The Effect of Educational Digital Games Designed by Students on the Teaching of the 6th Grade Effective Citizenship Learning Area in the Social Studies Course

Şima Özdemir Bülbül[1], Esra Mindivanli Akdoğan[2]
[1] Atatürk University, 0000-0002-6879-472X
[2] Ataturk University, 0000-0002-6508-3412

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Şima Özdemir Bülbül[1*], Esra Mindivanli Akdoğan[1†]
[1]Atatürk University

Abstract

Digital games have become more involved in our lives and entertainment culture with the development of technology. Digital games, which individuals of all ages play and derive great enjoyment from at the same time, have been actively used in educational activities. However, it is seen that the games used in the education process are mostly developed and marketed by different institutions. Thus, the aim of this study is to have secondary school students design and code the games that will be used in the effective citizenship learning area so that they can become more active in their own learning experiences and become digital producers as well as digital consumers. Considering this purpose, an explanatory sequential design, one of the mixed-methods research designs, was adopted in the study. After the data were obtained by using a quasi-experimental design in the quantitative aspect of the study, student opinions were taken to explain these data in depth, and the study was supported by the qualitative data. The qualitative data were collected with the Effective Citizenship Learning Domain Academic Achievement Test (ECLDAAT), and the quantitative data were gathered with student interviews. The quantitative data of the study were analyzed using the SPSS program and appropriate analyses. Student interviews were analyzed using content analysis. As a result of the study, it was found that educational digital games coded and designed by students had significant effects on learning. In addition, the students stated at the end of the implementation that the lesson was more fun, they were more motivated, and they boosted their learning during the implementation process.

Keywords: educational digital game, coding, social studies, student

Introduction

With the rapid development of technology, everyone, young and old alike, is now in contact with it, is affected by the living conditions introduced by it, and develops technology as its user. This process of influence and being influenced takes place in every field and inevitably requires mutual adaptation to each other. This adaptation process manifests itself in the field of education as in every other field. Now that educational materials are digitalized, more people can access education through such methods as distance education, digital educational contents, etc.

The century we live in is called the digital age because technological materials have both become widespread and cheap, internet access has increased significantly, and information and communication technologies have been used more by people. Children who are introduced to digital devices and digital media tools at an early age are interested in this field. Thus, they have an important role in this field as active consumers of digital materials. In fact, when the internet usage data of children aged 6–15 years in Turkey was examined, it was observed that while the usage rate of the Internet in this age group was 50.8% in 2013, this rate was 82.7% in 2021 (Turkish Statistical Institute [TUIK], 2021). When the data of TUIK (2021) are examined, it is found that children (6–15 years old) spend most of their time on the Internet for online lessons (86.2% of the pandemic period data) and learning purposes (83.6%), such as doing homework and research. Since children who have access to digital devices and the internet from an early age and can use technology as much as their parents use the internet for educational purposes, the number of studies carried out to increase the benefits of the internet and restrain its harms has started to increase in order to make the internet use more efficient as an educational

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resource for children (Avcı & Seferoğlu, 2011; Hicks & Ewing, 2003; Hatakka & Langsten, 2011; Henkoğlu et al., 2015; Kuzhan, 2019; Nartgün, 2002; Rakes, 1996; Shayan, 2015; Şenyurt, 2015).

The number of studies has increased due to the use of technology in education, and this has led to the introduction of new concepts. In 2016, the International Society of Technology in Education (ISTE) recognized "computational thinking (STEAM)" as a new 21st century skill (Ananiadou & Claro, 2009; Setle & Perkovic, 2010). Computational thinking (CT), also called computer thinking, is described as a type of problem solving. One of the definitions of this concept is to understand problem solving, system design, and human behavior by using computer science (Wing, 2006, as cited in Erol, 2020, p. 7). In other words, while solving problems, a person should think like a computer scientist and make it a skill. This defined skill can be acquired with coding and programming education (Erol, 2020). Regarding STEAM, Weintrop et al. (2014) have defined four sub-skills: modeling and simulation skills, data and information skills, computational problem-solving skills, and system management skills (ISTE, 2016). When these skills are integrated with the education and training processes, it is considered that students' latent learning processes will be supported. Hence, considering the stages and sub-skills of computational thinking, it is seen that not only computer science but also the research carried out in the physical sciences and social sciences are influenced by the development of these skills (Bundy, 2007). Therefore, the importance of developing relevant contents in the curricula in order to allow STEAM in all courses, especially in science and mathematics courses that aim to solve problems, is now accepted by many countries in the world. The studies carried out on this issue reveal the importance of STEAM (Batı et al., 2017; Bay & Üzümcü, 2018; Gülbahar & Kalelioğlu, 2014; Sarıkaya 2019). Thus, many countries have included coding in their curricula as a new literacy skill. It is stated that the countries that have integrated coding training into their curricula have the following rationale: fostering logical thinking, fostering problem solving, fostering coding skills, fostering employability in information technologies, and attracting students into information technologies (Balanskant & Engelhardt, 2015). Considering these purposes, it can be stated that teaching coding to children at early ages improves digital literacy, expands understanding of basic programming logic, reinforces interest in programming, develops computational thinking such as analytical thinking and algorithmic thinking, promotes creativity and imagination, develops productive skills with informatics, has positive effects on self-confidence, and boosts academic achievement in science, mathematics, and other courses (Erol, 2020, pp. 4-5).

Coding is the process of transforming a solved problem into a computer language format using a programming language (Fesakis & Serafeim, 2009). Coding is also defined as the process of application, development, and production that is formed by the interaction between humans and the computer in order to perform a certain task using the command sets of the computer (Business & Dictionary, 2015). According to these definitions, coding is a sub-process used in programming; that is, it is one small part of programming. The process of coding consists of design and training (Sayın & Seferoğlu, 2016). The analysis, design, development, and testing phases used in the coding process overlap with the understanding of the problem (analysis), finding solutions (design), implementing the appropriate solution (development), and solving and evaluating the problem (testing) phases of the problem-solving skill, and they are also guiding in the case of a problem encountered in real life (Çetin, 2012; Karabak & Güneş, 2016). Children who code can create new programs rather than using existing ones (Demirer & Sak, 2016). These children, who do research, ask questions, and create new products, keep pace with technology. This process develops children's imagination and creativity and increases their ability to find solutions to problems, their self-esteem, and their motivation in lessons (Clements & Gullo, 1984; Çiftçi et al., 2017; Deniz, 2021; Jenkins, 2002; Resnick & Silverman, 2005; Şahin, 2019).

Learning takes place through experience in coding (Mishra & Girod, 2006). According to constructivist theory, children who learn through experience use all their senses during the activity and learn depending on the cause-and-effect relationship. This, in turn, teaches children how to construct knowledge and provides permanent learning (Bilgin & Toksoy, 2014; Jaworsky, 1994). Children create games, digital stories, animations, and different robots with coding training. Computer game technology develops important skills such as motivation, persistence, curiosity, attention, and attitude in children and thus promotes their learning (Becker, 2007). Considering the benefits of coding education, different projects and so on have been organized to make teachers and students more effective and competent. Agreements have been signed with companies such as Google and Microsoft for the training of teachers, and preparation programs have been set up, especially in the USA. Teachers could receive free training through 'code.org' developed for this purpose. After the teacher training, student training was started, and students were supported to comprehend many coding languages and write their own codes. Code.org was translated into 45 languages, including Turkish, and used in 180 countries. These activities were announced to a wider audience by organizing coding Olympiads (USA Computing Olympiad, 2015). In Europe, in addition to teaching coding courses in schools, the "Code Week" project, which is a grassroots initiative to introduce coding and digital literacy to everyone in a fun and interesting way, was launched in October. In 2023, Code Week will take place between October 7 and 22 (https://codeweek.eu/).

When coding training in Turkey is analyzed, it is seen that the name of the Information Technologies course was replaced with the Information Technologies and Software course with the regulations made in 2012. In terms of the development of computational thinking skills, it is seen that problem solving and programming units were included in this program in the 5th and 6th grades (Ministry of National Education (MEB), 2018a). In secondary education, the name of the course became Computer Science, and its content was expanded. The first stage of these courses, which consist of two stages, includes problem solving, algorithms, and programming units; the second stage includes robot programming, web programming, and mobile programming units (MEB, 2018b). If there is a preparatory class in Anatolian and Social Sciences High Schools, this course is given as a compulsory course for 4 hours a week but as an elective course in all other grades (MEB, 2018b).

Coding education is considered important for the development of digital competence in students. Indeed, the Ministry of National Education (MEB) published new curricula for all domains in 2018 and specified a framework of core competencies for all of these curricula. Digital competence, included among these specified competencies, is described as "using information and communication technologies safely and critically in all areas of life" (MEB, 2018b). In addition to the digital competence involved in the competencies, digital skills are included in the social studies curriculum. In addition to digital literacy and media literacy skills that aim at promoting digital competencies, problem solving, critical thinking, and innovative thinking skills, which will develop in line with the development of these two skills, are also included, and it is emphasized within the scope of the curriculum that these skills must be fostered (MEB, 2018c). However, considering the development of these skills for the digital domain, the skills included in the social studies course have deficiencies in terms of implementation. Students are taught how to use digital platforms more effectively and correctly, rather than directly creating a digital product.

Considering the internet use among the secondary school students, it was determined that a large proportion of children aged 6–15 years used the existing digital content produced for different purposes (education, entertainment, etc.) as consumers. However, digital literacy, which social studies courses aim to have students gain, involves not only using digital products correctly but also producing digital content in line with their needs (Eshet-Alkali & Amichai-Hamburger, 2004). It is important for the secondary school students to develop this skill because they should deal with technological devices as much as necessary, and they should be encouraged to produce various digital products in this process so that they can gain this skill in the most accurate way. Because digital games are actively used, especially by students in the secondary school age group, it is important that they design their own digital games. In fact, according to the data from TUIK (2021), 66.1% of children aged 6–15 years actively use the internet to play digital games. Adding an educational dimension to students' recreational activities will make the education and training processes more effective. Coding training should be included more in teaching activities to ensure that secondary school students are more active in their own learning experiences and become digital producers as well as digital consumers. If students design digital games together with coding, educational content, and game processes, they will not only show great progress in terms of coding training but also achieve learning outcomes related to the relevant course. Based on these ideas, this study aimed to determine the effects of educational digital games designed by students on the teaching of the effective citizenship learning area in a social studies course. In line with this main purpose, the sub-problems of the study were determined as follows:

1. Is there a significant difference between the pre-test and post-test scores of the experimental group?
2. Is there a significant difference between the pre-test and post-test scores of the experimental and control groups?
3. What are the students' opinions about the implementation process of an educational digital game that they developed by coding themselves?

Explanatory sequential design, one of the mixed-methods research designs, was used in the research. Mixed-methods research is a research methodology in which researchers incorporate quantitative and qualitative data and analysis methods to develop an in-depth and comprehensive understanding of the purpose of the research (Clark & Ivankova, 2016/2018). In mixed methods research, quantitative and qualitative components are connected with each other, which ensures that all aspects of the research are discussed, quantitative and qualitative data support each other, and the weaknesses and strengths of the methods are integrated into the research (Clark & Ivankova, 2016–2018).

Explanatory sequential design, one of the mixed-methods research designs, was chosen as the research design in the study. The reason for the selection of this design is that the researcher first begins with the collection and analysis of quantitative data to address the research problem and then continues with qualitative research methods to support and explain the quantitative findings (Creswell, 2017). Experimental research objectifies events and phenomena experienced, expresses them as numerical data, and thus optimizes the precision of findings (Ural & Kılıç, 2006). In the quantitative part of the study, a quasi-experimental research design with

pre-test and post-test experimental and control groups was used. With the intention of finding cause-and-effect relationships, the researcher creates experimental contexts and attempts to reveal the reason for the variation in the dependent variable within the framework of the cause-and-effect relationship (Can, 2014). This method was preferred in this study because the effect of educational digital games designed by students by coding on the teaching of the effective citizenship learning area in a social studies course was examined. A case study design was administered in the qualitative part of the study to support the data of the study. According to Creswell (2017), a case study is a qualitative research approach in which the researcher carries out an in-depth investigation of a topic of interest or phenomenon within the implementation time with multiple data collection tools and describes the phenomena and impressions related to them.

Sampling

This study, conducted in the 2021–2022 academic year, was carried out with the 6th grade students studying in two different classes in a private secondary school in Erzurum province. None of the study coordinators work at the school where the study was conducted. The reason for choosing a private school for the study was the need for a computer laboratory and the need for students to have computers at home and to have basic computer skills. One of the classes formed the experimental group, and the other one formed the control group. The experimental group designed and played a digital game related to the effective citizenship learning area and learned the unit through this implementation process. The control group students continued their education as prescribed by the current curriculum.

The purposeful sampling method was preferred for the quantitative dimension of the research. In purposive sampling, the participants are selected due to their characteristics in the study that the researcher needs in the sample; that is, they are selected on purpose (Başkale, 2016). This sampling type enables the selection of individuals or groups with knowledge and experience about the research (Yağar & Dökme 2018). While selecting samples for the research, the following points were particularly taken into consideration: Students must have a desktop PC or laptop at home; there must be a computer lab in the school; and students must have enough computer skills for coding at the beginner level. Thus, purposive sampling was preferred when selecting the school. It was decided that the private secondary school was the most appropriate sample for this approach because it was not only affiliated with the Ministry of National Education but also served the purpose of the study, and thus the implementation was carried out in this school.

Simple random sampling is a method in which each member of the population has an equal probability of being selected and included in the sample. In this method, all participants have the same probability of being chosen (Demir & Çamlı 2011). In quasi-experimental designs, all previously formed groups are randomly assigned to experimental or control groups (Campbell & Stanley, 1963). Since there were two 6th grade classes in the school where the application was carried out in this study, the groups were randomly assigned as experimental and control groups. In the sample, there were 16 students in the experimental group and 14 students in the control group.

Data Collection Tools

Two data-gathering tools were used in the study. The learning outcomes that would be measured for the research problem were taken as references for the tests and forms that were developed before the implementation stage of the study, and data collection tools were developed accordingly (Hovardaoğlu, 2007, pp. 56–57). The ECLAAAT was developed to determine the effect of the coding activities on learning in the quantitative part of the research. Regarding the qualitative aspect of the research, a semi-structured interview form was developed and administered to the experimental group of students participating in the study.

Effective Citizenship Learning Area Academic Achievement Test (ECLAAAT)

A specification table was created considering the cognitive domain levels of Bloom's taxonomy for the content validity of ECLAAAT questions. According to this table, a detailed rubric was prepared for the ECLAAAT questions developed by the researcher. While preparing the ECLAAAT questions, more questions were included in the test, especially for the long-term and comprehensive learning outcomes (İlter, 2013). In order to ensure the content validity of the academic achievement test, a multiple-choice test specification table was prepared to cover the cognitive level steps. The test prepared as a draft for the 6th grade effective citizenship learning area consisted of 50 questions. Within the scope of validity and reliability studies, validity and reliability calculations of the test were carried out by administering it to 80 7th grade students. As a result of the analysis, the questions with low validity and reliability were modified or excluded from the test. As a result of

the implementation, a total of 13 questions with low reliability and content validity were excluded from the test, and the ECLAAAT consisted of 37 questions.

Semi-structured interview form

A semi-structured interview form was used in the study to support the quantitative data, increase the credibility (internal validity) of the research, and evaluate the coding training and digital game in terms of students' opinions. The data were obtained through interviews carried out with the experimental group students to determine their opinions about the process. While preparing the interview, first the problem was determined and the relevant literature was analyzed. The draft of the interview form was submitted for expert opinion, and the interview was finalized by making the necessary changes in line with the feedback received from two field experts. In line with the expert opinions, 3 questions were removed from the first version of the form and replaced with 8 questions. However, for these eight questions, it was stated that probe questions should be added in case the students did not fully understand the question. While administering the interview to the students, they were informed about the form; they were told not to write their names on the forms, and the drawbacks that may arise due to the name of the participant that is written on the form while answering the questions were tried to be minimized. Sufficient time was allocated for the data collection process. The forms were filled out by the experimental group students in the last lesson hour of the implementation process in the presence of the social studies teacher and the researcher.

Reliability and Validity of Data Collection Tools

Validity and reliability are two important criteria for scientific research. Validity refers to how accurately the study measures what it intends to measure without involving another characteristic (Balcı, 2010). External validity is about the generalisability of the results, and internal validity (credibility) is the extent to which the obtained results represent the truth in the population. Extra attention was paid to ensuring internal validity because the findings obtained from the data must be broad enough to cover the relevant research and narrow enough to exclude concepts that were not included in the study. In terms of external validity (transferability), the purpose of an in-depth description of the implementation process of the research is to convey the research process to the reader in a simple and understandable way. This study should be understood in the same or similar ways by the reader. For this purpose, the research process was carefully planned and implemented, as described in detail in the method (implementation) section of the study. In addition, the study group was determined in accordance with the purpose of the research.

In order to ensure the reliability of the research, firstly, internal reliability (consistency) was ensured. Validity and reliability studies of data collection tools, the calculation of internal consistency coefficients, and expert evaluations are the practices carried out for this purpose. The data analyses and all documents related to the study were kept by the researcher for external reliability (confirmability).

According to the ECLAAAT specification table prepared in accordance with Bloom's taxonomy, 8 questions are in the knowledge level, 21 questions are in the comprehension level, 1 question is in the application level, 5 questions are in the analysis level, and 2 questions are in the synthesis level. Subject matter experts' opinions about the test were also taken into account, and corrections were made accordingly. When the questions are evaluated in terms of content validity, it is seen that 7 questions are about national sovereignty, democracy, or republic; 5 questions are about forms of government; 4 questions are about three important powers of the state and separation of powers; 4 questions are about jurisdiction; 3 questions are about the Grand National Assembly of Turkey (TBMM); 2 questions are about the presidential system; 2 questions are about human rights; 2 questions are about women in history and women's rights; and 1 question is about other subjects. In this respect, it can be stated that the questions cover every subject in the learning area in terms of content validity.

Cronbach's Alpha Analysis: Cronbach's alpha is used to explain or question the homogenous structure of the items in the scale in cases where the items are mainly scored. The data obtained from this analysis helps determine whether the items consistently measure the same characteristic. Cronbach's alpha was used to measure the internal reliability (consistency) of the test in the study. Since the Cronbach's alpha coefficient was found to be .93 in the analyses, it can be stated that the items in the test are consistent with each other, the test consists of items that measure the same characteristic, and it has a homogeneous structure.

A student interview form was developed to obtain qualitative data for the research. The data obtained from the form was organized by two experts, and categories were determined. In cases where there was a difference of opinion between the experts, they discussed the category or categories and reached a consensus on the

categories. Finally, the categorization process was completed. While reporting the data, the student opinions were directly cited. (For the process of creating an interview form, see the title Semi-structured *Interview Form)*.

Data Analysis

This study was carried out in four weeks with the two 6th grade classes (CG14+EG16=F30) in a private school. The ECLAAAT was administered to the experimental and control groups as a pre- and post-test to determine the effects of the digital games developed by coding on the Scratch platform on students' academic achievement. The data of the experimental and control groups were analyzed with the SPSS 22.00 statistical package program and then evaluated. Before analyzing the obtained data, it was checked whether the data had a normal distribution or not, and then it was decided what type of parametric or nonparametric statistical techniques would be used according to the result obtained. The results of the normality test revealed that the data was normally distributed, but since the number of samples in the groups was small, non-parametric tests were used for the analysis of the data (Can, 2014). The following tests were adopted for the analysis of quantitative data:

Mann-Whitney U Test: The Mann-Whitney U test is a non-parametric test that is used to compare two sample means that come from the two samples, or groups. In addition, it is used under the following conditions: The sample size is small to compare the averages in two groups; even if the data in your sample size is sufficient, the data is not normally distributed, so the conditions of the test are not met, or the data are on an ordinal scale, that is, they can be ranked (Can, 2014, p. 126). It is a method by which we can analyze whether the data are significant or not according to the research questions. The reason for choosing the Mann-Whitney U test in this study is that although the data are normally distributed, the number of samples in the groups is small.

Wilcoxon Signed Rank Test: The Wilcoxon signed rank test is a non-parametric test used to compare two sets of scores or averages that come from the same participants under the following conditions: the sample size is small, even if the data in your sample size is sufficient, the data is not normally distributed, so the conditions of the test are not met, or the data are on an ordinal scale, that is, they can be ranked (Can, 2014, p. 142). The Wilcoxon Signed Ranks Test is chosen in this study due to the small sample size.

Analysis of Qualitative Data

The data obtained from the interviews was analyzed using content analysis. The experimental group's students' opinions were collected in writing. The data obtained from students' opinions was analyzed, and then categories were formed. The obtained data were read carefully, and the categories developed were examined by the two experts. Then, similar opinions were grouped into suitable categories by reaching a consensus in line with expert opinions.

Implementation Process

In this study, digital games coded and designed by the students were used for students to teach the learning outcomes within the content of the effective citizenship learning area in the 6th grade Social Studies course. Throughout a four-week coding training, after a social studies teacher informed the students in the first week of the implementation, the students were asked to do research about the story of the games, animations, and questions in the study. In the following weeks, the students selected the questions and stories that would be used in the games developed, and they wrote scenarios for the stories; thus, a total of 10 questions and 4 scenarios were created. After the students designed and coded the digital game developed by coding, they learned the subject by playing the game. During the implementation process, while scenarios and questions were written and the game was designed in the social studies course, the process of coding the game was carried out in the information technologies course. At the end of the study, the reasons for the students success in this implementation process were evaluated in line with the students opinions.

Findings

The findings obtained by analyzing the data with the data-gathering tools developed for the research questions were presented in this section of the research.

Finding Related to the Experimental Research

The experimental dimension of the research aims to determine the effect of educational digital games designed and played by students by coding on the teaching of the effective citizenship learning area. The Wilcoxon signed rank test was administered to compare the ECLAAAT pre-test and post-test scores of the experimental group students before and after the implementation of the educational digital games designed by coding, and the findings are presented in Table 1.

Table 1. A Comparison of Experimental Group's Pre-test and Post-test Scores of ECLAAAT

		N	$\overline{X}$	SS.	Mean rank	Mean total	Z	P
ECLDAAT	Pre-test	16	12.81	4.04	.00	.00	-3.526	.000
	Posttest	16	34.13	2.55	8.50	136.00		

When the pre-test and post-test results (x̄=12.81, SD=4.04) were compared with the ECLAAAT results (x̄=34.13, SD=2.55) after the implementation of the educational digital games designed by coding, it is seen in Table 2 that there was a significant difference between the pre-test and post-test scores of the students in the experimental group in favor of the post-test at a significance level of $p<0.05$. According to the findings obtained, it was observed that the experimental group students' ECLAAAT scores increased after the students in the experimental group carried out an activity in which they designed the game by coding and played it for four weeks. Considering these findings, it was determined that they learned the "effective citizenship *learning area*" with this implementation.

The Wilcoxon signed-rank test was administered to compare the control group students' ECLAAAT pre-test and post-test scores before and after teaching the content appropriate to the current curriculum with the traditional method, and the findings are presented in Table 2.

Table 2. A Comparison of Control Group's Pre-test and Post-test Scores of ECLDAAT

		N	$\overline{X}$	SS.	Mean rank	Mean total	Z	P
ECLAAAT	Pre-test	14	14.50	5.08	.00	.00	-3.298	.001
	Post-test	14	31.50	2.14	7.50	105.00		

It is seen in Table 2 that there was a significant difference between the ECLAAAT results (x̄=14.50, SS=5.08) of the students in the control group before the implementation and their ECLAAAT results (x̄=31.50, SS=2.14) after the implementation in favour of the post-test at a significance level of $p<0.05$.

The Mann Whitney U test was performed to compare the ECLAAAT pre-test scores of the students in the experimental and control groups before the implementation and the findings were presented in Table 3.

Table 3. *A Comparison of Experimental and Control Groups 'Pre-test Scores of ECLDAAT*

		N	$\overline{X}$	S.s.	Mean rank	Mean total	U	P
ECLAAAT	Experimental	16	12.81	4.04	14.56	233.00	97.000	.552
	Control	14	14.50	5.08	16.57	232.00		

It is seen in Table 3 that there is no significant difference between the ECLAAAT results of the students in the experimental group (x̄=12.81, SD=4.04) and the ECLAAAT results of the students in the control group (x̄=14.50, SD=5.08) before the application at a significance level of $p>0.05$. According to the findings obtained, it was concluded that there was no difference between the ECLAAAT pre-test scores of the students in the experimental and control groups before the implementation. Considering the result of this analysis, the data obtained reveals that both groups were equivalent to each other before the research.

The Mann-Whitney U test was performed in order to compare the ECLAAAT post-test scores of the students in the experimental group where the educational digital games designed by coding were applied and the control

group students who were taught the content appropriate to the current curriculum by the teacher in a traditional way, and the findings are presented in Table 4.

Table 4. *A Comparison of Experimental and Control Groups' Post-test Scores of ECLAAT*

		n	$\overline{X}$	SS.	Mean rank	Rank total	U	p
ECLAAAT	Experimental	16	34.13	2.55	20.59	329.50	30,500	,000
	Control	14	31.50	2.14	9.68	135.50		

When the ECLAAAT results of the students in the experimental group (x̄=34.13, SD=2.55) and the ECLAAAT results of the students in the control group (x̄=31.50, SD=2.14) are compared in Table 4, it is seen that there is a significant difference between the post-test scores of the two groups at a significance level of p<0.05. According to the findings obtained, it is seen that there is a significant difference in favour of the experimental group considering the ECLAAAT post-test scores of experimental and control group students after the implementation. According to the findings obtained as a result of the comparison of the ECLAAAT post-test scores, it was concluded that the experimental group was more successful than the control group.

Findings Related to the Case Study

The student opinions obtained through the semi-structured interview form in the qualitative part of the study were subjected to content analysis, and the data were grouped under the appropriate category headings in this section of the study.

Table 5. Students' Knowledge of Coding Before the Implementation

Opinions	F
Getting information from media and digital platforms	10
Lack of information	4
Informing the teacher during the application	2

According to the analysis of the interviews carried out with the students, when the students'
"knowledge of getting information about coding and digital games" in Table 5 was analyzed, the students stated that they had information about coding from media and digital platforms (f=10), they did not have information about coding before the implementation (f=4), and they acquired knowledge only with the preliminary information lesson given by the teacher to increase their level of readiness (f=2).

In line with these categories, S9 stated that he had information about coding through media and digital platforms with the following statement: *"I had information about coding from television and media".* S5 stated that he had no knowledge about coding as follows: *"I had no information".* S16 stated that he had knowledge about coding during the implementation with the following statement: *"I had no knowledge about coding other than our teacher's information".*

Table 6. Students' Favourite Parts of the Coding Activity

Opinions	F
Implementation stage	7
Creating an animation (character)	7
Creating a maze game	6
Creating a background (stage design)	4

When the results of the analysis in Table 6 regarding the students' liking of coding were analyzed, it was determined that most students liked coding (f=14), but some students had difficulty with coding (f=1). Some students stated that they liked the application phase (f=7), and some students stated that they liked the animation (character) (f=7), maze game (f=6), background (stage) design (f=6) and coding. Some students stated that they liked the implementation process (f=7); some of them remarked that they liked coding an animation (character) (f=7), maze game (f=6), and a background (stage design) (f=6). While S6 said that the implementation process was enjoyable and fun with the following statement: "*I liked coding throughout the whole gaming process; it was great fun*", S8 and S3 wrote that because they did not know coding, they were bored in this stage, but they started to enjoy coding while they were learning it, and thus, they liked the coding process. S10 explained why he liked animating with the following statement: "I *liked animating with characters because it was great fun."* S11 explained why he liked designing the maze game with the following statement: *"While coding the maze game and creating the characters, I liked them because they were enjoyable."* S14 stated that she liked coding

the background with the following statement: "*I liked designing the background for the game and an animation.*"

Table 7. Situations that Increase Students' Interest in the Course During the Implementation Process

Opinions	F
Making the implementation phase enjoyable (fun)	10
Participating actively in the lesson	5
Increasing curiosity due to coding	5
Enhancing knowledge	1

Considering the results of the analysis in Table 7 regarding the students' interest in the learning area during the implementation phase, it can be stated that all students answered yes (f=16) and they stated that their interest in the course increased during the implementation process. Most students stated that they found the implementation process of the digital game enjoyable (f=10), their interest in the unit increased as they actively participated in the lesson (f=5), the coding activity fostered their curiosity about the unit (f=5), and the more their knowledge improved, the more their interest grew (f=1). S10 explained that their interest in the course grew during the implementation process with the following statement: "*Yes, because I actively participated in the lesson and the unit was fun. I was so curious about the unit.*" S16 stated that due to the active participation in the lesson, their interest in the unit increased and explained it with the following statement: "*I was always present in the lesson. That's why I was interested in the course.*" S4 explained why the coding activity fostered their curiosity in the unit with the following statement: "*While coding, I was more curious about the unit, and thus I had growing interest.*"

Table 8. Situations that Help Students to Learn the Unit Easily During the Coding Process

Opinions	F
Learning in the coding process	13
Doing research in the process of developing questions	7
Doing research in the process of creating a story	5
Growing curiosity about the unit	1

Regarding the results of the analysis in Table 8, while coding the digital game, the students learned the unit more easily due to some situations. Most of the students stated that the coding process contributed to their learning (f=13), some of them stated that the question preparation activities (f=7) and the process of story creation process (f=5) during the coding process facilitated learning the unit. In addition, one student stated that because his curiosity about the unit increased (f=1), he learned the unit much more easily. S10 explained the contribution of the coding process to their learning with the following statement: "*I really enjoyed the section on writing codes.*" S6 explained the contributions of activities about developing questions and the process of story creation during the coding process to their learning with the following statement: "*Because I scanned the unit to find a plot for the story and questions while developing the game, I learned a lot.*" S2 explained his growing interest in the unit with the following statement: "*As I coded, I had a growing curiosity, and this helped me learn the unit much more easily.*" S5 said, "*Because I scanned the unit, I had preliminary knowledge, which in turn helped me to learn the unit easily.*" With this statement, S5 stated that doing research during the implementation process promoted his knowledge about the unit, so his learning increased.

Apart from these opinions, some students stated that coding facilitated learning the unit, but they were bored and had difficulty coding at the beginning (f=2), and one student answered no and stated that it did not facilitate learning (f=1). S14 expressed his opinion as follows: "*I got bored while coding. I was much more interested in coding than the unit.*" S13 stated why he was bored while coding at the beginning with the following statement: "*While coding, I had really difficulty with it; learning coding took my time. But then I even did not understand how I learned the unit as time went by.*"

Table 9. Students' Learning Situations While Playing the Digital Game They Coded

Opinions	F
Finding the game-playing stage enjoyable (fun)	10
Realizing mistakes in the playing process	6
Game-playing process being educational	3
Providing an opportunity for revision	2
Increasing curiosity about the unit during the process of game-playing	1

Drawing interest	1

Considering the results in Table 9 regarding the students' learning while playing the digital game that they coded themselves, all the students (f=16) answered yes and stated that they learned the unit more easily while playing the digital game. Most of the students stated that because the stage of game-playing was enjoyable (fun) (f=10) and the mistakes were realized during the game-playing process (f=6), learning could be facilitated. In addition, because the game-playing process is instructive (f=3), the game or animation keeps repeating (f=2) and it is interesting (f=1) it facilitates learning. S1 explained why the game-playing stage was enjoyable (fun) with the following statement: *"I didn't get bored because it was fun. I lost track of time during the lesson."* S16 stated the statement *"because I realized my mistakes while playing a game and this made my work easier"* as a reason for learning easily. S3 opined that the game-playing process was instructive with the following statement: *"I learned easily while playing games. Even my mom was surprised."* S5 explained why the repeatable game or animation facilitated learning with the following statement: *"Because the game was fun, I played the game over and over again, and this engraved information in my mind."* S8 stated that the game was interesting with the following statement: *"I think playing the game drew my interest, and thus I learned the unit more easily."*

Table 10. Concepts that the Digital Game Designed by Coding Helps Learning

Opinions	F
Public opinion-pluralism	8
Legislation-execution	5
Oligarchy-monarchy	3

If we look at the results of the analysis in Table 10 regarding the students' recognizing concepts, we can see that all students answered yes to "Recognizing Concepts" and stated that they differentiated some concepts (Public Opinion-Pluralism (f=8), Legislation-Execution (f=5), Oligarchy-Monarchy (f=3) during the implementation process.

Table 11. Situations in which Students Actively Participated in the Lesson During The Implementation Process

Opinions	F
Doing research in the process of developing the game	10
Game-playing process	6
Throughout the entire implementation process	8
Writing a story in the process of developing an animation	5
Having an opportunity for revision	4
Promoting participation with the information obtained from the game	2

When the results of the analysis in Table 11 regarding the students' active participation in the lesson during the implementation process are analyzed, it is seen that all students (f=16) wrote yes to the active participation in the lesson. They stated that they did research in the process of developing the game (f=10), they prepared questions (f=6), they were active in the process of game-playing (f=8), they were active in the whole implementation process (f=5), they wrote a story (f=4), they were active by playing the game over and over again (f=2), their participation in the lesson increased with the information obtained from the game (f=2). S5 expressed his opinion as follows: *"Yes, thanks to the information I got from the game, my participation in the lesson increased."* S6 explained that they did research during the process of developing the game with the following statement: *"While designing the game, I did some research, prepared questions, coded, and played."* S16 determined that they were active throughout the implementation process as follows: *"Yes, I was always present."* S1 reported that they wrote a story with the following statement: *"I participated, did research while developing the game, and wrote a story for the animation with my peers.".* S8 stated that they were active by playing the game over and over again as follows: *"Playing the game over and over again promoted my knowledge; when I gained knowledge, I participated more and more in the lesson."*

Table 12. Students' Willingness to Use the Digital Game They Developed While Revising the Learning Domain

Opinions	F
Yes	6
No	10

Considering the results of the analysis in Table 13 regarding the students' willingness to use the digital game they prepared while revising the unit, some of the students answered yes (f=6) but the majority answered no

(f=10) and wrote that it was insufficient for general revision. The reasons for this opinion were explained in Table 13.

Table 13. Effects of Coded Game and Animation in Revision

Opinions	F
Being appropriate for the revision of some learning outcome in the learning field	10
Being appropriate for revision in the entire learning field	6

Considering the analysis results of the interviews carried out with the students in Table 13, the students stated that the designed games were suitable for the revision of some learning outcomes in the learning domain (f=10). Fewer students stated that the games designed for the whole learning domain could be used for revision (f=6). Fewer students stated that the games designed for the whole learning domain could be used for repetition (f=6). S11, who stated that the games designed were suitable for general revision, explained his opinion as follows: *"When I play the game again, I think that I will remember."* S4 stated that some learning outcomes in the learning domain were suitable for revision and explained it as follows: *"The game is merely insufficient for all subjects; it is necessary to use the book for the missing subject."* In other words, the students stated that the game they designed would be insufficient for learning the relevant topic completely and added that learning should be supported with additional resources besides the game.

Discussion and Results
Educational digital games were designed and coded by the 6th grade secondary school students in the research, and thus the study examined the effects of these digital games on students' learning of the effective citizenship learning domain. After the quantitative data were analyzed, the students' opinions were taken into account about the implementation process for an in-depth explanation of the data. In other words, the study was supported by qualitative data.

Considering the analyses regarding the effect of digital games on the academic achievement of 6th grade students in the effective citizenship learning domain in the social studies course, a significant difference was found between the pre-test and post-test results of the experimental group. In addition to this result, when the post-test results of the experimental group, in which the digital games designed by the students by coding were used, and the control group, in which the teacher taught the students traditionally with content appropriate to the current program, were compared, it was revealed that there was a significant difference in favor of the experimental group. In fact, it was concluded that educational digital games designed by the students using coding were effective in teaching the effective citizenship learning domain.

At the end of the literature review, it was found that there was no study carried out about the effect of digital games designed by students using coding on the teaching of social studies courses. Indeed, when the meeting minutes of the National Council for the Social Studies (NCSS) held between 1995 and 2002 are examined, it is stated that only 4% of the academic studies carried out on the use of the Internet in the social studies course The literature has been analyzed since 2002, and it has been observed that although there are studies on digital games, the number of studies carried out by students about the coding of digital games is quite limited. It is noteworthy that existing games are still used in the studies (Aktemur, 2022; Bakar, Tüzün, & Çağıltay, 2008; Bayram & Çalışkan, 2019; Çakmak & Taşkıran, 2014; Doğan, 2017; Erkan, 2019; Hücüptan, 2006; İşçi, 2018; Korucu, 2019; Watson, 2010; Yeşiltaş & Turan, 2015).

Doğan and Koç (2017), who predicted academic achievement by using digital games in social studies courses, examined the effect of teaching earthquake subjects with digital games on academic achievement. Although the use of a ready-made game platform in the study differs from the coding of the digital game in this study, the quantitative data of the study and the data of this study support each other. As a result of the study, there was a significant difference in favor of the experimental group in which the digital game was applied, as in this study. In the social studies course, the effect of computer-assisted education on academic achievement was examined in some studies, and it was observed that there was an increase in academic achievement in favor of the experimental group (Erkan, 2019; Çakmak & Taşkıran, 2014; Hücübtan, 2006; Yeşiltaş & Turan, 2015). The quantitative data obtained in these studies support each other since this research is also a computer-assisted activity.

Aktemur (2022) examined the effect of context-based learning strategies with the Cities Skylines game on the teaching of 6th grade social studies subjects in a social studies course. As a result of the research, in addition to academic achievement, entrepreneurship, innovation, and research skills differed significantly when compared

to the control group students. Adanalı (2018) carried out implementations with educational games in geography teaching, and he concluded that students' academic achievement increased and knowledge retention was ensured. Moreover, it was also found in the same study that students with poor academic achievement improved their self-esteem, and their motivation levels towards the course increased in this process.

As a result of the research conducted on computer-assisted instruction in science and technology courses, it was revealed that there was a significant difference in favor of the experimental group in which computer-assisted instruction was applied (Akbaba & Mor, 2017; Akçay et al., 2005). In some of these studies, the effect of computer-assisted instruction on the academic achievement of computer and instructional technologies courses was examined, and it was observed that there was an increase in academic achievement in favor of the experimental group (Hiltz & Turoff, 2002; Kulik & Kulik, 1991; Morrison et al., 1995). It was concluded in some studies that computer-assisted instruction had a significant effect on academic achievement in mathematics courses (Ermac & Suson, 2020; Kehagias & Vlachos, 1999). In these studies, it was concluded that computer-assisted instruction increased students' academic achievement, as in this study. The discussion carried out reveals that digital games are effective not only in social studies but also in other disciplines such as science and mathematics. In addition, it is found that not only digital games but also computer-assisted instruction in general are effective for learning. Since today's secondary age group students are defined as digital natives, these results support the idea that digital activities can be used effectively in teaching these students.

In addition to the studies that reveal the effectiveness of educational digital games in teaching, there were studies that were not compatible with the results of this study. In a study carried out by Koka (2018), the effect of using computer games on academic achievement in a social studies course was explored; however, a significant difference was not found at the end of the implementation. There are other studies in which the implementation of educational digital games was carried out in different fields apart from social studies, but they were not effective. In a study carried out in a computer and technology course, Bayırtepe and Tüzün (2007) examined the effects of game-based learning on students' academic achievement. There was a difference between the pre-test and post-test results of the two groups forming the experimental and control groups, but there was not a statistically significant difference between the two groups. The results of the studies carried out about the effectiveness of digital games are not compatible with each other; thus, more studies are needed to determine the reasons for these results.

In the study, it was found that educational digital games designed and coded by students after the experimental research were effective for learning. In order to determine the reasons for this result, the study was supported with qualitative data, and the experimental group students' opinions on the subject were taken into account. There were many studies in the literature regarding the data obtained from the qualitative dimension of the study, but it was found in these studies that digital games were not coded and designed by students and that existing digital games and such content were used.

The experimental group students stated that they designed the digital game for the first time at the beginning of the implementation, so they sometimes had difficulty or got bored, but other than that, they did not encounter any negative situations during the application process. Most students stated that they had information about coding and digital game design through media and digital media; some students stated that they did not have any information or that they got information from their teachers. Since there was no study encountered in the literature review that investigated the effect of the educational digital games designed and coded by students on learning and explored student opinions, this issue was not supported and discussed in the literature.

The students who expressed their opinions about the implementation process stated that they actively participated in the lesson, the lesson was enjoyable, their curiosity and interest in the unit increased, and the implementation process facilitated learning. Bayram and Çalışkan (2019), Bakir (2015), and Aktemur (2022) reached similar results to these opinions. In fact, it was observed that the students who actively participated in the lesson developed positive opinions and increased their motivation at the end of the study. Similarly, Tonbuloğlu and Tonbuloğlu (2019) found that students generally displayed a high level of motivation and participation in unplugged coding activities, had difficulty concretizing certain concepts, found the activities interesting, and liked them because they made real-life connections. The qualitative data of the other studies and the qualitative data of this study support each other regarding the data obtained from the students' statements, such as "they actively participated in the lesson, the lesson was enjoyable, their curiosity and interest in the unit increased, and learning became easier". Çakmak and Taşkıran (2014) and Erkan (2019) investigated the effect of educational digital games on attitudes towards the course, and they concluded that the use of digital games positively affected attitudes towards the course. There are also other studies that have reached similar results (Deniz, 2021; Kulik & Kulik, 1991; Okal et al., 2020). Although student attitudes are not directly explored in

this study, there are student opinions that support the research in the qualitative data obtained. Bakar et al. (2008) concluded in their study that students liked the educational game environment and that using such an environment in a social studies course as a supportive element increased their motivation in the course. The results of this study by Bakar et al. (2008) and the current study support each other. Watson (2010) concluded that digital games programmed for the social studies course on the Internet met social standards and were appropriate for use in social studies education, and thus he emphasized that the digital games must be used in the social studies course. The teacher's opinions were shaped in this direction after the experiment, and they stated that using digital games in the social studies course would have positive effects on the lesson.

The findings of the study reveal that students learned the effective citizenship learning domain easily while coding and playing the digital game. Especially, it was stated that the game design eliminated misconceptions and clarified the meaning of confused concepts such as Public Opinion-Pluralism, Oligarchy-Monarchy, Legislation-Execution. In the Project Tomorrow (2008) report, when students in grades 6 through 12 were asked about the impact of game technologies on learning, they responded that games facilitated understanding difficult concepts, games made me more interested in the subject, I would learn more about the subject, and it would be more interesting to apply problems. These data demonstrate that students strongly believe that educational digital games will contribute not only to concept learning but also to motivation, academic achievement, and problem-solving skills.

As a result of the study, although the students also stated that the designed digital game was suitable for the revision of some learning outcomes in the learning area, most students stated that the game designed for revision in the whole learning area was insufficient, but they wanted to play the game again to remember the unit. In addition, they stated that, in addition to the game, other sources would be useful for the revision of the unit. However, because there were no studies that obtained data similar to this student's opinion in the literature review, this result was not discussed.

As a result, it can be concluded that digital games prepared accurately and suitably for the purpose will be effective in social studies education. The contribution of games to the development of higher-order thinking skills is considered a benefit that cannot be ignored in terms of social studies education. As understood from the results of the research, not only students but also teachers and pre-service teachers think that digital games will provide different types of learning (knowledge, thinking skills, values, etc.) both in the social studies course and in other fields. This situation reveals that students, teachers, and pre-service teachers have considerably positive perceptions towards the use of educational digital games in education. Of course, this perspective reveals that if teachers and students include the right educational games in their learning activities, teaching activities will become more fun and effective (Mindivanli-Akdoğan & Öner, 2021).

Recommendations

Prensky (2003) states that students' interest in the subject will increase with the pleasure and richness of experience gained during the game. According to Prensky (2003), generally, video games are designed to balance the subject matter with the game play, and the player's ability to retain and apply the subject matter in question is not the enemy but the best opportunity we have to engage our children in the real learning process. Williamson (2007) states that when it is considered that students have more knowledge about digital games than teachers, the importance of this training becomes more evident. In line with these views, it is thought that properly designed digital games in every appropriate subject area are an opportunity for education, and it is argued that the design of digital games in the field of education should be supported.

As a result of the discussion carried out on the quantitative data of the research, although there were results of the study that revealed the effect of using educational digital games on academic achievement in social studies and other courses, there were also data obtained showing that educational digital games did not significantly affect teaching. This situation may be related to the subject matter studied, the practitioner, the implementation process, the game used, etc., or it may be due to different reasons that have not been identified yet. Thus, it is seen that more studies are needed to be carried out about the use of educational digital games for teaching purposes in different courses and subjects, and it is suggested that the number of quantitative and qualitative studies in this field should be increased.

Jenkins (2002), in his research (Motivation of Programming Groups), in which he analyzed the studies previously conducted as a master's thesis, aimed at providing information about the advantages and disadvantages of coding by reviewing the articles on coding. The results obtained in the studies conducted till

now were evaluated in the articles reviewed, and it was stated that "too many students find coding and programming difficult, and therefore the learning environment should be designed quickly and ideally, and the problems encountered by the students should be solved in order to understand some difficulties and complications. It has been 21 years since this study was carried out, and since then, simple coding interfaces have been created. However, because the students did not have detailed knowledge and experience about coding before the implementation, the process became partially difficult at the end of the study. Hence, as a requirement of the age we live in, it is considered that academic studies that will enable students to design their own learning materials, even at a simple level, should be emphasized by providing basic coding education to students. Cevahir and Demir (2020) investigated the effect of coding on algorithmic thinking in the mathematics course, and the results of the achievement test were found to be low. According to these findings, it was argued that we were not good at teaching programming and algorithms. This result was justified with the following opinion: *"When the literature on coding is evaluated, it is found that coding training and STEAM skills are still not included in the curriculum in our country".* It was observed in this study that secondary school students were able to code at a basic level as a result of six lesson hours of information. Providing coding training in the Computer and Instructional Technologies course in all schools and supporting this practice with other disciplines indicates that students can improve in coding.

In this study, the social studies teacher and the computer and instructional technology teacher carried out a joint study to support each other's learning areas, and this cooperation significantly increased the level of learning. Thus, it is considered very important that academic studies in which teachers can carry out research in cooperation with each other on subjects that may be related to each other be designed.

Author (s) Contribution Rate
The first author contributed 60% and the second author contributed 40% to the study.

Conflicts of Interest
No potential conflict of interest was reported by the authors.

Ethical Approval
With the decision of Atatürk University Social and Human Sciences Ethics Committee dated 06.09.2022 and numbered 18, it was stated that the study was appropriate in terms of ethical principles.

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