



Primary school students' experiences in developing digital stories on environmental issues: An action research

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Abstract

This study explores the experiences of fourth-grade primary school students during the process of developing digital stories about environmental issues. Curriculum-based learning outcomes related to environmental topics were identified, and students were asked to create digital stories aligned with these outcomes. A distinctive feature of the study is that both the story-writing process and the transformation of written narratives into digital formats were carried out entirely by the students. The research was designed as qualitative action research. The study group consisted of 26 students selected through criterion sampling from a primary school. The implementation lasted seven weeks during the 2022–2023 academic year. Data were collected through questionnaires, semi-structured interviews, and researcher observation notes, and were analyzed using descriptive analysis. The findings indicate that the digital storytelling process improved students' imagination and writing skills and fostered positive attitudes toward integrating technology into education. Students reported that they learned to use a new web-based application and that collaborative group work and the presentation phase contributed positively to their learning experience. They also stated that digital storytelling could be applied in different subjects. The results suggest that digital storytelling can serve as an effective instructional tool in primary education, particularly in environmental education. However, due to the qualitative design and limited number of participants, the findings are context-specific and should not be generalized. The study is grounded in constructivist learning theory and frames digital storytelling as a pedagogical approach supporting experiential and differentiated learning.

Keywords Environmental education · Digital storytelling · Action research · Primary education · Collaborative learning.

1 Introduction

Stories are one of the literary texts that children meet at a very early age, enrich their world and vocabulary, develop their imagination and play an important role in the acquisition of values. While concepts and events related to real life are presented in stories, children have the opportunity to examine, analyze and explain events with their own thoughts (Kasapoğlu, 2013). In this context, stories have an important place in child education. For children, telling a complex event with stories activates children's emotions and provides both motivation and meaningful learning (Turgut, & Kışla, 2015). Presenting environmental education with stories helps children recognize the environment, learn concepts related to the environment, and gain awareness of environmental protection. Utilizing stories in the expression of basic concepts and relationships between concepts can be a good teaching method (Demircioğlu et al., 2006). In addition, environmental education given in childhood positively affects children's cognitive development and contributes to their positive attitudes towards science education (Taşkın & Şahin, 2008).

Environmental education is the process of gaining knowledge, skills and attitudes about protecting the environment in order to create environmental awareness in individuals (Erten, 2004). In the world and in our country, environmental education is considered as one of the most important issues for protecting the natural environment, encouraging environmentalist behaviors, solving environmental problems and achieving sustainable development (Demir & Yalçın, 2014; Erten, 2004; Lopez et al., 2023; Sharma et al., 2023; Teksöz et al., 2010). One of the issues that should be emphasized within this importance is how environmental education can be made more effective.

Considering the new generation's interest in technology in environmental education, it is thought that it will be effective to offer enriched learning environments that make students active, where technological tools are used in addition to traditional methods. Technology-supported environmental education positively affects students' attitudes, achievements and behavioral development towards the environment (Karataş & Yıldırım, 2019). As a matter of fact, technology integration in education has become a prominent method in education (Chen et al., 2023). The new generation, whose ability to use technology develops quite early, should move away from being passive in front of the screen and be introduced to new learning environments where they can take responsibility for learning by taking an active position. In their study, Modi & Rahmatullah (2024) integrated digital storytelling into the education curriculum and observed students' participation and learning levels. According to the findings of the study, they stated that digital stories enable students to develop sensitivity towards environmental problems and that this method is more inclusive and interactive than traditional educational approaches.

Raising students who think creatively and critically, know how to access information, and can use technology effectively are among the main goals of new curricula (Seferoğlu, 2015). In this context, information and communication technologies should be integrated into education to provide students with active and creative learning environments and new learning opportunities (Niemi et al., 2014). Digital technologies used in education not only help students develop their knowledge,

skills and competencies but also facilitate the work of teachers (Jobirovich, 2022). Jobirovich (2022) stated that digital technologies facilitate teachers' tasks such as preparing course materials, increasing student interaction and visualising the learning process; they make learning more accessible by diversifying pedagogical styles. Digital story development software is one of the Web 2.0 tools that allow the traditional story writing process to be integrated with technology, where students move from a passive to an active position in the processes of acquiring knowledge, questioning the source of knowledge, restructuring knowledge and producing new knowledge (Elmas & Geban, 2012). Digital story development software contributes to teaching by enabling students to be active in the processes of research, analysis and combining visual images with written text and by developing their creativity (Alismail, 2015). Students' content studies in line with their educational achievements will contribute to their better learning of that subject (Elmas & Geban, 2012).

Digital stories combine technological processes such as audio, video clips, music, and various multimedia tools with traditional story writing processes such as story creation, research, and script writing (Hafner & Miller, 2011; Robin, 2008). While creating digital stories, students develop their knowledge capacities by re-investigating the topic (Alismail, 2015), as well as many of the 21st century skills such as planning, questioning, critical thinking, searching for new solutions to problems and explaining the reasons for their solutions (Niemi et al., 2014). The process of creating digital stories provides students with content knowledge, improves students' technology use, literacy, research and vocalization skills (Karakoyun, 2014) and increases memory capacity (Çıralı, 2014). However, this process also offers a learning environment that can be customised according to students' individual learning styles and preferences. Differentiated learning envisages the adaptation of content, process and product in line with students' readiness levels, interests and learning preferences (Tomlinson, 2017). Digital storytelling is a tool that naturally supports this adaptation: In this context, digital storytelling is positioned not only as content transfer but also as a pedagogical tool that is sensitive to students' learning styles, respectful of their preferences and revealing their creative potential. In this respect, it makes a strong contribution to the differentiated learning approach. Cisneros et al. (2023) stated that game-based storytelling is more participatory and effective than traditional environmental education methods. They also emphasised that highly interactive story content makes users more sensitive to environmental messages and that storytelling increases the emotional and behavioural impact of environmental messages, and that stories not only provide information but also encourage action.

There are many benefits for teachers to use digital stories in their classrooms, but the main benefit is that students are given the task of creating their own digital stories individually or collaboratively (Robin, 2008). It has been stated that students who write their own stories about a subject can realize more permanent learning by using higher level cognitive skills such as synthesis and evaluation (Turgut & Kışla, 2015). Preparing collaborative digital stories also significantly increases students' creative writing skills (Uslu, 2019). Niemi et al. (2014) also argued that collaboration in digital story creation is an important tool as it allows students to learn from others and consider others' perspectives. In addition, digital stories developed collaboratively are longer, more structured and richer in meaning than those developed individually

(Rutta, Schiavo, Zancanaro, & Rubegni, 2020). Digital storytelling increases students' interaction with technology. It supports 21st century skills such as creativity, decision-making and co-operation. Students move from being passive listeners to active producers (Aktaş & Yurt, 2017).

There are studies on digital stories in the literature (Alismail, 2015; Aljaraideh, 2020; Çoruk & Seferoğlu, 2020; Demirbaş & Şahin, 2022; Ertan Özen & Duran, 2021; Karakoyun & Kuzu, 2016; Kocaman Karoğlu, 2016; Küçüköğlu, 2019; Niemi et al., 2014; Rubino et al., 2018; Ulum, & Ercan Yalman, 2020; Uslu, 2019; Yang et al., 2020). However, there are few studies in which primary school students themselves are involved in the story development process (Ayten & Polater, 2021; Bilaloğlu, 2019; Çıralı, 2014; Polater, 2019; Rutta et al., 2020; Uslu, 2019; Yamaç, 2015). However, it has been stated that the studies mostly focus on the digital part rather than storytelling in the educational sense, the goal of individual skill development rather than the workshop process is predominant, and the components of experience sharing are not defined (Şimşek et al., 2018). At this point, it is important to convey the experiences of students at the elementary school level in the process of developing digital stories on environmental issues in this study as it will shed light on future studies. Digital stories support high-level thinking skills even in young age groups (Karakuş et al., 2023). In recent years, digital stories have been reshaped with E-STEAM-oriented approaches by combining with environmental education. Cisneros et al. (2023) developed the Eco-Digital Storytelling (EDS) model to promote environmental action in historically excluded youth groups. Funk (2024) examined the impact of storytelling on cultural sensitivity and behavioural transformation in an Asian context. Modi et al. (2024) developed global citizenship and sustainability awareness through digital stories. Tramonti et al. (2024) evaluated environmental awareness raising through a combination of digital stories and gamification. It is considered important for both students and teachers to convey how technology can be used in education and the experiences experienced in this process. During the study process, it is also expected that students' knowledge about the environment will increase and their achievements will be reinforced. As a matter of fact, it has been observed that the studies on environmental education in primary schools in our country are mostly studies conducted using the survey model to determine attitudes or awareness towards the environment (Ültay et al., 2021). Skanavis & Voutsinos (2018) investigated the effect of digital storytelling method to increase the awareness of students aged 8–12 on recycling, reuse and waste reduction. According to the findings of the study, students' recycling knowledge and environmental attitudes improved significantly. The digital story process increased students' willingness to show behavioural change. In particular, skills such as emotional bonding and creative expression were supported. In this study, which was designed as an action research, students first wrote environmental stories in line with the acquisitions related to environmental issues, took an active role in the learning process and created products by blending them with technology. Although the digital story development process creates a new experience in itself for students at the primary school level, it is important to transfer these experiences as they will shed light on future studies.

In this study, it is aimed to present 4th grade students' development of digital stories about environmental issues and their experiences in this process. While the

study does not introduce a novel technological tool or theoretical model, its original contribution lies in documenting the process-oriented implementation of eco-digital storytelling in the context of primary environmental education in Turkey. By focusing on how digital storytelling is enacted, adapted, and experienced within a real classroom setting, the study provides timely insights into the pedagogical possibilities and constraints of emerging approaches such as EDS and E-STEAM at the primary level. In this sense, the contribution of the study is contextual and procedural rather than purely technological.

1.1 Problem

What are the experiences of 4th grade primary school students in developing digital stories about environmental issues?

How can environmental education be made more effective as a result of these experiences?

1.2 Purpose of the study

The aim of this study is to explain the experiences of primary school 4th grade students in the process of developing digital stories by utilizing technology in lessons and using technology in education through a sample web-based digital story development application on environmental issues. In this context, it is aimed to support students' environmental education with technology and reinforce their achievements unlike traditional environmental education by addressing the environment in the digital stories to be created. Another aim of the study is to provide a guiding tool for teachers in the process of integrating technology into environmental education based on the processes experienced by students.

2 Method

This research is a qualitative study conducted to reveal the experiences of 4th grade primary school students in developing digital stories about environmental issues.

2.1 Research model

In this study, action research design, one of the qualitative research methods, was used. Action research is a research design that is generally planned to reveal how something works rather than proving it; its aim is to solve the existing problem, bring new perspectives and explain how it works (Johnson, 2014). Action research is a process-oriented research design that brings research and practice together and facilitates the transfer of research results to practice (Yıldırım & Şimşek, 2018). In action research, the researcher and participants take an active role in the research process and try to obtain information that will change and improve a certain situation (Büyüköztürk et al., 2020). In this study, application-oriented action research design, one of the types of action research, was used. Since this design is practice-oriented,

the researcher focuses on identifying the problems encountered in the process, the causes and solutions to these problems (Holter & Schwartz-Barcott, 1993, as cited in Yıldırım & Şimşek, 2018). This research is based on the researcher's various experiences as an expert in the field of information technologies and doctoral studies in the field of classroom education. These experiences encouraged the researcher to adopt the action research approach. Especially with the active participation of students in the learning process, producing their own stories and developing creative solutions to environmental problems, action research has become not only a research method but also an intrinsic part of the teaching process.

Qualitative research approach has been preferred as the overarching methodology of action research because it enables in-depth understanding of students' experiences, perceptions and production processes. Especially within the framework of constructivist learning theory, students' discovering their own learning paths and producing content with digital tools are among the basic learning dynamics observed by the researcher (Hong & Lawrence, 2017; Baumfield, 2021). Therefore, the role of the researcher as both practitioner and observer overlaps with the cyclical structure of action research; problem identification, solution development, implementation and evaluation stages are based on direct classroom experiences. This approach strengthens the teacher-researcher identity and increases the authenticity of the research (Stenhouse, 1975; McNiff, 2016). The action research process consists of 5 basic steps. The first is to identify the research question or problem situation, the second is to decide how and how often to collect data, the third is to collect and analyze the data, the fourth is to make an action plan by determining how the findings can be used, and finally to report and present the findings (Johnson, 2014).

2.2 Action research process

Before deciding on the problem situation, which is the first stage of the research, a literature review was conducted and it was seen that the studies on environmental education in primary schools in our country were mostly studies conducted using a survey model to determine attitudes or awareness towards the environment (Ültay et al., 2021), and that studies presenting digital story development experiences were limited (Bilaloğlu, 2019; Çıralı, 2014; Polater, 2019; Uslu, 2019; Yamaç, 2015).

In the second stage of the study, a study plan was prepared by the researchers to decide how and how often the data would be collected and interview forms were developed as data collection tools.

In the third stage of the research, which is the collection and analysis of the data, the questionnaire form was first applied to the students. The researcher kept weekly researcher diary notes and conducted focus group interviews at the end of the application to evaluate the experiences of the students.

The data from the questionnaire form were presented in tables according to frequency frequencies, and the data obtained through focus group interviews were presented through descriptive analysis by coding student names and including direct student discourses.

In the last stage, the data were evaluated and the findings were written and the results were discussed and recommendations were made. Thus, the study report was prepared.

2.3 Study group of the research

This study was conducted with 4th grade students studying in a primary school in Kırşehir province in the 1st semester of the 2022–2023 academic year. A total of 26 students, 13 girls and 13 boys, participated in the study. Criterion sampling, a type of purposive sampling, was employed to determine the study group. In this method, participants are selected based on predefined criteria relevant to the purpose of the research (Büyüköztürk et al., 2020). Accordingly, the study group consisted of 26 fourth-grade primary school students who met the following criteria: a class size of fewer than 30 students, access to personal technological devices such as tablets or computers, and basic technology usage skills. These criteria were established to ensure the effective implementation of digital storytelling activities and to support active participation throughout the action research process. All selected participants met these conditions, providing a suitable context for achieving the aims of the study.

Although the sample size used in this study may seem limited compared to quantitative research, this situation is considered methodologically acceptable due to the nature of action research methodology. Action research is conducted with the goals of contextual depth, participant interaction and action-oriented transformation rather than generalisability (Cohen et al., 2017). Indeed, Kemmis & McTaggart (2000) state that in the cyclical structure of action research, small samples are suitable for in-depth observation and reflection, especially in the context of education. Naughton (2001), on the other hand, emphasises that in action research, it is not the sample size, but the active participation of the participants in the process and the potential to create transformation that is at the forefront. In applications with primary school students, small samples may be more pedagogically appropriate. In this age group, factors such as individual differences, learning styles and emotional development require qualitative depth. Small groups allow students to express more comfortably and the researcher to monitor the process more closely (Longhurst & Johnston, 2021). In this context, although the sample size was limited, the data collection process was supported by multiple tools (interviews, digital story products, observations). The findings were interpreted not only for generalisation, but also for action-oriented development, student-centred transformation and generating examples of practice.

According to Table 1, when the number of students with their own technological devices was examined, it was found that 8 students had computers, 9 students had cell phones, and 22 students had tablets. There were no students who did not own any of these technological tools. Regarding usage preferences, 18 students stated that they use computers, 17 students use cell phones and 22 students use tablets. There are no students who do not use any of these technological tools (students were told that they could choose more than one option).

Findings regarding students' daily technology usage time are given below.

According to Table 2, the majority of the students use technological tools for 0–1 h and 1–2 h a day, while fewer use technology for 2–4 h and only 1 student uses tech-

Table 1 Demographic characteristics of students

		N	%
Gender	Female	13	50
	Male	13	50
Own technological tools	I have a computer	8	31
	I have a cell phone	9	35
	I have a tablet	22	85
	None	0	0
Preference for using technological tools	Computer	818	70
	Cell phone	1717	65
	Tablet	222,222	85
	None	00	0
Total		26	100

Table 2 Duration of students' daily use of technological tools

		N	%
Duration of daily use of technological devices (computer, cell phone, tablet)	0–1 h	10	39
	1–2 h	9	35
	2–4 h	6	23
	4 h or more	1	4

Table 3 Frequency of students' access to the internet

		N	%
Frequency of access to the Internet	Every day	9	35
	1–2 days a week	6	23
	Weekends	10	39
	Not entering	1	4

nology for 4 h or more. Accordingly, it was determined that there were no students in the study group who did not use technological tools and one student used technological tools for 4 h or more.

Findings regarding the frequency of students' access to the Internet are given below.

According to Tables 3 and 9 students go online every day, 6 students go online 1–2 days a week, and 10 students go online on weekends. 1 student stated that he/she does not go online. Accordingly, it is seen that most of the students spend time on the Internet every day or on weekends.

Findings on what students do on the internet are given below.

According to Table 4, almost all of the students stated that they watch videos and play games on the Internet. In addition, 14 of them stated that they did research and 15 of them did homework. Among 5 students, 2 of them stated that they read books, 1 of them painted, 1 of them listened to songs and 1 of them made interviews. Accordingly, almost all of the students mostly watch videos and play games while spending time on the internet (Students were told that they could choose more than one option).

Students were asked about their opinions on stories and digital stories and the findings are given below.

Table 4 What is done on the internet

	N	%
What you do on the Internet	Watching videos	22 85
	Playing games	22 85
	Conducting research	14 54
	Doing homework	15 58
	Other	5 19

Table 5 Story related questions

		N	%
Have you ever written a story before?	Yes	25	96
	No	1	4
Do you know about digital storytelling?	Yes	11	42
	No	15	58
Do you think you can develop a digital story?	Yes	19	73
	No	7	27
Total		26	100

According to Tables 5. and 25 of the students stated that they had written stories before, while only 1 of them had not. While 11 of the students had knowledge about digital stories, 15 of them did not. While 19 of the students stated that they thought they could develop a digital story, 7 of them stated that they thought they could not develop a digital story.

The 11 students who had knowledge about digital stories were asked about the source of their knowledge. It was determined that 2 students learned by researching themselves, 1 student learned from the computer, 5 students learned from online video producers (youtubers), 1 student learned from the phone application and 2 students did not specify where they learned from.

2.4 Data collection tools

In action research, it would be more appropriate to use data collection methods that complement each other as much as possible in order to ensure diversification in data collection in order to achieve more valid and reliable results (Büyüköztürk et al., 2020). In this study, a questionnaire form, semi-structured interview form and researcher observation notes were used to collect data in order to ensure triangulation. The questionnaire form consists of 9 questions to obtain demographic data. The semi-structured interview form consists of 6 semi-structured questions. The survey form questions are aimed at determining the students' experiences and frequency of using technology as well as their knowledge about digital storytelling. The semi-structured interview questions consist of questions that will enable students to make an evaluation of the collaborative work they have carried out. After the semi-structured interview form questions were prepared, in order to ensure the validity of the questions, the questions were submitted to the opinions of a Turkish Language expert, a Classroom Education field expert, a Science Education field expert, a Computer and Instructional Technology field expert and a classroom teacher working at the university. In order to ensure the internal reliability of the study, interrater agree-

ment was calculated using the “agreement/disagreement” formula proposed by Miles & Huberman (1994). The agreement between the researchers was found to be at a reliability level of 96%. The semi-structured interview form, which was submitted to 5 experts, was revised and finalized. During the weeks of the implementations, the researcher kept researcher notes and recorded the observations about the process.

2.5 Action research process

After obtaining the necessary ethical permissions, a face-to-face meeting was held with the school principal and information about the research was given. Then, the class teacher was contacted and the implementation plan was made for 12 class hours, one day a week and two class hours, so as not to disrupt the flow of the lessons.

In the first week of the implementation, the students were met, informed about the research to be conducted and the questionnaire form was primarily applied. What the students should do in the digital story development process was mentioned.

In the second week of the implementation, students were informed about digital stories and examples of predetermined digital stories were shown on the smart board of the classroom. Five collaborative groups were formed by utilizing the data from the questionnaire form and taking the opinions of the classroom teacher. While forming the groups, a balanced distribution was ensured by taking into account the students’ skills such as reading, writing, creativity, and using technology in line with the opinions of the classroom teacher. Taking into account the achievements of the Science course, 5 topics related to the environment were determined and the groups were allowed to choose one topic each. Among the determined topics; recycling, efficient use of resources, the importance of plants and animals, environmental pollution, touristic places in the immediate vicinity.

In the 3rd week of the implementation, students were asked to write stories about the environment related to the topic they chose. Since the desk arrangement in the classroom was not suitable for collaborative work, the desks were transformed into clusters and students were able to work more interactively with each other. Students exchanged ideas by sharing tasks among themselves. Group members determined who would do research on which topic, who would write the story text, and who would play a role in digital design and voice-over. Since there were missing students in the groups and there were differences of opinion among the students, the time given was not enough, (Fig. 1, 2, 3 and 4) the stories could not be completed and the students were given one more week. For this reason, the implementation period planned as 6 weeks was extended by one more week and completed in 7 weeks.

The incomplete stories were completed in the 4th week of the implementation. The stories were checked with the classroom teacher for spelling and grammar and necessary corrections were made. The researcher transferred the stories written by the students on paper to the computer environment. This process facilitated the transfer of story texts to the digital story environment.

In the 5th week of the implementation, the application (storyjumper) to be used to develop digital stories was introduced to the groups separately via a smart board in an empty classroom, and sample stories were created with the students on how to use the application. The groups were called from the classroom one by one to have



Fig. 1 Screenshot of the digital story titled “The Hatchetman and Sino the Squirrel” created by students in StoryJumper



Fig. 2 Screenshot of the digital story titled “5 Friends in Kırşehir” created by students in StoryJumper



Fig. 3 Screenshot of the “Recyclable Wastes” created by students in StoryJumper

a more productive working hour. In this way, students were given the opportunity for the application and were dealt with more closely on a one-to-one basis. Students who could bring tablets or laptops for the following week were asked to bring them with them.

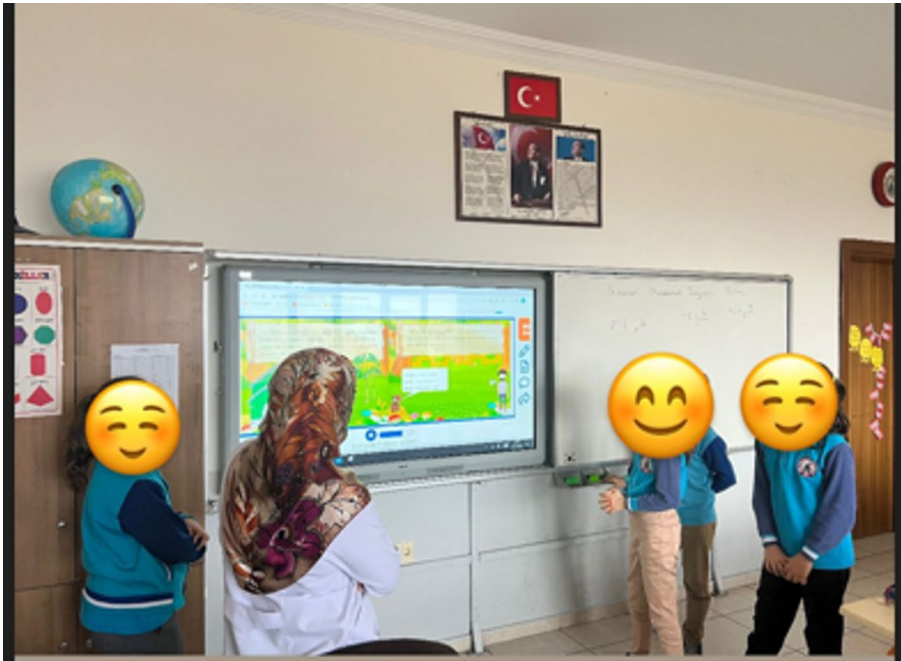


Fig. 4 Classroom implementation of the activity with student participation (photograph taken by the researchers with informed consent)

In the 6th week of the implementation, the groups were called one by one and worked in the teachers' room. The stories, which were first transferred to the computer environment, were checked again with the students and finalized. It was observed that at least one student from each group brought a tablet or a computer. In case the students forgot, the researcher came prepared with two computers, two tablets and a phone. Digital story designs were realized simultaneously with the students. The students first designed the background and then the characters. They copied and pasted the texts from the ready-made file. They enriched the story pages with the objects ready in the application. Finally, the students role-played and voiced their characters. The digital stories were completed with the support of the researcher. Only one of the groups' stories was incomplete due to lack of time and it was stated that it would be completed next week.

In the 7th week of the implementation, the story of the incomplete group was completed and each group was allowed to present their digital stories to their classmates on the smart board. At the end of the implementation, focus group interviews were conducted with the students to evaluate the digital story development process and audio recordings were taken to be analyzed later. Focus group discussions enable students to produce richer and more diverse views by being influenced by each other's ideas. Especially students in the 9–10 age group speak more comfortably in interaction with their peers and feel safer in a group environment (Longhurst & Johnston, 2021). For this reason, focus group interviews were conducted with students using semi-structured interview forms.

Among the stories developed by the students, Sino the Axeman and Sino the Squirrel is related to the learning outcomes “Recognizes the importance of the natural environment for living things (F.3.6.2.5)” and “Understands the importance of plants and animals for human life (HB.3.6.1)”. The digital story The Struggle in the Forest is related to the learning outcome “Proposes solutions by conducting research to protect the natural environment (F.3.6.2.6)” and 5 Friends in Kırşehir is related to the learning outcome “Introduces the characteristics of historical, natural and touristic places in the immediate vicinity (HB.3.5.3)”. The digital story titled Recyclable Wastes is related to the learning outcomes “Recognizes the importance of recycling and the resources necessary for life (F.4.6.1.2)” and “Gives examples of the contribution of recycling to himself/herself and the environment he/she lives in (HB.3.6.6)”. The digital story titled “The Power of Nature” is related to the learning outcomes of “Shows care to be economical in the use of resources (F.4.6.1.1)”, “Makes original suggestions for the effective and efficient use of resources at home (HB.3.2.6)”, and “Uses the resources in the environment without wasting them (SB.4.5.5)” (MEB, 2018).

2.6 Data analysis

The data obtained through the questionnaire form and semi-structured interview form were analyzed using descriptive analysis method. Wolcott (1994) stated that it is one of the ways of qualitative data analysis to present the data to the reader with a descriptive approach by making direct quotations from what the individuals participating in the research said by remaining as faithful as possible to the original form of the collected data (as cited in Yıldırım & Şimşek, 2018). In this study, the data of the focus group interviews with the students were coded as S1, S2 and presented by including direct student discourses. The aim here is to convey student experiences directly. As a matter of fact, Johnson (2014) stated that action research is usually organized to reveal how something works and the aim is to solve the problem, evaluate it and explain how it works.

2.7 Theoretical model

The Digital Story-Based Environmental Awareness Development Model (DHTÇFG) developed in this study addresses primary school students’ technology access, digital literacy level, cooperative learning attitude and environmental awareness levels with cognitive, affective and behavioural dimensions. The model allows students to be positioned as both content producers and solution-oriented learners of environmental problems in the digital storytelling process. At the same time, it supports the measurement of experiential gains in the process and their transfer to educational practices.

2.8 Ethical approval of the study

In this study, all the rules specified to be followed within the scope of the “Directive on Scientific Research and Publication Ethics of Higher Education Institutions” were complied with. None of the actions specified under the second section of the Direc-

tive, “Actions Contrary to Scientific Research and Publication Ethics”, have been carried out.

Ethics committee permission information name of the ethics committee Ahi Evran University Social and Human Sciences Scientific Research and Publication.

Ethics committee date of ethical evaluation decision 02.03.2023.

Ethical evaluation document number number Decision No: 2023/02/12.

2.9 Competing interests

The authors did not receive support from any organization for the submitted work.

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

3 Findings

In this part of the study, the focus group interview data obtained from the semi-structured interview form and the observation notes kept by the researcher regarding the process are included. In the Results section, the findings are presented descriptively through direct student quotations, observation notes, and tables, without interpretive commentary. Interpretations and connections to the literature are intentionally reserved for the Discussion section.

3.1 Findings from the semi-structured interview form focus group interviews

3.1.1 What was your role in the group while creating a digital story? Answers to the Question

According to the interview results regarding the students’ roles in the group while developing digital stories, the students stated that they made a division of labor before writing a story, and that they determined who would do what and which character they would vocalize by sharing tasks. In this context, instead of including the opinions of each student, the statements of the students who expressed different opinions were included and presented below.

S3 from Group 1: “First of all, we assigned tasks among ourselves. Then we shared the topics we were going to investigate. We all investigated our topics one by one, and then we combined what we did in order.”

S2 from Group 3: “First we wrote a story, then we gave up writing it. We started again with my friends. Then we decided who would voice what. Then we finished the story.”

S1 from Group 4: “First, we shared our thoughts, then we divided the work among us. We decided who would research which topic and who would vocalize whom.”

3.1.2 Did you have difficulties developing a digital story? If yes, at which stage did you have the most difficulty? Answers to the question

In the process of developing a digital story, some of the students stated that they did not have any difficulty in creating a digital story, while others stated that they had some difficulty. They stated that they were excited during the process, and that they had difficulty in the stages of finalizing the story, vocalizing it and doing research on their own topics. Student statements are given below.

S3 from the 2nd Group: “I had difficulty in doing research and vocalization.”

S2 from the 3rd Group: “I was a little excited during the vocalization stage, my heart felt like it was going to burst.”

S1 from the 4th Group: “Yes, I had difficulty, I had the most difficulty while doing research and writing the story.”, while S3: “Teacher, now there is writing and thinking. It took some time to reveal what we thought, so it was difficult to write.” He expressed his opinion by saying. S5 said: “The beginning of the story was easy, but it was difficult to find the end.”

3.1.3 Which stage of the digital story development process did you like the most? Why? Answers related to the question

When students were asked which stage of the digital story development process they liked the most and why, they stated that they liked the stages of story writing, research, presentation, voice-over, character and background design and working with their friends the most in the story development stage.

Student statements are given below.

Group 1 S1: “For me, the most beautiful stage was story writing and research. I did research in my free time, I learned new information. I liked the story writing stage the most.”

Group 1 S2: “Teacher, I liked the presentation stage the most, because we made our friends learn new things.”

Group 2 T1: “I liked the vocalization stage the most. When we vocalize, we both show our voices to ourselves and we take part in the story.”

Group 2 S4: “I liked working with my friends and working as a group more.”

Group 3 S1: “I liked writing the story the most, and I liked transferring the story to the computer the most.”

Group 3 S3: “It was also very nice when we chose our characters, for example, we thought about what kind of person the owl should be, the owl is a scholar, it was exciting to find someone like him.”

Group 4 S1: “I liked designing the background very much and it was nice to write a story.”

They expressed their opinions as follows.

3.1.4 Would you like to develop digital stories in different courses? Responses to the question

When the students were asked whether they would like to develop digital stories in different courses, they stated that digital stories can be used in other courses, that they would like to develop digital stories for different courses, and that digital stories for Science, Social Studies, Turkish, Religious Culture and Moral Knowledge, Visual Arts and Mathematics courses can be developed. Student statements are given below.

S5 from the 1st Group: “I think digital stories can be used in mathematics lessons, the subjects can be explained in a simplified way.”

S2 from the 2nd Group: “We can use them in Turkish, art and mathematics lessons.”

S3 from the 4th Group: “I would like to create a digital story about the effects of force in science lesson.”

3.1.5 What kind of benefits did this study bring to you? Answers related to the question

When the students were asked about the benefits of the study, they stated that in the process of developing a digital story, they gained knowledge about the scientific knowledge and achievements within the scope of the story, learned new vocabulary and a new web-based application. In addition, they stated that their imagination and writing skills improved, they learned to work collaboratively with their friends in the process and they had fun. Student statements are given below.

Student expressions indicating that they learned the relevant achievements: “First of all, we learned about the resources in nature.” (Group 1 S1), “We learned to use our resources and nature efficiently, our knowledge increased.” (Group 1 S2).

Student expressions expressing that they learned a new web-based application: “Teacher, we have learned that we can write stories with such an application on the computer.” (Group 1 S3) “We have learned digital stories and a new application.” (Group 5 S2).

Some of the students expressed that they learned to work collaboratively, “I learned to work together with my friends in the group, I learned solidarity.” (2nd Group S1), “We shared tasks in the group, we learned to work together in the group, but I wish we had chosen our groupmates ourselves.” (4th Group S3).

Student expressions indicating that their imagination developed: “It contributed to us, my imagination was weak, my imagination improved when I wrote a story.” (3rd Group S4), “We wrote a fable, we made animals talk and used our imagination.” (3rd Group S5).

Different from these, student expressions are as follows: “I revealed my own skills and it was very useful for myself. That’s why I am proud of myself.” (Group 2 S2), “Our writing skills improved.” (Group 3 S2), “We learned new words.” (Group 3 S3), “We had fun, we laughed, it was nice to work together.” (Group 4 S1), “We

also learned to vocalize, we learned to work in cooperation.” (Group 4 S2), “We learned to write stories, we watched the presentation of other friends and learned new things.” (Group 5 S1).

3.1.6 How did this study change your perspective on environmental issues?

Answers to the question

When asked how the students’ perspectives on environmental issues changed within the scope of the study, the students stated that their knowledge about the environment increased; they became more conscious and sensitive about recycling, environmental pollution, protecting the environment and animals, and the use of resources, as well as getting to know their immediate environment better. Student statements regarding the findings are given below.

S4 from Group 1: “We have become more conscious about recycling, we throw leftover paper into recycling bins. We try to use paper economically, we don’t waste it in vain.”

S1 from the 2nd Group: “For example, I did not know the Japanese Garden before writing the story. I learned about it.”

S3 from Group 2: “I didn’t know Ahi Evran Mosque very well. After writing the story, I went to visit it with my mother and saw it closely.”

S5 from Group 2: “After this activity, we became more conscious about the environment, we should protect our environment better. For example, we waste our energy. We may run out of energy in the future. For example, there is a drought this year. What will happen if we run out of water? We will be without water, we should use our water resources efficiently. We should not pollute our waters.”

S4 from Group 3: “When cutting trees, animals’ nests should not be harmed, even if trees are to be cut down, dry trees should be cut down.”

S5 from Group 3: “We should not leave electronic devices on and go away, we should turn them off. Because the water in the dam is decreasing, and when the windmills rotate too fast, they can kill birds in the air. We should not consume energy in vain, we should use it efficiently.”

S5 from Group 4: “We learned how wastes are recycled. For example, we saw what is produced when waste glass is recycled. Both our knowledge has increased and we have a more positive attitude towards the environment.”

S1 from Group 5: “My perspective did not change, I was already protecting the environment, I already knew these things.”

S2 from Group 5: “I knew the places in Kırşehir, I knew them, nothing changed.”

S3 from the 5th Group: “Our knowledge increased, but we already knew, we only learned a new application, we also made a vocalization, we had never done it before.”

3.2 Researcher observation notes

Week 1: It was observed that the students were very excited to do an application related to technology, and the idea of bringing a tablet or computer to school excited them a lot. While explaining the steps of digital story development, it was observed that the students were most interested in transferring the story to digital media and were impatient.

Week 2: While determining the student groups, the students stated that they wanted to choose their groupmates themselves, but it was explained that the class teachers would form the groups so that the group levels would be balanced. Similar dissatisfaction was experienced in the distribution of environmental topics. Although more than one group wanted to choose the same outcome, they were guided that they should choose different outcomes in line with the purpose of the research.

Week 3: It took a lot of time to set up the order in order to provide a cooperative working environment. Students worked quite noisily while making division of labor. Some students put themselves forward as group leaders, which led to differences of opinion. Since there were missing students in the groups, the stories could not be completed in the allotted time, and it was stated that the stories could be completed at appropriate times with the support of the class teacher.

Week 4: The stories written with the class teacher were checked for spelling and grammar. It was observed that the transitions between paragraphs in the story were sometimes disconnected and were revised and edited with the students.

Week 5: In the previous weeks, some chaos occurred in the classroom because the class was crowded and the students were excited. In order to deal with the students one-on-one, to answer their questions in more detail and to prevent confusion, the students were called to an empty classroom in groups and one-on-one applications were made to the students via the smart board and the program was introduced in detail.

Week 6: Since the planned time was not enough and in order not to disrupt the lessons, students were again called in groups and it was decided to work in the teachers' room. Since some of the tablets brought could not be connected to the school internet network, the students were connected to the internet with the researcher's personal internet. In the digital story design phase, although there were difficulties in the selection of characters, backgrounds and objects due to differences of opinion, the most appropriate ones were decided jointly with the group. During the vocalization phase, students made incomplete or incorrect readings because they were excited, and repeated recordings were made. During the recording, sometimes the bell and sometimes the sound of people entering the teachers' room caused sound pollution in the background. Since there was not enough time to complete the story of only one of the groups, it was decided to complete it next week.

Week 7: First, the story of the missing group was completed and each group presented their digital stories to their classmates on the smart board. Although there was some confusion about who would make the presentation, the problem

was solved by reminding the task sharing. At the end of the implementation, focus group interviews were conducted with the students in the guidance room to evaluate the digital story development process and audio recordings were taken.

4 Discussion, conclusion and recommendations

In the light of the findings obtained from the study, it was observed that students mostly use technological devices such as computers, tablets and mobile phones for watching videos and playing games, and their usage time varies between 0 and 4 h. According to 2021 data from the Turkish Statistical Institute, it was determined that students mostly attended online classes (due to distance education during the pandemic), did homework or research, played and downloaded games, watched videos, and made audio or video calls over the internet (TÜİK, 2021). In a 2014 comprehensive study conducted in Finland, Greece and California, it was stated that students use the internet more actively such as video editing, making simulations and animations, composing and editing music, and designing computer games (Niemi et al., 2014). In the study conducted by Svenningsson et al. (2021), it was stated that there are significant relationships between the cognitive, affective and behavioural components of students' attitudes towards technology; especially individual interest and access level shape attitudes. In addition, the research conducted by Andrew et al. (2018) revealed that students' preferred digital tools (e.g. tablets vs. laptops) affect their interest in the learning process and their perceptions towards technology.

It was observed that the majority of the students had no knowledge about digital stories, but all of them completed digital stories during the study process. Among the students who had knowledge about digital stories, it was seen that most of them learned digital stories from online video content producers (youtubers). When the number of students who thought that they could develop digital stories was analyzed, it was seen that 19 of the students thought that they could develop digital stories and 7 of them thought that they could not develop digital stories at the beginning of the study. It is thought that students' interest in technology is effective in completing digital stories. Similar to the findings of this study, Niemi et al. (2014) also stated that students had no previous experience in their digital story development study.

When the students were asked about their roles in the group while developing digital stories, they stated that they made a division of labor before writing a story, determined who would do what by sharing tasks, and determined who would voice which character while doing voice-over. In the literature, it is seen that the role sharing of the students in the digital story development process of the groups is similar (Niemi et al., 2014; Küçükoğlu, 2019). Kouklatzidou & Gkountouma (2015) created a recycling-themed interactive digital story with 3rd grade students. The students wrote the story, designed and voiced the characters and created the digital application. They mentioned that the students assumed the roles of both narrator and listener, which made the narrative process more interactive.

Some of the students stated that they had difficulties in the stages of completing the scenario, doing research on their own topics and vocalizing. In the studies in the literature, it was observed that similar difficulties were expressed, learners

experienced stress during the implementation processes due to the short duration and therefore the scenario could not be implemented, they had difficulty in writing the story because they did not know the story topic (Ayten & Polater, 2021; Çoruk & Seferoğlu, 2020) and they were afraid of failure (Ulum & Yalman, 2020).

At the story creation stage, students stated that they liked the stages of story writing, research, presentation, vocalization, character and background design, and working with their friends the most. It is seen that the results of the studies are similar (Ayten & Polater, 2021; Çoruk & Seferoğlu, 2020; Karakoyun, 2014). There are also studies on the vocalization stage that reveal that students are happy to hear their own voices (Yüksel, 2011; Ulum & Yalman, 2020). According to student opinions, the digital story process was stated as interesting, fun and instructive. The most challenging step was the “story creation” stage (Aktaş & Yurt, 2017). Alevli (2023) stated in his study that the digital story writing process was defined as fun, interesting, practical and creative by the students. In addition, it is among the findings in the literature that some students did not like creating a story board, vocalizing and using the digital story application, and some students found the activities boring in general (Karakoyun, 2014).

Students stated that digital stories can be used in other courses and that they would like to develop digital stories for Science, Social Sciences, Turkish, Religious Culture and Moral Knowledge, Visual Arts and Mathematics courses. When the studies on the subject are examined, there are also studies indicating that digital stories can be used in History, Science (Karakoyun & Kuzu, 2016; Robin, 2008); Mathematics (Robin, 2008), Turkish, Painting, Music courses (Karakoyun, 2014).

It is also reported in the literature that students develop better verbal skills with the use of digital storytelling techniques and that this technique can be considered as an important tool in foreign language learning and teaching (Razmi et al., 2014; Sever, 2014). In his thesis study, Olur (2021) stated that digital stories increase the active participation of students and make learning more meaningful and permanent. In addition, digital story production increased students’ self-confidence and expression skills. It was stated that technology-supported narration supports both individual and social development. Digital storytelling is a good tool for teaching English to foreign students, especially at the elementary level, and it has an important role in the process of improving students’ English language learning skills (Aljaraideh, 2020). They also mentioned that skills such as critical thinking, collaboration, digital literacy and creative expression were supported. At the end of the study, it was stated that students became more conscious about recycling and environmental protection, and that the process increased students’ self-confidence and creative expression skills. It was stated that the project process supported students’ critical thinking, problem solving and cooperation skills. Teachers observed positive changes in students’ environmental attitudes and digital storytelling was found to be more effective than traditional environmental education methods (Kouklatzidou & Gkoutouma, 2015).

Students stated that they gained knowledge from digital stories, learned a new application and how to work collaboratively with their friends, and were able to develop their own skills. In addition, they stated that their imagination and writing skills improved, they learned new words, and they had fun. Ulum & Yalman (2020) examined the interview results in their study and stated that students learned the

subjects better with digital stories, thought that their learning would be more permanent, improved their research skills, and learned by having fun. Digital story creation tools enable children to tell stories with their own voices and increase the sense of authenticity and ownership (Karakuş et al., 2023). Perez, Martinez, & Pineiro (2016) concluded in their study that collaborative digital storytelling improves creativity skills in students and that the digital story creation process contributes to the development of creative thinking and social skills and encourages student motivation and digital literacy. In addition, students who create digital stories increase their creativity, problem solving, writing, communication, presentation, use of technology, cognitive high-level thinking capacity, perspective development, critical thinking, empathy skills and motivation (Turgut & Kışla, 2015). As a result of their experimental study, Aktaş & Yurt (2017) stated that students who learnt with the digital story method showed significantly higher success than those who learnt with the traditional method. The motivation of the students in the experimental group for learning increased significantly. The information learned with digital stories was more permanent in the retention test conducted 30 days later.

Beyond the descriptive associations between digital storytelling and the observed outcomes, the findings may be interpreted through underlying pedagogical mechanisms. The increased student motivation and collaboration can be explained by the multimodal and student-centered nature of digital storytelling, which allows learners to actively construct meaning, assume roles, and negotiate ideas within their groups. Similarly, the reported challenges related to time management and group dynamics may stem from students' limited prior experience with open-ended, project-based learning environments. In this sense, the outcomes observed in the study reflect not only the effectiveness of digital storytelling itself but also students' adaptation to a more participatory learning structure.

Research findings show that students develop positive attitudes towards the environment. However, it is open to discussion whether these attitudes are solely due to the digital storytelling process or whether they are influenced by other factors such as students' home environment, parental attitudes, cultural values, and out-of-school learning experiences and should not be ignored. Digital storytelling allows students to express their personal experiences of the environment. This process supports students' emotional connection with the environment and empathy towards environmental problems (Robin, 2008). In addition, research and group discussions during story production can positively affect attitudes by increasing the level of environmental knowledge (Sadik, 2008). Students' attitudes towards the environment are largely shaped by the environmental values of their families. Environmentally sensitive behaviours of parents serve as models for children and increase their environmental awareness (Meeusen, 2014). Especially at an early age, practices such as recycling and energy saving at home are effective in children's development of responsibility towards the environment (Masykuroh et al., 2022). Children's perception of the environment is also closely linked to the way the society they live in relates to the environment. Cultural values determine the ways of interaction with nature and the importance given to the environment (Marouli, 2002). Community-based environmental education enables children to interact directly with the environment. Informal

learning experiences such as park trips, recycling projects and local environmental activities reinforce students' attitudes towards the environment (Mintoff et al., 2023).

According to the findings obtained from the observation notes regarding the digital story development process, it was observed that the students were very excited to make an application related to technology. It is thought that students' positive attitudes towards technology enabled them to enjoy this process and facilitated the process. Başar (2022) examined how the digital stories he prepared in his study affected the academic achievement, attitudes towards the course and learning motivation of 3rd grade students. Students in the experimental group showed higher achievement than the control group. Digital stories increased students' interest in the course and their desire to learn. They developed more positive attitudes towards science course. According to student opinions, digital stories were found to be fun, interesting and instructive. Students stated that they could associate what they learnt with daily life. In addition to this, it is seen that there are contrary situations in the literature. Karakoyun & Kuzu (2016) stated that 6th grade students were reluctant to develop digital stories, found digital story lectures boring, copied scenarios from the internet, and did not do the activities at home.

While determining the student groups, a balanced distribution was created in line with the opinions of the classroom teacher. It was observed that the students wanted to choose their groupmates themselves and were not satisfied with this situation. As a matter of fact, Şimşek et al. (2008) also emphasized the importance of forming heterogeneous groups as much as possible by taking into account the academic achievements and various individual characteristics of the students while forming cooperative groups and underlined that students will not be allowed to form their groups according to their own wishes according to their sincerity.

One of the dissatisfactions experienced by the students was the distribution of environmental topics. A topic was distributed to each group in order to reinforce the gains of environmental issues. However, there were also students who were not satisfied with the topics because there were differences of opinion within the group. At this point, conducting digital story studies on the topics of their own choice in line with the gains will contribute to student motivation.

The desk arrangement in the classroom is not suitable for collaborative work environments. There are studies in the literature on the importance of collaborative work environment. It has been stated that in order for group members to work effectively and efficiently in collaborative group work, attention should be paid to ensure that group members are close enough to look eye to eye (Şimşek et al., 2008). For this reason, a cluster order suitable for collaborative work was created. It took a considerable amount of time to create the order.

The students were quite noisy in their division of labor, and some students even put themselves forward as the group leader, which led to disagreements. It was reported that participants tried to express their own arguments while trying to understand the point of view of other group members during group discussions, and although they had some difficulties in overcoming disagreements, they ultimately learned to work as a team and enjoyed working as a team (Chen et al., 2023). It was mentioned that students' motivation to work with others should be taken into consideration before

forming cooperative groups (Klein, 2000). Similarly, in the current study, the opinion of the classroom teacher was sought.

In some weeks during the study, the stories could not be completed in the allotted time due to students' absenteeism. Therefore, extra time was given to the students. It is thought that time constraints can be avoided by bringing students together in online environments, students can continue their studies outside of school, and these will contribute positively to the process.

In the introduction phase of the program to be used, the groups were called to an empty classroom in turn and student questions were dealt with one-on-one in order to avoid confusion and to better understand the application to be made, considering the class sizes. In the following weeks, students were called in groups and worked in the teachers' room. During the vocalization phase, a quieter place was needed and empty classrooms were preferred.

At least one student from each group brought a tablet or computer. Some tablets did not have an internet connection, so tablets and computers were used together. It was observed that some students were more passive and each student was allowed to perform the application steps in turn.

There were disagreements within the group when deciding on story titles and designing characters and backgrounds. There was confusion about who would make the presentation in the role distribution. It can be ensured that each student takes an active and different role with more studies to be conducted on other courses and achievements.

In this study, the experiences of 4th grade students in the process of developing digital stories about environmental issues were presented. Although this study does not aim to offer a comprehensive theoretical model for interpreting digital storytelling in environmental education, it contributes to the field by providing a detailed, practice-oriented analysis of an authentic classroom implementation. The Eco-Digital Storytelling (EDS) model is referenced as a guiding pedagogical structure rather than as an analytical lens, and the findings are therefore interpreted within the immediate educational context of the study. From this perspective, the study is positioned as an exploratory action research case that informs educational practice and innovation, while recognizing that deeper theoretical integration and model-based analysis remain important directions for future research. In the light of the findings obtained from the study; in future studies, digital story development studies can be conducted at different grade levels and addressing different achievements. Since digital stories contribute to students in many ways, it is recommended that teachers include such studies in their lessons. It is thought that strengthening the technological infrastructure and opportunities of schools will be beneficial for the utilization of technology in education. Criticism or evaluation of student products by their peers can be useful in the emergence of better products. Despite the methodological strengths of the study, several limitations should be acknowledged. First, the small sample size, which is typical for qualitative action research, limits the generalizability of the findings beyond the specific educational context. Second, the absence of a control group restricts the ability to make causal comparisons regarding the effectiveness of digital storytelling. Instead, the findings were interpreted through analytical comparison with relevant literature. These limitations are considered inherent to the exploratory

and practice-oriented nature of action research and should be taken into account when interpreting the results.

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Declarations

Competing interests The authors declare that they have no competing interests.

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