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AN EXAMINATION OF DIGITAL GEOGRAPHY GAMES AND THEIR EFFECTS ON MATHEMATICAL DATA PROCESSING AND SOCIAL STUDIES EDUCATION SKILLS

Ömer DEMİRCİ, Zekeriya Fatih İNEÇ

Abstract: This study aims to advance the development of the mathematical processing skills of students by suggesting the use of digital geography games. This includes an analysis of its contribution to the standard mathematics curriculum in areas such as data processing as well as its contribution to social studies curricula in areas such as map literacy, location analysis, problem solving, and other skills related to understanding tables, graphs, and diagrams. The study also examines the findings of the experts that relate to these dynamics. A case study of a digital geography game called Gezgin, developed by İneç (2021) is examined in this research using qualitative research approaches. Under this framework, the data obtained by critical case sampling from six experts through a semi-structured online interview were collected with cloud technologies and examined by using a content analysis. The findings obtained showed that the use of Gezgin can help develop skills related to data processing, problem solving, problem formulation, general mathematical processes, the ability to transfer mathematics to real life, and the ability to create and correctly interpret tables and graphs. The findings also indicate that the real-life context that is provided by this game supports educational development in the areas of map literacy, location analysis, problem-solving skills and graph, table and diagram creation and interpretation for social studies curricula. The expert opinions about Gezgin were determined to be mostly positive, especially with respect to the interdisciplinary structure and its rich content, but some of its functions were found to be limited.

Key words: Digital geography games, data processing, skills, mathematics education, social studies education

1. Introduction

It is impossible for this new generation of students to distance themselves from the digital world around them and technological gadgets such as computers, smartphones, or tablets. In this context, there is an important need to support the educational process with useful technology to overcome the challenges of the digital age, including the increasing number of students addicted to technological devices (Taylan-Koparan et al., 2021). Transferring technological devices into helpful educational tools is possible with certain types of digital games, especially at the early childhood and primary school level (Genç-Çopur, 2021). Digital games can support the development of skills, competencies, and abilities by making the teaching and learning process fun and increasing the student's motivation to learn. When technological tools are mentioned, digital games are often the first type of tool that comes to mind. Therefore, it is inevitable that digital games will be used and have an important role in the educational field. The concept of a digital game is a form of electronic entertainment governed by certain rules that develops certain types of skills and levels of intelligence (Turkish Language Association [TLA], 2022). In other words, digital gaming can be explained as the inclusion of technology in the gaming process and the gaming platform.

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The literature in this field emphasizes how certain teaching structures that use digital games increase the student's motivation for learning (Garris et al., 2002; Genç-Çopur, 2021; Hwang et al., 2014; Kiili, 2007; Kulik et al., 1983; Rosas et al., 2003), class participation (Annetta et al., 2009; Charles & McAlister, 2004) and positively contributes to academic achievement (Aksoy, 2014; Appropriate, 2008; Ke, 2009; Liu & Chen, 2013; Obut, 2005; Robertson & Howells, 2008; Watson, 2007). In addition, many researchers have determined that digital games improve problem-solving skills (Akçaoğlu, 2013; Gros, 2007; Lieberman et al., 2009). Digital games are also thought to be effective in gaining experience and knowledge with respect to technology, as well as increasing the development of eye-hand coordination and motor skills (Griffith et al., 1983).

In curricula that use educational digital games, students develop a concrete process for learning by having fun and engaging in real-life types of situations. Therefore, the development of digital games that support educational programs and are used as a teaching tool in the classroom is a necessity in the digital age. This is particularly important because mathematical concepts are abstract and these games allow mathematical concepts to be embodied in real-life examples, especially for the primary school level. There tend to be difficulties in standard math programs regarding statistical concepts in the data processing area (Çakmak & Durmuş, 2015; Dogan, 2009). A study by Jones et al. (2000) found that elementary school students have difficulty in visualizing, organizing, analyzing, and interpreting data. The American Statistical Association has published a report called the Guidelines for Assessment and Instruction in Statistics Education and it emphasizes the use of technology to improve data analysis and conceptual understanding (Guidelines for Assessment and Instruction in Statistics Education, [GAISE], 2016). Educational digital games can make the process of teaching mathematics fun and more concrete (Foster et al., 2011). In addition, it is possible to use education-based digital games to develop and effectively use abstract conceptual knowledge that can allow mathematical concepts to transfer to real life.

In line with these advantages, it is important to transform digital games for entertainment into digital games for education and integrate them into the teaching curriculum. More recently, education-oriented digital games that make use of geographical features have been used in education and training activities (Ahlqvist et al., 2014; Feulner & Kremer, 2014; Ihamaki, 2015; İneç, 2021; Kiefer et al., 2006; Paulus et al., 2007; Schaal et al., 2015; Schaal et al., 2018; Schlieder et al., 2006; Tomaszewski et al., 2020; Tomaszewski & Schwartz, 2017). These games, which are characterized as digital geography games, are designed based on using geographical locations (Schaal, Otto, Schaal & Lude, 2018). There are various studies in the scientific literature in which digital games that are designed for education are evaluated by different variables used in mathematics and social studies programs. However, no study evaluates how digital geography games are used in mathematics curriculums, and only one study carried out by İneç (2021) evaluate them with respect to social studies curriculums. Therefore, an education-oriented digital geography game called Gezgin (İneç, 2021) has been adapted as a case study to fill this gap. The aim is to better facilitate how concepts in the field of data processing are conveyed to primary school students by applying real-life situations that are used in a social studies context. In this context, the research is seen as a scientific study in which various disciplines are integrated and evaluated together.

1.1. Purpose of the research

This study intends to evaluate how a digital geography game (geo-game) called Gezgin (İneç, 2021) might support conceptual learning and mathematical processing skills in the data processing area of a mathematics curriculum at the third-grade level. The study also intends to determine its contribution to map literacy, location analysis, problem solving and the ability to understand tables, graphs, and diagrams in a social studies curriculum. Finally, expert findings related to Gezgin are also compiled and evaluated. To this end, the answers to four basic questions are explored:

1) What are the expert opinions on the level of reflection of the outcomes in the Gezgin designed for the data processing learning area?

2) What mathematical processing skills are being employed with Gezgin in the learning area of data processing?

3) What is the impact of Gezgin on the various social studies skills of the students?

4) What are the findings from the experts about Gezgin in general?

1.2. Importance of the research

The scope of the study seeks to assist students in developing their abilities to collect data, process data, create research questions, and analyze and interpret results (MoNE, 2018). While developing these abilities, it is expected that students will be able to better organize data when they encounter various situations in real life. It is also expected that they will be better equipped to understand and interpret the data with the help of tables or graphs when necessary (Schield, 2010). Studies show that primary school students have difficulty performing these tasks (Jones et al., 2000). The American Statistical Association's report, called the Guidelines for Assessment and Instruction in Statistics Education, emphasizes the use of technology to improve data analysis and conceptual understanding (Guidelines for Assessment and Instruction in Statistics Education, [GAISE], 2016). These findings highlight the importance of this study, particularly concerning the fact that a similar interdisciplinary study is not included in the scientific literature.

2. Method

2. 1. Research model

This study was conducted using qualitative research methods. As an interdisciplinary study that uses a holistic approach, the study was structured as a case study to ensure that rich and in-depth answers to research problems could be evaluated and confirmed (Yıldırım & Şimşek, 2013). In this context, a substantial amount of time was given to the experts to experience and evaluate the game to ensure the validity and reliability of the data that was collected. In line with the objectives of the study, the expected generalizations were shared with the participants and accurate and unbiased descriptions were obtained. In addition, the results were compared with the evaluations of the experts and different perspectives were included in the process (Yıldırım & Şimşek, 2013).

Online standardized open-ended interviews were conducted to gather expert opinions from a multidimensional perspective and to compare the views of the participants (Patton, 2018). In addition, the gaming activities of the experts were monitored from a central database and the suitability of these experiences to the case study was continuously analyzed and feedback was given to the experts. The data were examined by content analysis and were described by determining the relationships between the various concepts and themes that were identified (Yıldırım & Şimşek, 2013).

2. 2. Study group

In qualitative research approaches, holistic single cases are examined with small samples which are selected purposefully. In these non-experimental cases, abundant data are included that can be examined in depth and purposeful sampling is obtained with different forms of understanding. In this context, since the information available should be broad and effective, the objective is to reach logical generalizations from the six expert participants by using critical case sampling (Patton, 2018). These specialists are made up of classroom education specialists who work within the elementary education department of the faculty of education as the content of the study is related to primary education. The descriptive information of the participants in the study group is given in Table 1.

Table 1. *Participants*

Designation	Gender	Degree of Education
Expert 1 [E_1]	Male	PhD
Expert 2 [E_2]	Female	PhD
Expert 3 [E_3]	Male	PhD
Expert 4 [E_4]	Male	PhD
Expert 5 [E_5]	Female	PhD

Expert 6 [E_6]	Male	PhD

2. 3. Data collection tools

In the study, a semi-structured interview form was created to analyze the experts' opinions of the digital platform with respect to the research questions. Existing literature and expert knowledge were used to structure the content of the questions within the form and care was taken to to organize the questions in a way that addressed the research question. The form was converted into an online format and participants were given access via online communication tools. As the data were obtained, they were instantly transferred to the cloud accounts of the researchers.

2. 4. Data analysis

The data obtained from the standardized open-ended online interviews that were conducted using the semi-structured data collection form were examined by the method of content analysis. The content analysis allowed the analyzed data to be transformed into concepts and themes. Thus, the data from the interviews were able to be organized meaningfully and logically (Yıldırım & Şimşek, 2013).

After the data analysis was completed, feedback from four experts was taken to determine the reliability of the analysis and these were evaluated according to the reliability formula proposed by Miles and Huberman (1994). The reliability of the data analysis was carried out using the formula that assesses the meaningfulness and compatibility of the data in reliability control. It was determined to be 92%. A reliable result is expected to be over 90% in terms of significance and adaptability; thus, this result is considered reliable (Miles & Huberman, 1994, p. 64).

2. 5. Research process

There are two dimensions to this study. First, the digital game was adapted for this study and then it was presented to the experts for evaluation. Since the development and implementation process of this study coincided with the pandemic in 2022, the process was carried out completely online. The process of adaptation took four weeks, and the application and evaluation process took about three weeks.

2. 6. Material

The study uses a digital platform named Gezgin (İneç, 2021), which was developed originally by İneç (2012) with an ADDIE instructional design model and has been turned into a digital geography game with a 4C/ID instructional design model. Seyyah is essentially an internet-based geographic information systems application and serves as a web mapping service. Thanks to its own database and coordinate system, it performs the processing and presentation of geographical data quickly. Consisting of approximately fifteen thousand lines of code, Seyyah is suitable for interdisciplinary studies and allows users to work and configure data interactively for social studies programs (İneç, 2012; İneç & Akpınar, 2012), Republic of Turkey Revolution History and Kemalism (Bozkurt, 2021), history (İneç, 2021) and culture (İneç & Akpınar, 2018).

For this study, Gezgin (İneç, 2021) was adapted to present the data processing aspect of the mathematics curriculum for primary schools created by the National Education Ministry of the Republic of Turkey. It was specifically adapted to the target audience in a real-life context. In this context, the game's ability to engage the relevant educational topics including the sub-dimension of the data processing area for third graders was evaluated and deemed appropriate for the study. The fact that this is a study that blends geographical systems, content related to mathematics and an analysis of pedagogical techniques where students can have fun while learning allows the study to maintain unique interdisciplinary dimensions for social studies education. The interface of the material adapted for the data processing learning field is shown in Figure 1.

Figure 1. *Explorer adapted for data processing.*

The data processing elements that are important for primary school educational curriculums have basically two dimensions. These are teaching about data and the reflection of data. Teaching about data includes components such as formulating problems, data collection, processing and analyzing data and interpreting results. The reflection of data involves the ability to interpret the data by creating a graph or table. In early primary school, students are taught to read simple tables of up to two data sets. In fourth grade, they are taught to read, interpret, and edit simple tables that include up to three data groups (MoNE, 2018).

The following components are included in the data processing part of the third-grade curriculum:

Outcome M.3.4.1.1: Converting and interpreting the information from the graph to the scoring table and to the frequency table by describing what is shown in the figure and the object graph.

Students are asked to comment on all the data by comparing different parts of the data. For example, when the graph shows the number of loaves of bread sold in a week at a grocery store, students are expected to notice that the number of loaves of bread sold on the weekend is more than the number of loaves sold on other days.

Outcome M.3.4.1.2: Solving problems that require addition and subtraction by using the information provided in a graph or by creating graphs.

a) Number limitations according to grade levels shall be maintained.

b) Problems that require comparison are included.

c) Studies that develop a student's ability to form and shape problems are also included.

Outcome M.3.4.1.3: Reading and interpreting simple tables with three data sets and editing the data obtained from the table.

The outcomes obtained from the data processing aspects for the third-grade level are reflected in a real-life context to cloud-based content from the countries configured in Gezgin's database. For this, the content created by the researchers was equipped with various visuals and presented for use in the classroom. The content has a dynamic structure and allows students to work individually or to collaborate as a group. Since interactive data sets are presented to students with various spreadsheet tools, they allow all the graphs, tables, and diagrams to be created, reflected, and related to real-life situations within the geographical system. The visual about this situation is presented in Figure 2.

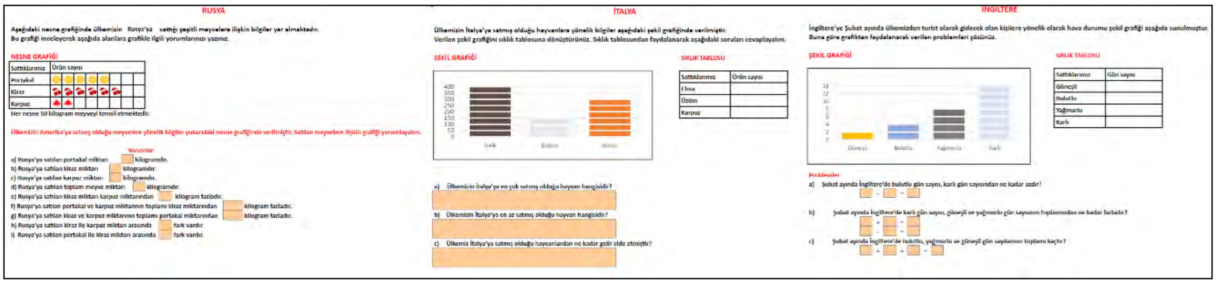

Figure 2. *Cloud-based collaborative and dynamic datasets*

A pilot test was used to evaluate the features of the program and repeatedly examine its overall stability within the system. During the application of the pilot test, Gezgin worked efficiently and was assessed by the experts.

3. Findings

This part of the research examines the student’s engagement with the mathematical processes, conceptual comprehension, map literacy, location analysis, problem solving and their understanding of the relevant tables, graphs, and diagrams in standard mathematics programs as it relates to data processing. The general evaluation is analyzed through the findings of the experts participating in the study and the evaluation is presented in tables below. The presentation of these findings was conducted under the framework of the four questions mentioned above.

The standard mathematics curriculum aims to teach third-grade students data processing under three specific goals. In order to assess whether Gezgin reaches these goals, the findings and opinions of the experts were examined, and the information obtained is presented in Table 2.

Table 2. *Expert insights on teaching data processing with Gezgin*

Category	Code	Views	f
Creation and interpretation of tables and graphs	Contributes to reading, interpreting, and editing tables and graphs	E_1, E_2, E_3, E_4, E_6	16
	Uses data	E_2, E_3, E_4, E_6	
	Gives an opportunity to review charts	E_1, E_4, E_6	
	Convert from graphs to tables	E_1, E_3, E_6	
	Develops comprehension of charts and graphs	E_3	
Problem-forming skills	Supports problem-forming skills	E_1, E_3, E_4, E_6	6
	Develops different types of problem-forming activities	E_1, E_2	
Problem-solving skills	Develops problem-solving skills	E_1, E_4, E_6	3
Transferring mathematics to real life	Relates math to real life	E_2, E_3	3
	Real-life information	E_4	

The findings of the experts on the use of Gezgin and its ability to promote the development of certain data processing skills are represented in Table 2. Specifically, the categories of "creation and interpretation of tables and graphs" (f=16), "problem-forming skills" (f=6), "problem-solving skills" (f=3) and "transferring mathematics to real life" (f=3) are represented by ten different codes. Under the category of creation and interpretation of tables and graphs, five of the experts believe that in this case, digital games contribute to the student’s abilities to read, interpret, and edit diagrams and graphs. Four experts found that it improves the ability to use data. Three found that it provides the opportunity to examine charts as well as providing the opportunity to convert from graphs to tables. One expert stated that the digital game provides improved comprehension of tables and graphs. Under the problem-forming skill category, four of the experts found that the geography game supports problem-forming skills, while two determined that it allows for the development of different types of problem-forming activities. Under the category of problem-solving skills, three of the experts stated that the students improved their problem-solving skills. Finally, under the category of transferring mathematics to real life, two of the experts found that the game contributes to a student's ability to relate mathematics to real life, and one found that the game provides information about real life. In addition, Table 2 shows that the experts coded E1, E3, E4 and E6 found six different aspects of data processing. The expert coded E2 found four aspects and, it is noteworthy, that E5 determined that the game did not contribute to any of these aspects.

The categorized findings of the experts on the data processing components are presented below:

Creation and interpretation of tables and graphs:

Contributing to reading, interpreting, and editing tables and graphs – E4: *"It develops skills such as reading, interpreting and arranging the tables that are created during the games in this study to integrate them into different problems."*

Using data – E3: *"He also needs to analyze and further examine the existing data so that he can identify the problems. In this respect, it also supports the student's understanding of the graphs."*

Allowing them the opportunity to examine the graphs – E6: *"These comparisons are nicely created to give students the opportunity to both read the relevant figures or graphs and perform the relevant operations."*

Converting from graphs to tables – E1: *"Students have the opportunity to examine the graphs embedded in this geography game. There is the possibility to convert shape and object graphs into frequency tables and to make interpretations from the graphs. It also offers the opportunity to understand mathematical concepts."*

Developing Comprehension of tables and graphs – E3: *"Another aspect is that it gives the opportunity to see the advantages and disadvantages of chart types compared to each other. In this respect, the student will be able to be more informed about which graphs to use in future activities."*

Problem-forming skills:

Supporting problem-forming skills – E1: *"Well thought out. The goal of developing problem-forming skills is very good. As a matter of fact, the ability to shape and form problems requires some different progressions and skills than problem solving."*

Developing different types of problem-forming activities – E2: *"... I think that providing examples through different situations will increase the likelihood of encountering and identifying different problems."*

Problem-solving skills:

Developing problem-solving skills – E4: *"Problem-solving skills, which is one of the critical skills of the 21st century, is engaged well by this study."*

Transferring mathematics to real life:

Relating mathematics to real life – E3: *"Through the problems [in the game], the student must examine the data in the graphs. In this respect, the student will be able to be more informed about which graphs to use for other situations in the future."*

Real-life information – E4: *"The game is supported by real-life information. Import and export trade was discussed. Real-life situations create a learning-by-doing environment which is the most permanent type of learning. Therefore, in this way students are given the opportunity to combine mathematics and real life."*

In line with the insights of the experts, it has been seen that digital geography games affect a student's mathematical processing skills. The findings from the data are presented in Table 3.

Table 3. *Expert insights into mathematical processing skills*

Category	Code	Views	f
Mathematical processing skills	The ability to make predictions and comparisons	E_2, E_3, E_4	3
	Uses inference	E_2, E_4	2
	Establishes mathematical relationships	E_3	1
	Develops creativity	E_4	1

The findings of the experts are represented in Table 3 under the category of "mathematical processing skills" (f=7) with respect to Gezgin. Under this category, three of the experts reported that the game contributed to the ability to make predictions and comparisons. Two experts found that it engages a student's ability to make inferences. One expert found that it supports both the ability to establish mathematical relationships and to develop creativity. In addition, Table 3 shows that the expert coded E4 found the game to contribute to three different aspects of these mathematical processing skills while E2 and E3 found two.

Below are the categorized findings from the experts related to mathematical processing skills:

Mathematical processing skills:

The ability to make predictions and comparisons – E3: *"Estimation and comparison are important types of reasoning. I think this is valuable for this level of elementary school. These activities will enhance them."*

Using inference– E2: *"Students' ability to make inferences and comparisons using the data sets that are given to them will support their problem-making skills."*

Establishing mathematical relationships – E3: *"Problem-solving and problem-forming activities are built into the game. The data in the graphs and tables are related and are used to solve problems. In addition, the problem-forming activities and problem-solving activities support each other."*

Developing creativity – E4: *"The game requires students to be able to identify and formulate problems with creativity by ensuring that the student's mental processes are active"*.

The expert findings about how this geography game promotes certain aspects of social studies programs such as map literacy, location analysis, problem solving and the ability to create tables, graphs and diagrams were also examined. The findings that were obtained are presented in Table 4.

Table 4. *Expert findings for the skills related to social studies program.*

Category	Code	Views	f
Creating and interpreting tables, graphs, and diagrams	Creating tables, charts, and diagrams	E_1, E_2, E_4	6
	Interpreting tables, charts, and diagrams	E_3, E_5	
	Converting charts and diagrams into frequency tables	E_2	
Location analysis	Analyzing location	E_1, E_2, E_3, E_4, E_6	5
Map literacy	Improving map literacy	E_1, E_4, E_5	4
	Recognizing country symbols	E_1	
Problem solving	Supports problem-solving skills	E_1, E_2, E_4, E_6	4
Real-life context	Providing information in a real-life context	E_3, E_4, E_5	4
	Transferring geographic information	E_4	

The basic social studies skills that were identified and promoted in Gezgin were "creating and interpreting tables, graphs and diagrams", "location analysis", "map literacy", "problem solving" and understanding the "real life context". According to the experts' findings, skills related to "creating and interpreting tables, graphs and diagrams" (f=6), "location analysis" (f=5), "map literacy" (f=4) and "problem solving" (f=4) were used the most in this game. Under the ability to create and interpret tables, graphs and diagrams, the game was found by the specified experts to allow for students to develop their creative (f=3), interpretive (f=2) and conversion (f=1) skills. The student's ability to analyze the location was also determined to be high (f=5). The game was also found to promote the skills related to map literacy (f=3) and the ability to recognize country symbols (f=1). It was stated by most experts to have supported problem-solving skills (f=4). The gaming platform was found to have a real-life context for the purposes of a social studies curriculum (f=4). More specifically, the information provided was understood to be real-world appropriate (f=3) and one expert found that it transferred geographical information well (f=1) in digital play. Table 4 shows that the expert coded E4 found that the game promoted six different components, while E1 found five and E2 found four. E3 and E5 found three relevant aspects and E6 found two.

The categorized findings of the experts on the basic social studies skills are presented below:

Creating and interpreting tables, graphs, and diagrams:

Creating tables, graphs, and diagrams – E1: *"I think it is effective in promoting [a student's] readiness to create and interpret tables, graphs and diagrams. I believe it will contribute further to the educational experience."*

Table, graph, and diagram interpretation – E5: *"Content for tabular chart interpretation was presented, but I didn't see content for creating them."*

Converting from charts, graphs, and diagrams to tables – E2: *"This practice can be useful for all the skills specified in the question. I think the conversions, especially between graphs, are quite useful for solving problems."*

Location analysis:

Analyzing the location – E3: *"I think it is valuable for countries to show their geographical location amongst their neighbors. Maybe if the countries are represented by their capitals on the maps, students can expand their geographical knowledge by seeing the capitals."*

Map literacy:

Improving map literacy – E4: *"It has a variety of information about countries in general. For example, it can make weather forecasts for a given month in the UK. Students can compare these estimates to the country they live in or with other countries."*

Recognizing the symbols of countries – E1: *"If students are going to study countries based on the flags, the map can contribute to their literacy. But if they do so by random selection, it may not promote permanent proficiency for students. With frequent and repeated use, at least students can learn about the location of the countries."*

Problem solving:

Supporting problem-solving skills – E6: *"I think the practice will have a positive impact on students' problem-solving proficiency."*

Real-life context:

Providing information in a real-life context – E3: "Interpreting tables and graphs is very important in social studies and other subjects because we work with data in the various activities within our curriculum. In this context, it allows students to organize the situations in their social life in a way that allows them to make better interpretations and have opinions.

Transferring geographical information – E4: " Problem-solving skills, which is one of the critical skills of the 21st century, are well implicated in this study. The ability to read, interpret and edit tables which is one of the skills that it tries to develop seems to be important in terms of exposing students to various problems. Students outside of this study will be able to develop a positive attitude towards learning about countries and geographical graphs."

The general findings of the experts related specifically to this game are examined and outlined in Table 5.

Table 5. *General findings of the experts on the adapted digital geography game*

Category	Code	Views	f
Positive	Interdisciplinary features	E_1, E_2, E_4, E_5	12
	Supplying rich content	E_2, E_4	
	Designed according to grade levels	E_2, E_3	
	Presenting meaningful problems	E_2	
	Enabling learning by having fun	E_6	
	Contributing to proficiency	E_3	
	Applying high-level skills	E_4	
Negative	Content limitations	E_1, E_3, E_5, E_6	9
	Tables should be improved	E_5	
	Guidance in problem solving	E_2	
	Lack of diversification in problems	E_2	
	Lack of interaction	E_1	
	Function limitations	E_1	

Within the scope of this study, Table 5 presents the general findings from the experts that display the positive and negative aspects of Gezgin as an educational tool. The positive characteristics (f=12) that were found include the interdisciplinary nature of the material (f=4), supplying rich content (f=2), suitability for each grade level (f=2), presenting meaningful problems (f=1), providing a fun educational environment (f=1), contributing to overall proficiency (f=1) and the ability to apply high-level skills (f=1). In addition, the expert coded E2 has four positive opinions related to Gezgin, E4 has three and E3 has two. E1, E5 and E6 have each given one positive opinion about the game in general.

Some of the positive findings of the experts regarding digital gaming are as follows:

Interdisciplinary features – E5: *"The work is very original and valuable in terms of teaching both mathematical processing skills and the skills required in social studies programs..."*

Supplying rich content – E4: *"A wealth of content is presented, suitable for addition and subtraction."*

Designed according to grade levels – E3: *"These are the types of graphs included in the curriculum. It supports their understanding of mathematics because it allows students to see mathematical connections between different types of graphs. In other words, it contributes to their development in understanding mathematics. Another point is that it gives the opportunity to see the advantages and disadvantages of different chart types when compared to each other. In this respect, the student will be able to be more informed about which graphs to use in future activities"*.

Presenting meaningful problems – E2*: "In this context, looking at the example of Turkey, I think the content structure presents meaningful problems. There are also examples where object and shape graphics are used in the same structure."*

Enabling learning by having fun – E6: *"I think it's a good instructive game that serves its purpose."*

Contributing to proficiency – E3: *"In addition to reinforcing the ability to interpret graphs, these activities show that there are different situations in the graphs that can be focused on. That is, various information can be extracted from the graphs. It also supports the ability to make associations with different areas of mathematics."*

Applying high-level skills – E4: *"These types of skills can enable students to achieve higher-order thinking skills. For example, they will need to use skills at the level of analysis and synthesis based on information about the different countries. It will also help develop the ability to read and interpret graphs and solve problems related to it."*

According to Table 5 some of the expert findings related to the geography game are categorized as negative (f=9). Some experts found that the material designed under this category has content limitations (f=4). One expert suggested that the adapted tables should be more developed (f=1), and another found guidance for problem solving (f=1). Similarly, one expert found there to be a lack of diversification in the prepared problems (f=1), lack of interaction within the game (f=1) and limits to its functionality (f =1). Table 5 also shows that the expert coded E1 has three criticisms about the educational effectiveness of the game, while E2 and E5 have two criticisms. E3 and E6 have given one negative criticism each.

Some of the negative findings of the experts regarding digital gaming are as follows:

Content limitations – E1: *"I wondered if we could relate it to physical geography as well. For example, a weather report is given for several different countries as well as imports/exports. Could it have included features such as known landforms and so on, so that it has less repetition and more diversity? For example, the distance to other countries, as the bird flies, is mentioned on the Turkey page and it could be given as a graph. I think that would give more diversity."*

Tables should be improved – E5: *"Scoring tables can be improved a little more."*

Guidance in problem solving – E2: *"I would like to point out that I consider it to be a negative feature that the addition and subtraction answers contain a redirect."*

Lack of diversification in problems – E2: *"Questions with a different approach can be added instead of questions with the same goal and solution."*

Lack of interaction – E1: *"Students may also be asked to express in writing what they have done in relation to "language", which is one of the components of meaningful mathematics education. To increase engagement, patterns of thinking can also be revealed by asking questions such as 'Why did you do this?'."*

Function limitations – E1: *"It seems useful to review the way the cursor functions and the font sizes (those in the interface). For elementary school students, larger sizes may be useful. An icon can be designed for referrals."*

4. Discussion and Conclusion

This study examines a digital geography game called Gezgin (İneç, 2021) as a case study to determine its effectiveness in teaching "data processing" for the primary school mathematics curriculum used by the National Education Ministry in Turkey. The study also evaluates how the game contributes to the student's mathematical processing skills, conceptual understanding, map literacy, location analysis, problem solving and the ability to create tables, graphs and diagrams related to social studies programs. The study also examines the findings obtained from the experts with respect to Gezgin in general.

The results of the first research question are related to the data processing aspects of the standard mathematics curriculum. The results showed that primary school students can create tables and graphs through the activities that are integrated into Gezgin. In addition, the students had the opportunity to examine and use the data presented to them while engaging in the various tasks of the game. At the same time, they also encountered various tables and graphs. In the activities where graphs and tables are examined and various interpretations are given, the educational value of the data processing aspects of the game was found to be effective. In other words, the experts stated that the student's educational development specifically in conceptualizing and understanding the data processing aspects was potentially significant. The findings from the relevant literature in this area are similar to the results obtained in this study. That is, using technological tools, software and materials support learning and understanding in the statistical sciences, particularly within the field of data processing. (Ben-Zvi, 2000; Steel, 2014; Dogan, 2009).

The development of problem-forming and problem-solving skills (NCTM, 1989), which is an important part of a mathematics curriculum, can help students engage with real-life problems more effectively. Therefore, using real-life problems to teach mathematical processing is important as it makes mathematical concepts more concrete especially for younger students. Thus, teaching mathematics in the context of problem solving is beneficial in helping students understand mathematical concepts (Kwek, 2015). It is observed that one of the goals of third-grade education is an emphasis on problem solving and problem-forming activities (MoNe, 2018). In the activities within Gezgin, students are given shape and object graphics, scoring tables and frequency tables. These tables show the weather conditions for multiple countries as well as the products that are imported and exported by Turkey to various countries. Within this context, students were given various problems and expected to work through and find solutions. Students who tried to understand the problems closely by examining the data were able to find solutions and put a plan into action. This process was supported by problem-forming activities during the control phase, which is the last step of problem solving. Therefore, problem-forming activities that are closely related to problem solving (Gonzales, 1994) are also included in the process. Thus, it is shown that Gezgin supports the student's skills in problem solving and formulating problems. The experts also emphasized that mathematics can be effectively connected to real-life situations through problem-solving and problem-forming activities. Additional research in the literature also shows that using digital games in a learning environment can have positive effects on problem-solving skills (Aktaş, Bulut and Aktaş, 2018; Gee, 2007; Gallipoli, 2013; Lieberman, Bates and So, 2009).

In an educational context, digital games allow educators to model real-life situations easily. The findings of the experts participating in the research have shown that Gezgin can be an effective tool in transferring mathematics to real life. This result is similar to the result of Hewet's study (2016) with high school students. In this study, the researcher found that using digital games enabled high school students to transfer their experiences more easily from the game into a real-life context.

The results of the second research question in the study revealed that Gezgin supports mathematical processing skills such as prediction, comparison, inference, association, and creativity. The tables and graphs designed for the students who play the game provide opportunities to examine the connections found within the data and allow them to comment on and critically assess the data themselves. In addition, students who make inferences and comparisons from the graphs and tables, use them for formulating the problems and for problem solving. This process also strengthens and enhances the student's creativity. The results of this study are similar to the relevant literature that shows that digital games develop a better understanding of mathematical concepts and processes (Aksoy and Küçük Demir, 2019; Can and Cagiltay, 2006; Crompton and Traxler, 2015). In fact, hidden in digital games are activities and tasks that enhance cognitive, temperamental, and motor skills. Beyond these skills, the educational content of the game can contribute to the development of high-level skills. Digital games, which often simulate situations that cannot be applied in real life, are seen in some cases as one of the most important educational tools (Gelibolu, 2013).

The results of the third research question show that Gezgin employs data processing tasks within a real-life context. These tasks explore issues related to social studies programs such as location analysis, map literacy, problem solving and the ability to create and interpret tables, graphs, and diagrams. In addition, the findings from the experts indicate that the engagement involved in these tasks is on an interdisciplinary level and occurs in a real-life context. These results contribute new findings to the literature due to the limited number of studies that examining digital geography games in an interdisciplinary setting, particularly studies focusing on map skills. (Dulamă, 2014; Dulamă et al., 2016; Dulamă & Ilovan, 2016). The studies in the literature, in general, demonstrate that digital games including geography-based games are effective in developing social studies skills and skills in related subjects (Artvinli & Dönmez, 2021; İneç, 2021; İş & Yeşiltaş, 2020; Melero & Hernández-Leo, 2017). These results are consistent with the findings of this study. The significant potential that digital geography games offer for the field of geography underlines the variety of skills that can be supported (Feulner, 2016; Kiefer et al., 2006).

An additional finding obtained from the study is that a digital geography game like Gezgin supports the ability to create and interpret tables, graphs and diagrams related to social studies courses. There are no other scientific studies in the literature that connect this skill with digital games or geography games. However, in a study where geographic information systems are used, which is the digital infrastructure of a geography game, the ability for relevant skills to be developed has been observed at the teaching level (Sezer et al., 2022). This is also in line with the findings of this study.

Among the other skills examined in this research, location analysis and map literacy skills have been observed to be considerably improved and developed by using digital geography games (Tomaszewski et al., 2020). These observations also highlight how connected these skills are and remind us that the skills associated with location analysis are a subset of the skills related to map literacy. Similar studies that focus on developing spatial skills have found that geography games can enhance a student's ability to analyze their location. (Bartoschek & Schwering, 2022; Adanali, 2021; Tomaszewski & Schwartz, 2017; Feulner, 2016). Since spatial skills are a sub-dimension of skills related to map literacy, this process of developing spatial coding, perspective awareness and mental rotation can also support the ability for students to engage meaningfully with maps (Feulner & Kremer, 2014; Schwering et al., 2014).

One of the skills examined in this study is problem-solving skills. It is determined that this skill can be improved by using digital geography games. In the relevant literature, problem-solving skills have been connected to geography skills and comprehension. It is thought that geography games can be a meaningful tool in geography education by facilitating the development of useful processes and helping students produce solutions to the problems they encounter (Adanalı, 2021). Positive results have also been found in studies where problem-solving skills are associated with geocaching for mathematical-based problems or are applied in real-life types of situations (Referowska-Chodak, 2020; Adanalı & Alım, 2019; Zemko et al., 2016).

Scientific studies have found that digital geography games are immersed in a real-world framework. Specifically, the space factor is thought to be quite effective in determining this framework. In other words, the space in the game itself is accepted as the real world. Therefore, the structure of geography games shares the same patterns, nature, and structure as a real-world context. This again allows for the development of skills related to problem solving, perception of space, map literacy and location analysis. Therefore, the results obtained from this study are that Gezgin, the digital geography game, is presented in real-world context such that it is educationally beneficial. There are similar results obtained in other scientific studies that support these findings (Bartoschek & Schwering, 2022; Referowska-Chodak, 2020; Ahlqvist et al., 2018; Zemko et al., 2016; Ahlqvist et al., 2014; Vemuri et al., 2014).

The results of the fourth research question in the study show that the general views about the geography game called Gezgin used in this study are mostly positive but have a few negative aspects. The study found that the game is based on learning techniques that integrate having fun with substantive education. The game is designed according to specific grade levels, contains meaningful problems, contributes to the proficiency and development of students, and supports the use of high-level skills. While the game is unique for integrating some interdisciplinary features, the content it offers is defined and understood to be quite rich. These results are like the results of other studies that evaluate geography-focused applications. (Artvinli & Dönmez, 2021; İneç, 2021; Adanalı & Alma, 2019; Zemko et al., 2016; Melero & Hernández-Leo, 2014; Schwering et al., 2014). The negative aspects of the game that were found are a lack of interaction, function limitations, orientation in problem solving, the inability to diversify the problems and limitations related to the tables, graphs, and diagrams. Since other related studies do not have interdisciplinary features that integrate mathematics and social studies, the results of this study cannot be directly compared with them. Nevertheless, the game allows users to instantly and constantly interact because it is a cloud-based application. This means that tables, graphs and diagrams and other types of features can be changed simultaneously by users. In fact, the function limitations expressed by one of the experts could be a result of the expert not using the cloud technology sufficiently. The content limitations that were observed could be a result of a lack of depth in the content. Since the study analyzed a wide range of the interdisciplinary aspects of its complex structure, it may have limited a deeper exploration of the content.

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Authors

Ömer DEMİRCİ, Erzincan Binali Yıldırım University, Erzincan, Türkiye. E-mail: omer.demirci@erzincan.edu.tr

Zekeriya Fatih İNEÇ, Erzincan Binali Yıldırım University, Erzincan, Türkiye. E-mail: fatihinec@erzincan.edu.tr