examined whether Web 2.0 tools influenced students' geometry learning, the extent of this impact, and the perspectives of students and teachers regarding using Web 2.0 tools in digital integration.

Study Group

The study group was determined using a purposive sampling method. It consisted of 35 third-grade students enrolled in a private school in Eskişehir province during the 2020-2021 academic year, along with their teacher. Participation was voluntary, and parental consent was obtained for each student. Among the 35 students, 17 were assigned to the experimental group and 16 to the control group. The experimental group received geometry instruction using technology-based Web 2.0 applications. In contrast, the control group followed a traditional lesson plan devised by the teacher, which did not include technology integration.

Data Collection Tools

Data were collected using an achievement test (pretest and posttest) and semi-structured interview forms. The achievement test was developed based on the 3rd-grade Mathematics Curriculum to assess students' geometry learning. In mixed-methods research, validity and reliability analyses draw on both quantitative and qualitative approaches (Creswell & Plano Clark, 2011). The achievement test, administered to the control and experimental groups, was designed and validated by three subject-matter experts.

In developing the achievement test, primary school-level learning outcomes related to geometric shapes and objects in the Mathematics Curriculum were identified. Table 1 presents the targeted learning outcomes and the corresponding Web 2.0 applications related to each test question.

Table 1. Achievement test target outcomes and web 2.0 tools used for the experimental group

Course/Lesson Outcome	Web 2.0 Tool Used
M.3.2.1.1. "Identifying the faces, corners, vertices, and separations of the cube, square prism, rectangular prism, triangular prism, cylinder, cone, and sphere models."	Storyjumper Digital Storytelling Toytheater Mathlearningcenter (MLC) Canva NCTM Illuminations
M.3.2.1.2. "Explaining the similarities and differences between cube, square prism, and rectangular prism."	IXL Toytheater Canva NCTM Illuminations
M.3.2.1.3. "Drawing a square, rectangle, and triangle using a ruler; determines the diagonals of a square and rectangle."	Whiteboard.fi Mathlearningcenter (MLC) Canva
M.3.2.1.4. "Realizing that shapes are named according to the number of sides."	Brainingcamp Mathlearningcenter (MLC) Canva Mathplayground Kangaroo Hop
M.3.2.2.1. "Determining that shapes have more than one line of symmetry by folding the shape."	Mathlearningcenter (MLC) Whiteboard.fi
M.3.2.2.2. "Completing a symmetrical shape given a part of it according to a vertical or horizontal line of symmetry."	Mathlearningcenter (MLC)
M.3.2.3.1. "Making coatings using shape models, draws the coating pattern on dotted or squared paper."	Toytheater Mathlearningcenter (MLC) Whiteboard.fi

Expert opinions were sought in designing and revising the achievement test questions to ensure they effectively assessed students' geometry learning with Web 2.0 tools. Additionally, the targeted learning objectives for the 3rd-grade "Geometric Objects and Shapes" unit were reviewed by experts to confirm alignment with the test questions. The finalized test included multiple-choice, fill-in-the-blank, and open-ended questions. The achievement test was administered to the control and experimental groups as an initial measurement. Nine students from the experimental group and their teacher were interviewed through semi-structured interviews to collect qualitative data. Two field experts reviewed the semi-structured interview form, and the necessary revisions were made based on their feedback before finalizing the instrument.

Data Collection Process

The data collection process lasted six weeks during the spring semester of the 2020-2021 academic year. Table 2 presents the research implementation process.

Table 2. Implementation process

Week	Experimental Group	Control Group	Tools
Week 1	Pretest	Pretest	Informing Students and Teachers about Collecting Research Data and Administering the Achievement Test
Week 2	Implementing Technology Integration Practices	Geometry Teaching (traditional form)	Storyjumper “Lost in the Forest” Storytelling Activity, Whiteboard.fi Event
Week 3	Implementing Technology Integration Practices	Geometry Teaching (traditional form)	Mathplayground “Kangaroo Hop” Event, Brainincamp “Pattern Blocks” Event
Week 4	Implementing Technology Integration Practices	Geometry Teaching (traditional form)	NCTM Illuminations “Geometric Solids” Activity, Toytheater “Toytheater” Event
Week 5	Implementing Technology Integration Practices	Geometry Teaching (traditional form)	Mathlearningcenter (MLC) “Geoboard” Activity, IXL “Classify Polygons: up to 12 sides” Activity, Summary Lesson Activity with Canva
Week 6	Posttest	Posttest	Implementation of the Achievement Test, Interviews with the Class Teacher and 9 Students in the Experimental Group

As part of the research, nine different Web 2.0 applications were implemented in the experimental group. These applications are Storyjumper, Brainingcamp, IXL, NCTM, Toytheater, Mathlearningcenter, Canva, Whiteboard, and Mathplayground. The first application used was Storyjumper, through which a digital storybook titled "The Lost One in the Forest," written and prepared by the researcher, was presented to the students. In this process, students were not expected to create a new digital storybook via Storyjumper; instead, they were asked to listen to a story incorporating geometric concepts. The content of the text and the post-reading evaluation were linked to the characters, plot, and geometry topics covered in the digital storybook. Introducing Storyjumper to students, answering questions related to the digital story, and presenting Whiteboard.fi took 40 minutes. Whiteboard.fi was the second Web 2.0 tool utilized in the study. This tool was primarily used to receive immediate feedback from students following Web 2.0 instruction, to simulate a real classroom environment, and to provide students with a platform for self-expression. Whiteboard.fi is an online whiteboard service specifically designed for classrooms. It was preferred in this study due to its ability to recreate a classroom atmosphere in remote learning. The most distinctive feature of this tool is that each student has an individual whiteboard, and all written or drawn content is visible only to the teacher. After using the Web 2.0 applications, students provided feedback to their teacher via Whiteboard.fi. Third, the Maths playground Web 2.0 tool was introduced, specifically the game "Kangaroo Hop," categorized under geometry for the 3rd-grade level. The game provides hints to students by presenting prompts such as “Octagons? Triangles? Squares?”. Fourth, the Brainingcamp application was used, specifically focusing on "Pattern Blocks," which include geometric shapes such as an orange square, green triangle, blue parallelogram, and beige rhombus. This application aimed to reinforce the names and number of sides of these geometric shapes and to encourage students to create new combinations or structures by integrating these shapes. Fifth, the study utilized NCTM Illuminations, a project developed by the National Council of Teachers of Mathematics (NCTM). This project provides interactive tools for students and instructional support for teachers. Using this tool, students explored concepts such as surfaces, edges, vertices, and faces through interactive cube manipulations, enabling a detailed examination of cube nets. Sixth, the Toytheater application was used to help students identify unit measurements of geometric solids, create new models, and examine the 3D movements of cubes. Seventh, the Math Learning Center (MLC) application, specifically the Geoboard tool, was utilized. In this application, students used line segments and elastic bands wrapped around pegs to create polygons, exploring perimeter, area, angles, symmetry, fractions, and more. Eighth, the IXL Web 2.0 tool was used, which provides a comprehensive and personalized learning experience for mathematics education. Students participated in an activity titled “Classify Polygons: Up to 12 Sides”, where they categorized polygons with up to 12 sides. Finally, the Canva application was used as another Web 2.0 tool in the study. The purpose of incorporating Canva was to provide students with a formalized summary of the geometric concepts they learned through digital materials. The acquired geometry knowledge was reviewed in line with the learning objectives, and the study concluded with an overview session in which students and their teacher revisited the key learning points through Canva. Due to the study conducted during the pandemic, Web 2.0 tools and the instructional process were introduced remotely via Zoom. In all Zoom sessions, the teacher accompanied the researcher. To collect data, students in the experimental group participated in a six-week remote learning program using Web 2.0 tools for geometry education. Although the instruction was online, lesson durations were limited to 40 minutes, as in face-to-face lessons. In the first lesson, students in the experimental group were informed about the research process, materials, and lesson plans that would be followed throughout the study. Before the implementation, Zoom administered a pretest achievement assessment to both the control and experimental groups. Students were given 35 minutes to complete the test. They were instructed to write their answers on paper while sharing their screens and then submit their responses to their primary school teachers through their parents. During the data collection process, an achievement test was administered to the control group before and after the experiment. In this context, the study employed a quasi-experimental design, utilizing a pretest and posttest control group design. Additionally, qualitative data were collected through interviews. Following the administration of the pretest, instruction on 3rd-grade geometry concepts was conducted using Web 2.0 tools. Lessons were designed to support students’ conceptual understanding through interactive Web 2.0 applications. This instructional intervention lasted six weeks following the pretest. Upon completing the intervention, a posttest was administered. After the pretest and posttest, focus group interviews were conducted with students who scored the highest, closest to the average, and lowest. A total of nine students participated in these interviews. Additionally, a semi-structured interview was conducted with the teacher of the experimental group. To ensure the reliability and validity of the study, all semi-structured interviews with students and teachers were audio-recorded to prevent data loss.

Data Analysis

Parametric analysis methods were used to compare the pretest (experimental group and control group) and posttest (experimental group and control group) scores of the students who participated in the study and the effects of Web 2.0 tools on student geometry learning due to the normal distribution of the data. The study used an independent sample t-test analysis to compare the pretest and posttest results of the control and experimental groups. Dependent sample t-test analysis was used to compare the pretest and posttest results of the control and experimental groups. The data obtained after the interviews were analyzed using a content analysis method. Based on the data obtained from the interviews, thematic coding was made.

Findings

Findings Related to the Pre-test Results of the Control and Experimental Groups

An independent sample t-test analysis was performed to determine whether there was a statistically significant difference between the pretest achievement scores of the students in the control and experimental groups. Table 3 shows the mean values, standard deviation values, degrees of freedom, t-value, and significance levels of the pretest results of the experimental and control groups.

Table 3. Independent sample t-test results for the pretest of the control and experimental group students

Groups	$\bar{x}$	*N*	*SE*	*Sd*	*t* Tests		
					t	*df*	*p*
Control Group	73.49	16	2.6	10.65	1.372	15	0.19
Experimental Group	67.55	16	3.74	14.96			

Table 3 shows that no statistically significant difference exists between the experimental and control group pretest results (*t*=1.372, *p*>0.05). The control group pretest results ($\bar{x}$=73.49) were higher than the experimental group pretest results ($\bar{x}$=67.55).

Findings Related to the Pretest and Posttest Results of the Experimental Group Students

A dependent sample t-test analysis was applied to determine whether there was a statistically significant difference between the pretest and posttest achievement scores of the students in the experimental group. Table 4 shows the results of the dependent sample t-test for the pretest and posttest results of the experimental group.

Table 4. Paired sample t-test results of experimental group students' pretest and posttest

Test	$\bar{x}$	*N*	*SE*	*Sd*	*t* Tests		
					t	*df*	*p*
Posttest	78.40	17	3.64	15.02	-4.291	16	0.001
Pretest	67.55	17	3.54	14.61			

According to Table 4, a significant difference was found between the pre-test ($\bar{x}$=67.55) and post-test ($\bar{x}$=78.40) scores of the experimental group (*t*=-4.291, *p*<0.05).

Findings Related to the Pretest and Posttest Results of the Control Group Students

A dependent sample t-test analysis was applied to determine whether there was a statistically significant difference between the pretest and posttest achievement scores of the students in the experimental group. Table 4 shows the results of the dependent sample t-test for the pretest and posttest results of the experimental group.

Table 5. Paired sample t-test results of control group students' pretest and posttest

Test	$\bar{x}$	*N*	*SE*	*Sd*	*t* Tests		
					t	*df*	*p*
Posttest	75.39	16	2.98	11.92	-0.626	15	0.541
Pretest	73.49	16	2.66	10.64			

Table 5 shows that there is no statistically significant difference between the pretest ($\bar{x}$=73.49) and posttest ($\bar{x}$=73.39) results of the students in the control group (*t*=-0.626, *p*>0.05).

Findings Related to the Posttest Results of Experimental and Control Group Students

An independent sample t-test analysis was performed to determine whether there was a statistically significant difference between the posttest achievement scores of the experimental and control group students. Table 6 shows the posttest results of the experimental and control groups..

Table 6. Independent sample t-test results of posttest results of experimental and control group students

Groups	$\bar{x}$	*N*	*SE*	*Sd*	*t* Tests		
					t	*df*	*p*
Control Group	75.39	16	2.98	11.92	-0.775	15	0.451
Experimental Group	79.26	17	2.66	15.08			

According to Table 6, there is no significant difference between the posttest achievement results of the students in the experimental ($\bar{x}$=79.26) and control groups ($\bar{x}$=75.39) (*t*=-0.775, *p*>0.05).

Teacher and Students Opinions on the Use of Web 2.0 Tools in Geometry

The answers from the nine students in the experimental group and the teacher to the semi-structured interview questions were first coded under themes. The interviews aimed to examine the learning experiences of the students in the experimental group and to explore the teacher's views on geometry instruction enhanced by Web 2.0 tools. The themes developed for the study are presented in Figure 1.

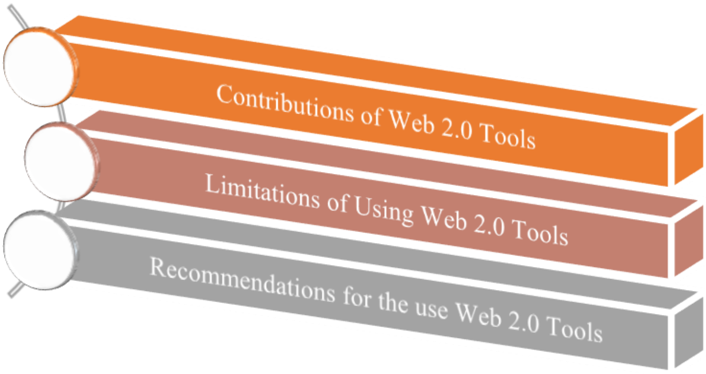

Figure 1. Qualitative analysis themes

The Contribution of Web 2.0 Tools to Education

The impact of Web 2.0 tools on learning and education has been examined under three categories: ease of use, different approaches, flexibility, and concretization. It has been stated that Web 2.0 applications enable easier and faster access to information about geometric objects and instructional content.

S8: "I enjoyed the lessons. I learned comfortably; it was very detailed."

S5: "All the applications were easy. Using these applications in mathematics made learning easier more fun."

Integrating Web 2.0 technologies, which is considered a different approach, captured students' interest. They expressed that lessons were enjoyable and engaging thanks to Web 2.0 applications.

S4: "When we learned how to use the applications, the lessons became more fun. Before, we always wrote in notebooks, which was boring."

S2: "Before using Web 2.0 tools, we only used rulers, erasers, pencils, books, and notebooks for everything."

S6: "I really enjoy our lessons with you. Using Web 2.0 tools made them both easier and more enjoyable."

Additionally, the primary school teacher emphasized individual differences among students and noted that Web 2.0 tools cater to different learning styles.

Teacher: "Web 2.0 tools are a blessing for children who cannot learn through traditional methods or learn more slowly. That's why they appeal to everyone. As students saw Web 2.0 tools, they became more motivated in class."

Teacher: "My expectation from educational technologies is that they provide tools that help students learn quickly through diverse content. It is also essential for students to discover things independently."

Moreover, it was highlighted that Web 2.0 tools offer flexibility in the classroom.

Teacher: "Since we have seen them used in mathematics, they can certainly be used in math lessons, but why not in other subjects if the content is appropriate?"

S3: "I would like to learn different applications as well."

S2: "I already repeat the applications independently after the lessons."

S1: "If I need something, I will recheck the applications. The lessons were great. I didn't understand edges before, but now I do."

Making geometry concepts more concrete for third-grade students through Web 2.0 tools helped them learn them more easily.

S3: "Our web-based lessons were great. I had fun and was able to complete the tasks. My favorite application was the Geometry Board. I tried to build a cube. The Activity was fun, and I'd love to do it again."

S1: "If I need something, I will recheck the applications. The lessons were great. I didn't understand edges before, but now I do."

Limitations of Web 2.0 Tools

The limitations of Web 2.0 tools have been examined under two categories: technical limitations (such as internet connection issues or device malfunctions) and linguistic limitations (the language used in applications). When analyzing the language category, it was observed that most applications were originally in English. Since geometric concepts were also presented in English, students struggled to understand them and could only comprehend them after the researcher provided translations. Some students expressed their difficulties with the language barrier.

S2: “The fact that the applications were in English was discouraging. My tablet displayed everything in English. It would have been better in Turkish.”

S8: “The application I liked the least was the Kangaroo game. The others were better, but for this one, you need to know English.”

During the application-based lessons, students encountered various problems, including internet connection issues, technical failures of devices such as computers or tablets, and linguistic limitations. Additionally, participating in these lessons remotely created another challenge. However, these issues could be minimized or completely eliminated in face-to-face instruction. Students shared different perspectives on the problems they faced.

S2: "On Whiteboard.fi, you could see everything I wrote, but my writings kept getting erased. I really enjoyed it, but my camera turned off since I used a tablet."

S5: "The Web 2.0 application for cube unfolding was my least favorite because I couldn't access it. Also, I usually study in a quiet environment, but some applications are sound, so I wouldn't prefer using Web 2.0 tools when studying alone."

Recommendations for Using Web 2.0 Tools

Throughout the research, students expressed that they enjoyed the lessons, found Web 2.0 tools helpful in making geometry concepts more tangible, and learned more easily and quickly. Some students also expressed interest in re-experiencing these applications. It was noted that the different features of Web 2.0 tools provide advantages for use in various disciplines.

S7: “Web 2.0 tools could be used in Turkish and Science. In short, I think they can be used in all main subjects. In specialized subjects, their features would be even more useful. I enjoyed the lessons. I learned comfortably; they were very detailed.”

S7: “I would like these applications to be used in Turkish and Science. Also in English and Swimming classes.”

S3: "We could use Web 2.0 tools in every subject. They could be used in specialized lessons, too. They were educational, fun, and enjoyable."

S9: "Before using Web 2.0 tools, our teacher would project textbooks onto the screen during online lessons. They would also prepare slides. With these applications, we can do that ourselves, too."

Teacher: "Web 2.0 tools are actually modern teaching tools that engage students and can be supported with lesson plans. Why shouldn't they be used just like notebooks, books, and resources? I see them as tools that children can also use at home. That's why, after this project, I would like to integrate them into lessons more frequently."

Conclusion, Discussion and Recommendations

As technology has become an indispensable tool in today's rapidly changing world, transformations and advancements in every field where technology is utilized are crucial. In education, Web 2.0 tools, among the primary resources teachers and students rely on for technology integration, require developing the necessary skills to be actively used in line with curriculum objectives. Among the digital technologies used in learning processes, Web 2.0 tools are frequently preferred (Arabacı & Akıllı, 2021; Bayram Yılmaz & Ertem, 2025). This study has determined that the impact of Web 2.0 tools on technology-assisted geometry teaching is significant in student learning. Similar findings have been reported in previous research, indicating that digital applications improve primary school students' mathematics achievement (Akkuş & Gök, 2024; Beşaltı & Kul, 2021; İncekara & Taşdemir, 2019; Pili & Aksu, 2013; Ukdem & Çetin, 2022). Other findings suggest that such digital applications positively influence student success, increase their engagement in learning processes, enable them to learn at their own pace and in their preferred environments, and make the learning experience more enjoyable.

Contrary to these findings, another study has shown that although Web 2.0 applications positively impact students' academic performance, they do not significantly affect test anxiety (Korkmaz et al., 2019). Moreover, research has indicated that the effects of these technologies on student learning are not always positive and may, in some cases, have negative effects. Therefore, it is recommended that efforts be made to raise teachers' awareness of how, why, and under what conditions Web 2.0 tools should be used. In particular, excessive exposure to technology during learning processes due to Web 2.0 tools has been found to cause distractions in students, shorten deep learning periods, and lead to only superficial learning (Mustafaoğlu et al., 2018; Yaşaroğlu & Gelmez, 2022; Tucker & Kimbrell, 2013). Thus, although digital technologies play an active role in every aspect of life, increasing awareness regarding their use is essential.

During the COVID-19 pandemic in 2020, a sudden digitalization of education occurred due to the disruption of face-to-face learning. In both planned and unexpected digitalization processes, technological failures are inevitable. It is important to recognize that technical issues may arise in environments where digital technologies are used. During the pandemic, such issues affected primary school students and adult learners who could not solve specific technological problems (Elemam et al., 2024; İnci-Kuzu, 2020). This is because technology integration is relevant for face-to-face education and essential for flexible remote learning, as well as during global crises such as pandemics or wars (Izgı Onbaşılı & Sezginsoy Şeker, 2021; Kırık, 2014). In such cases, teachers' digital competencies and technological skills significantly impact the successful implementation of technology integration. Teachers must be familiar with digital technologies and possess at least the basic skills required for effective technology integration (Korucu & Sezer, 2016; Türkben & Alptekin, 2023; Yucedal, 2023).

When technology integration is carried out purposefully and consciously, it can enhance the quality of education. This perspective aligns with findings in the literature. Digital technologies with well-defined objectives, adequate skills, and appropriate choices for the target audience have positively influenced academic success, increased motivation, and encouraged students to be more eager to learn (Akkuş & Gök, 2024). Additionally, similar to the findings of this study, other research has found that students' enthusiasm increases, they enjoy learning, and their interest in technology grows (Akbaba & Ertaş-Kılıç, 2022; Azid et al., 2020; Çelebi & Satırlı, 2021; Işık & Karal, 2023). Öztop (2022) emphasized that when students' motivation toward a subject increases through such applications, their success in that subject also improves. For example, digital storytelling has been identified as a tool that helps students develop practical skills such as motivation, concentration, and commitment to a lesson (Çakıcı, 2018). Another study by Şahin (2021) also highlighted the positive effects of digital storytelling on students. As observed in this research, students also desired to experience similar technologies in other subjects. Furthermore, studies have shown that technology integration influences student motivation across different age groups and subjects (Almalı & Yeşiltaş, 2020; Karadağ & Garip, 2021; Sendal et al., 2008). Digital applications provide enriched content for subjects beyond geometry, serving various learning objectives and outcomes. Research suggests that these technologies can be effectively used in language learning, geography, and science education (Akbaba & Ertaş-Kılıç, 2022; Almalı & Yeşiltaş, 2020; Kuş-Gürbey & Büyük, 2024; Karadağ & Garip, 2021; Livingstone, 2015).

Over time, using digital materials in education has enabled learning to occur across different times and locations. As students and teachers adapt to this shift, resources, technologies, and sometimes even curricula are continuously updated to optimize digital technologies. For example, in Türkiye's "Century of Türkiye Maarif Model ([Türkiye Yüzyılı Maarif Modeli] CTMM)," concepts such as digital literacy have been defined by considering technological advancements and contemporary educational needs (Banaz, 2024). Given the positive aspects of technology integration in enhancing primary school students' learning through Web 2.0 applications and similar tools, teachers' knowledge and skills in technology integration should align with these needs. Additionally, to ensure that primary school students benefit effectively from these technologies, developing Turkish-language Web 2.0 tools is necessary.

This study uniquely contributes to the literature by focusing on technology integration in primary-level geometry, a rarely explored area, and by examining third-grade students' geometry learning outcomes, which are seldom addressed at this grade level despite their critical role in early mathematical development. Furthermore, employing an integrative mixed-method design has enabled a comprehensive understanding by combining quantitative and qualitative perspectives. These features position this research as a significant contribution to digital pedagogy and mathematics education. Based on the findings, several implications can be drawn. The positive effects of Web 2.0 tools on student achievement and motivation indicate the need for targeted teacher training on effective technology integration. In addition, students' interest in experiencing similar digital practices in other subjects suggests that Web 2.0 tools could be explored for cross-curricular applications. Finally, extending the scope and duration of future studies and incorporating a broader range of digital tools in face-to-face and hybrid learning settings could provide deeper insights into sustainable technology integration in primary education.

This study also has limitations. The implementation was limited to six weeks during the spring term of the 2020-2021 academic year, focused solely on the third-grade "Geometric Objects and Shapes" unit, and involved only the experimental and control groups and the experimental group teacher. Moreover, nine specific Web 2.0 tools were used, and the process was conducted via Zoom during remote learning. Future research could address these limitations by expanding the duration, exploring different grade levels and subjects, using a wider variety of digital tools, and applying the intervention in face-to-face or hybrid environments.

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