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eTwinning in Science Learning: The Perspectives of Pre-service Primary School Teachers

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Abstract: eTwinning is a community of European schools that promotes networking and transnational collaboration projects. Therefore, as part of the Initial Teacher Education (ITE) initiative, we decided to explore how the research projects on scientific topics familiarize pre-service primary school teachers with eTwinning. 251 pre-service primary school teachers from Spain, Iceland, and Slovenia designed and carried out joint research projects on scientific topics. The aim was to gain insight into their self-assessment of their knowledge of the platform, the limitations of working with it, and their responses. An electronic questionnaire was used as the main instrument for data collection. It turned out that the pre-service teachers enjoyed this international collaboration, but also found it challenging. By the end of the projects, they were familiar with the eTwinning platform, although the least engaged prospective teachers recognized that they needed strong support and considered the platform a non-intuitive environment. Overall, they were willing to use the platform with pupils in the future, which is in line with the aim of the ITE initiative.

Keywords: *Collaborative research, eTwinning, ITE initiative, teacher training.*

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Introduction

eTwinning and the Initial Teacher Education (ITE) Initiative

eTwinning is a European platform for collaborative projects across countries, cofounded under Erasmus+, the European programme for Education, Training, Youth, and Sport. The eTwinning network includes almost all European and some external countries, and it provides a platform for staff (teachers, head teachers, librarians, etc.), working in a school in one of these associated countries, to communicate, collaborate, develop projects, share and, in short, feel and be part of a live learning community in Europe (Gilleran, 2019; Pham et al., 2012). The platform makes it safe for educators to connect, develop collaborative projects, exchange ideas and promote digital literacy (Demir & Kayaoğlu, 2022; Gajek & Poszytek, 2009; Vuorikari et al., 2011). It aims to enhance teachers' and students' technical, language and intercultural skills, ultimately contributing to European identity formation (Papadakis, 2016).

Since 2012, eTwinning has been running an initiative involving Teacher Training Institutions (TTI) from several European countries. This former TTI initiative has been called ITE - Initial Teacher Education - since January 2021. The TTI initiative (now ITE) aims to incorporate eTwinning into initial teacher training as a complementary strategy to engage trainee teachers and in the long run embed eTwinning in schools worldwide. The ITE initiative allows several types of collaboration: I) within a class, simulated eTwinning projects; II) involving only trainee students; and III) involving school students guided by a trainee (for example during school placement).

This article describes a study with a type II project (trainee-trainee) involving pre-service primary school teachers from Iceland, Slovenia, and Spain. The collaborative sequence included a research project that implied real scientific research on issues that were likely to vary with latitude and required joint data collection and sharing results across regions.

As such, this joint research effort served a dual purpose. First, and in line with the overall aim of the ITE initiative, to familiarize students with the platform and its affordances for transnational online collaborative projects. Second, to

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expose students to a real research scenario that could serve as a meaningful context for collaboration in eTwinning with international peers.

Contribution of eTwinning to Teacher Development

eTwinning contributes to the enhancement and development of global education through intercultural interaction and equips students with twenty-first-century skills, such as collaboration and communication (Camilleri, 2016). Indeed, in-service teachers who have led eTwinning projects often describe them with words such as cooperation, exchange, technological development, and innovation. But, apart from these benefits on the side of the students, eTwinning projects have also a positive impact on teachers' professional development (Başaran et al., 2020). According to the European Commission (n.d.):

> The contribution of eTwinning in initial teacher training provides discovery and implementation of project teaching and multidisciplinary work; development of ICT and language skills; European, international, intercultural experience; development of professional skills (project management, setting goals, planning, teamwork); reflection on professional practice; and exchanges with teachers from other education systems.

Besides, it provides possibilities for teachers' social and professional interaction; eTwinning action contributes significantly to teachers' professional development by fostering quality improvements, innovation excellence, and internationalization at the level of education (Camilleri, 2016).

Indeed, a growing number of examples demonstrate that introducing eTwinning into the training of student teachers brings significant benefits to them and their institutions (e.g., Gajek & Poszytek, 2009; Papadakis, 2016; Tonner-Saunders & Shimi, 2022). As reported by these authors, significant benefits for trainee teachers in using eTwinning can come from the immersive experiences of communication and collaboration in online environments. In terms of professional development, most of the trainee teachers interviewed in the study by Kostas and Ioannidou (2023) agreed that opportunities to develop ICT and metacognitive skills were provided during the eTwinning seminar.

Collaboration Skills

Teachers are increasingly expected to participate in collaborative networks, as sustained interaction between groups of teachers is a key form of professional development (Lantz-Anderson et al., 2018), so effective professional learning is increasingly acknowledged to involve teachers in sharing knowledge and experience with others – particularly in the form of participation in a network of teachers as reported by The Organization for Economic Cooperation and Development (OECD, 2014). These groups and networks provide a source of "knowledge [that] is situated in the day-to-day lived experiences of teachers and best understood through critical reflection with others who share the same experience" (Vescio et al., 2008, p. 81), and allow the participants to co-create pedagogical understanding and build didactic strategies (Lantz-Anderson et al., 2018). Specifically, teachers who participate in collaboration networks are reported to be more motivated and positive and experience greater efficiency, improved communication, enhanced technological skills, and reduced personal isolation. Instructional strategies become more student-centered, and alignment between real and hidden curricula increases (Vangrieken et al., 2015), and tend to implement active teaching practices involving projects, group work, and the use of new technologies (Macià & García, 2016; OECD, 2014). At the organizational level, reported benefits include improved perception of the school climate, which is more often seen as supportive of innovation, better adapted, and more innovative; it is also associated with a cultural shift toward greater equity, school-wide attention to students' needs and a flattened power structure that fosters a professional culture of intellectual inquiry (Vangrieken et al., 2015).

In addition, student teachers are not intensively trained in the pedagogical use of collaborative learning for their future teaching practice, so student teachers may avoid collaborating during their learning process itself. However, they should develop soft skills during their training (Huda SA et al., 2021). An example of this is eTwinning projects that require collaboration and provide a scenario that encourages meaningful collaboration and contributes to the development of this skill.

Communication Skills

Effective communication skills are also competencies central to profiling good teachers. Teachers use public speaking, small and large group discussions, storytelling, and interpersonal communication skills daily, in a variety of communication exchanges with students, other teachers, administrators, and parents. These skills, in turn, help teachers facilitate learning, manage the classroom, and make decisions. This reinforces the idea that teachers should be trained in all of these relevant communication areas (Johnson & Roellke, 1999). Again, eTwinning projects both foster and depend on effective communication, thus providing a relevant arena for teacher training in this dimension.

The above-mentioned professional learning efforts, which may emanate from self-initiated Personal Learning Networks, may or may not involve mobility activities, but are increasingly likely to occur in an international setting. Moreover, more and more European countries emphasize English language learning in schools and set language requirements for

teachers, making international collaboration schemes even more attractive. Nevertheless, student teachers whose native language is not English experience feelings of inadequacy and anxiety when they use English (Tum, 2012). Indeed, although many of them have language certificates, they are scarcely functional in terms of being able to teach in this language (Woolston & Osório, 2019). Considering the potential negative impact of such feelings on learning and teaching and overall teacher well-being (Fathi & Derakhshan, 2019), measures must be taken to create a non-threatening environment within our teacher education programs and help student teachers overcome their feelings of anxiety before their teaching careers (Tum, 2012).

This may include participation in projects and extended encounters with opportunities to use the English language to communicate authentically with students from other cultural backgrounds and with similar difficulties in using the English language (Lázár, 2015).

Digital Competence

Technology has become increasingly important in our lives, with a high potential to enhance learning and transform education. Like other professionals, teachers have gained increased access to digital tools, media, and digital resources in recent decades, which in turn influences how students and teachers interact and engage with learning (Burden et al., 2016; Krumsvik et al., 2016; Nguyen, 2024).

However, the integration of information and communication technology (ICT) into the educational infrastructure requires that curriculum structures and materials, teaching practices, and assessment models are redesigned at all levels (Livingstone, 2012). This also includes the empowerment of teachers, as this technological context requires them to have a high level of technological knowledge to develop their work (Fernández-Batanero et al., 2022). In addition, the innovative work behaviour of teachers is also positively and significantly influenced by digital competence (Sary et al., 2023).

One of the most widely accepted ICT Competency Framework for Teachers (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2023) emphasizes, in line with other frameworks such as DigCompEdu (Redecker & Punie, 2017) that students and teachers should be able to be creative and effective content producers, and be able to share, communicate and collaborate using ICT. That encompasses capacities in five broad domains that the European Union identifies as necessary for active citizenship and long-life learning (Ferrari, 2013). Teachers are also expected to integrate ICT to leverage their professional and educational competences, as well as to promote students' digital competence (Redecker & Punie, 2017).

However, teachers usually report just mild levels of digital competence, that would just allow for technology appropriation, but not innovative or transformative practices involving ICT (Krumsvik et al., 2016). While most teachers are proficient in using basic software (basic commands, Word processors, spreadsheets, slide presentations), their mastery of other skills is limited. In particular, they fall significantly behind in problem-solving and content creation using technology (Napal Fraile et al., 2018). For example, they show limited knowledge of apps necessary for the construction of instructional materials or appear as knowledgeable about the tools and the skills but are not confident in their use (Bayucca, 2020). In addition, although they may know the routine for searching for information, they cannot find professionally-relevant information in specialized sources, such as thematic websites or portals of resources (Walraven et al., 2009). Furthermore, newly qualified teachers report rather scarce and poor-quality ICT training during their teacher education, and many had negative experiences of ICT in the classroom (Guðmundsdóttir & Hatlevik, 2017).

All things considered, training teachers in ICT implies professionalizing their figure, incorporating desirable professional competencies to optimize their professional performance (Michos & Hernández-Leo, 2020), and this involves actions ranging from incorporating ICT into the trainee curriculum to providing significant experiences with ICT (Khan, 2014). Notwithstanding the importance of improved knowledge of tools to encourage the use of technology (Harris et al., 2009), the focus should be on classroom implementation, including aligning the dimensions of pedagogy and content knowledge to effectively build trainee teachers' Technological Pedagogical Content Knowledge (TPACK) (Tan et al., 2019).

In this respect, eTwinning is part of the European policies and strategies to help teachers become digitally aware (Aksu & Reisoğlu, 2023; Cîmpean & Bocoș, 2022) and increase their competence level, as it requires the teachers to create search or curate contents; manage learning scenarios; use tools to scaffold interaction and communication; and take care of students' privacy and personal data.

Specifically, the study by Huertas-Abril and Palacios-Hidalgo (2023) reports on the improvement of language teachers' digital skills through eTwinning activities. Acar and Peker (2021), based on interviews with in-service teachers from different subject areas, found that eTwinning activities contribute to their professional development and collaboration. Moreover, the platform makes a great contribution to the teachers, both personally and professionally.

As our study was also affected by the pandemic, we also consulted the study by Delen et al. (2021), which describes the challenges faced by eight primary school teachers running eTwinning projects before and during the pandemic. In addition, the transition to online learning posed several challenges for teachers. Teachers stated that their support for the design decreased during the pandemic, and they preferred to support their students in face-to-face lessons. The

pandemic also decreased the connections between the teachers and the supporting group, which affected the quality of the students' work (less creativity, less interdisciplinary thinking in the design products, lower attention span, etc.).

Preparing Science Teachers

As advanced in the previous paragraphs, the proposal will deal with collaborative research on selected science topics, with the aim to also contribute to training high-quality primary science teachers. This endeavour has long been one of the major foci of science education reforms (American Association for the Advancement of Science [AAAS], 1994; National Research Council, 2012; Next Generation Science Standards Lead States, 2013).

Many pre-service teachers enter college with limited knowledge of science content and an inadequate understanding of many science topics (Tekkaya et al., 2004). This could be partly due to majority access to teacher training programs from specializations in social sciences and humanities, or from gymnasium programs with different orientations (Eurydice, 2018; Şengül et al., 2008), but also due to experiences related to science during school years (Garraway-Lashley, 2019).

This precludes developing an identity as science teachers (Yoon et al., 2006), as pre-service teachers' beliefs about science serve as a lens through which they build their professional projections (Burden et al., 2016). A study by Menon and Sadler (2016) showed that prospective elementary teachers' initial levels of self-efficacy beliefs vary at the beginning of a specialized science content course and that these beliefs can change positively as the course progresses because self-efficacy beliefs and the development of science conceptual understanding are interrelated.

As for digital competence, content knowledge is a vital component of good science teaching: research suggests that teachers need accurate, deep, and rich science knowledge to teach effectively and that deep knowledge gained through rigorous, advanced academic study provides a solid teaching background (Kind, 2009). However, evidence indicates that this background is necessary but not sufficient alone to ensure good classroom practices, as teachers also need to acquire pedagogical knowledge to make science accessible to students through 'school science' (Arzi & White, 2008). Teachers need to take ownership of their teaching, as teaching is a highly interactive process influenced by the context. Teaching cannot be programmed down to the last detail - or teaching machines and programmed learning envisaged decades ago would have begun to replace teachers (Taber, 2014).

However, this means that training teachers themselves must be exposed to learning situations where they have the opportunity to deepen their knowledge, enhance their skills, and nurture their pedagogical insights (Kang et al., 2013; Lewis, 2019). Going through these experiences encourages teachers to try different things with their students as well (Forbes, 2013).

In summary, the literature shows a significant improvement in teaching development through the use of the eTwinning platform in both digital literacy and communication skills. However, most of the research has focused on in-service teachers' development, particularly in foreign language teaching. On the contrary, there are few research studies involving pre-service teachers and the samples are limited (Huertas-Abril & Muszyńska, 2022; Huertas-Abril & Palacios-Hidalgo, 2023; İzgi Onbaşılı et al., 2022; La Marca & Gulbay, 2021). In this way, İzgi Onbaşılı et al. (2022) also suggested that the studies should be conducted with pre-service teachers who have no experience with eTwinning.

Objectives of the Research

In this research, and in the context of an immersive experience in eTwinning, which included a collaborative research project, we aimed to answer two research questions:

1. To what extent has the experience improved the trainee teachers' knowledge of the pedagogical affordances of the eTwinning platform?
2. What were the main barriers to practical implementation?

Methodology

Participants

The project is a collaboration between three countries, using the eTwinning platform. A total of 251 students from the University of Ljubljana (Slovenia, n=86), the University of Iceland (Iceland, n=53) and the Public University of Navarre (Spain, n=152, from three different classes) participated. All were studying the Bachelor's Degree to become teachers at primary levels (Spain and Slovenia) and lower secondary levels (Iceland: compulsory education 6-16).

The participants had no previous contact. Most of them had an intermediate level of competence in English (Table 1). Regarding technology, 61% of respondents had a high level of self-reliance in the use of devices such as computer and phone; they had mild previous interest in science (56%) and in the educational use of ICT (62%), and slightly higher in learning about people in other countries (78%).

In terms of technological availability, 86% of respondents had a good internet connection at home and as many as 96% owned a device (tablet, laptop or computer for personal or shared use excluding smartphones).

Table 1. Background Information of the Participants.

	n[a]	%
Country		
Spain	111	49
Slovenia	76	33
Iceland	42	18
Gender		
Male	55	24
Female	174	76
Age (median, range)	20 (19-44)	
First contact with eTwinning (level)		
In the school	7	3
In the secondary	5	2
Never before the project	217	95
Science as a specialization in secondary		
No	141	61.6
Yes	87	38
Other	1	0.4
Level of English skills		
Written		
Basic	57	25
Intermediate	115	50
Advanced	57	25
Oral		
Basic	64	28
Intermediate	107	47
Advanced	58	25

[a] Figures are based on 229 answers to the background questionnaire (91% of the sample).

Design of the Intervention

The project spanned 6 weeks, taking into account the agenda of each of the countries involved. The project was divided into different phases, each with specific activities and learning objectives (Table 2). Students in each country were divided into 15 groups that gathered in mixed clusters consisting of one group per country.

Table 2. Schedule by Phases, Including Activities and Learning Objectives.

Phase	Date	Objective	Learning objective
I. Nice to meet you!	WEEK 1	Ice breaking, getting to know each other	Communication in online communities
II. Sorry, may I ask you a question?	WEEKS 2 - 3	Research question, experimental design	Writing good research questions Variables, procedures and methods
III. Data, data, data! Recording and sharing Analysing the results	WEEKS 4 - 5	Gathering data Sharing data Basic representation and statistical analysis	Recording, storing and representing data (tables, graphics, basic statistics)
IV. Let me show you something	WEEK 6	Presenting results in scientific posters or videos	Instructions and tools for [interactive digital] scientific posters or videos

Phase I. Contact - Nice to meet you

As an ice-breaking activity, students shared some photos from their country related to science. They could show natural phenomena, scientists at work, industries, etc. The objective was to familiarize them with the platform and make them think about nature and science in their respective countries.

Phase II. Design of the research - Sorry, may I ask you a question?

In this phase, the groups defined the research questions in several steps that aimed to break down the process of asking questions and make it explicit for the students. Students were prompted to propose science topics of their interest within each of the broad themes (biodiversity, physics, climate, and weather) that might be conditioned by latitude and that could be affordably studied during the time of the project. The research questions were revised after a class discussion on the characteristics of good research questions (for school) (Sanmartí & Márquez Bargallo, 2012).

Then the groups had to reformulate the exact research question, define the research design and create a video to share the question and protocol with the other countries in the cluster (Table 3). The Icelandic group were all given the same research question and data collection to facilitate the alignment of the eTwinning project with the course objectives.

During that week, students had to check out their partners and contact them using tools embedded in the platform. The videos and data collection prompts were posted on the TwinBoard for the phase, and students were encouraged to use these embedded tools or the external tool Meeting Words to contact their partners if they had trouble collecting data. Each group was expected to collect data for the other groups in their cluster so that all of them would end up with data from all three countries.

Table 3. Specific Research Questions and Experimental Design. One Example per Country.

Country - cluster	Topic	Question	Methodology
Spain - group 2	Birch phenology	How does latitude influence birch phenology?	Monitor 5 birches in a park for 11 consecutive days. Randomly select 3 branches in each, count the number of buds and record the maturative stage (using a key provided). https://youtu.be/JRbbmhCwE4I
Slovenia - group 15	Weather	How does latitude influence weather (temperature, clouds)?	During 7 days record information about precipitation, cloud cover, temperature and the main cloud type in the sky.
Slovenia - group 2	Astronomy - Moon phases	How does latitude influence Moon phases?	During 7 days observe the Moon, draw a phase, and measure the elevation angle and luminosity.
Iceland - all groups	Weather	How does latitude influence weather (temperature, precipitation, cloud formation)?	During 7 days record information about precipitation, cloud cover, temperature and the main cloud type in the sky.

Phase III. Data, data, data!

In this third phase, students were prompted to collect and share the requested data in a collaborative document that could be accessed by all members of the cluster and was visible to the rest of the participants. Some specific scaffolds were provided, to ensure the quality of data collection (Figure 1).

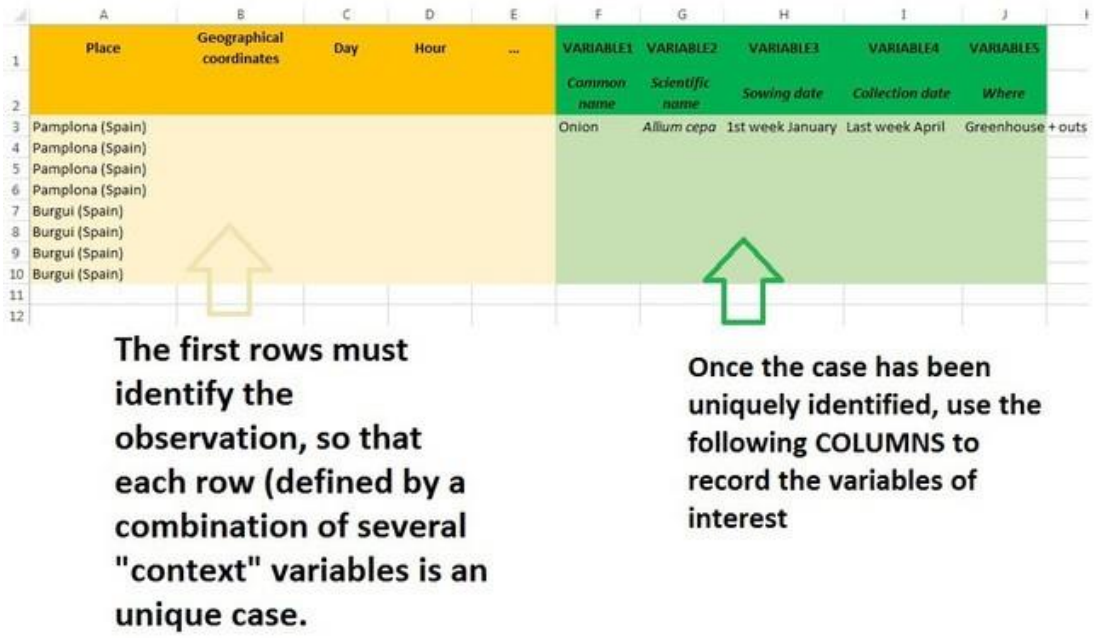

Figure 1. Template for Data Collection.

Subsequent steps included analysis of the data collected. Although each of the groups worked closely with their teachers, some background information was given on how to get a clear and clean data set, basic statistics, and basic data representation.

Phase IV. Let me show you something

In the final stage, the students had to prepare a presentation of their results to be uploaded on the eTwinning platform. They were asked to create an interactive poster, an infographic, or a video, although many of them opted for PowerPoint presentations.

The best presentations from each country group, judged by the responsible teachers, were invited to present their work in a synchronous live event.

The criteria for selecting the best posters, videos or PowerPoint proposals were the quality of the research question, the soundness of the data collection process, and the diversity and coherence with the evidence of the conclusions reached. In some of the groups, technical quality was also considered.

Phase V. Evaluation of the proposal

The evaluation of the proposal included questions about the prospective teachers' perceptions of the eTwinning project, the learning attained, and their expectations to use eTwinning projects in their future teaching roles. The instrument is described in the next section.

Research Instrument

The questionnaire was delivered via Google Forms and was mandatory. In total, 229 of the responses were complete and valid (91%).

The questionnaire included 16 items divided into four sections (background information (8 items), general views about the project (2 items), learning from the project (4 items), future intentions (1 item), and a final question to add free comments. Background information provided contextual information about previous interests and training as well as the availability of technology; general views about the project inquired about the satisfaction with the different activities and the dynamics of the projects; learning from the project focused on learning gains in terms of pedagogical use of eTwinning, collaboration and scientific skills; finally, the question about future intentions referred to the possible use of eTwinning in professional practice.

Two items were open-ended questions and 14 were closed-ended items consisting of a choice from a list of adjectives or adapted to a 4-point Likert scale. The open-ended questions were coded and then categorized using an inductive approach. i.e., the researchers identified emergent topics (e.g., requisites for effective communication, difficulties found, opportunities of an online international experience, personal experience, etc.), and then chose keywords that expressed shared meaning (i.e., for first hard experience - hard/difficult, challenging, rewarding …). Responses were jointly ranked,

and tags and categories were jointly created by two of the researchers, working together, and conflict classifications were further discussed until full inter-rater agreement was achieved, which implies that inter-rater agreement was 100%.

All questionnaires were delivered in English, the language of interaction during the project, but students also had access to a translation into their mother tongue, in case of doubt.

To ensure content validity, the questionnaire was revised by three experts in science education who checked the items for sufficiency, clarity, coherence, relevance and pertinence. The evaluators were selected because they were knowledgeable about the topic, due to their academic background and their professional experience. The items were revised in successive rounds, until the three experts agreed on their quality.

Intending to supplement the information collected via the questionnaire, we conducted a semi-structured interview with students at different levels of engagement to limit bias in student responses: high engagement with good results in poster/video presentations (n=3), high engagement but mild results (n=1), medium engagement (n=1) and low engagement (n=2). Although we had planned to interview 15 students (3 categories of engagement in 5 groups of students), only seven students responded to our call, probably due to the COVID-19 situation, final exams, and asynchronous schedules between countries. The interviews served to enrich and get a deeper insight on the perspectives conveyed through the questionnaires.

Results

Although the aims of the study were to determine the extent of pre-service teachers' knowledge of the pedagogical affordances of the eTwinning platform and the barriers to its practical implementation, we can report at the outset that the students successfully completed all project tasks: 37 scientific posters, 14 videos and 9 PowerPoint presentations were submitted as final reports of the research projects. Overall, 27% of the posters and videos were of high quality, 55% of medium quality and 18% of low quality. The detailed evaluation of the scientific knowledge and scientific skills acquired in the eTwinning project *Science Across Europe* is not the subject of this paper. Below you will find the results of the study with regard to the research questions posed.

Learning About eTwinning

Considering the 229 valid responses to the final questionnaire, 95% of participating students had never had any contact with eTwinning during their school years (Table 1).

According to the student's responses, 49% of them liked the project (agree and strongly agree; Figure 2). 60% found it easy to work with the technology to perform the project and 45% understood what was expected of them. About 70% of the students felt that they worked well and cooperatively.

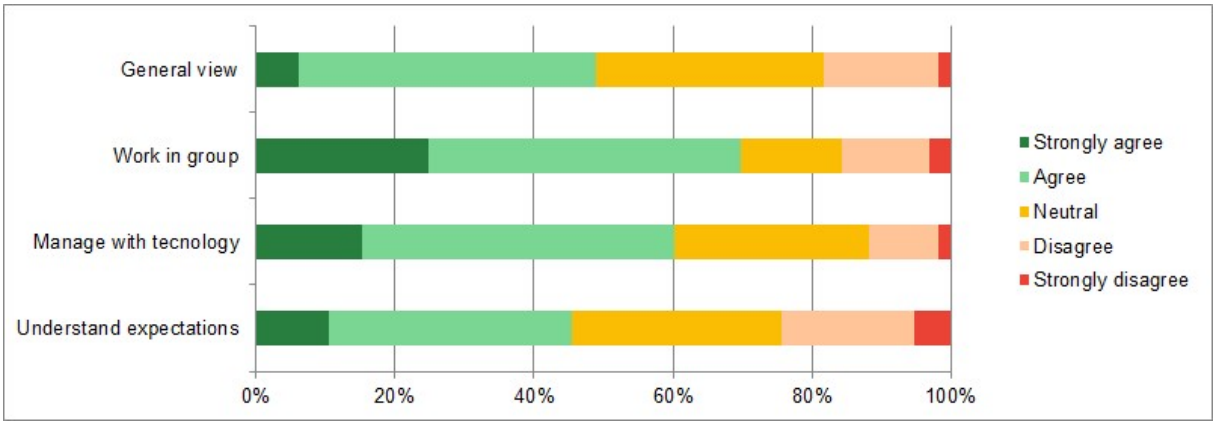

Figure 2. Percentage of Students' Agreement on Categories Related to General Views of the Project.

Skills cannot be learned without reference to a context (Howard & Aleman, 2008), and so our context consisted of tasks related to the scientific method.

When analyzing these different tasks, students considered that ice-breaking activity and posing questions were the easiest tasks (51% and 45% respectively); collecting data, compiling results, and creating the video/poster were mainly considered time-consuming tasks (41%, 37%, 39%, respectively). Finally, as many as 34% rated presenting the results in the live event as the most enjoyable task (Table 4).

Table 4. Percentage of Students That Assigned Each Adjective to the Different Tasks of the Project.

Tasks	Easy	Enjoyable	Too time-consuming	I learned a lot
Icebreaking activity	51	32	14	15
Posing question online	45	18	25	20
Designing the methodology	30	17	31	30
Collecting data and sharing them	23	22	41	30
Compiling results and communicating them	24	20	37	37
Creating a video/ a poster to communicate my results	19	29	40	29
Presenting my results in the live event	31	34	23	18

One of the goals of ITE is to familiarize students with eTwinning; with this in mind, we asked them specifically about the knowledgeability of the platform after the project. 58% of the students (considering those who agree and strongly agree) could explain what eTwinning is, and over 47% of them said they knew how to use TwinSpace. Regarding other eTwinning tools (TwinLab for continuous training, eTwinningLive for interaction with the community) we found that students hardly used them (21%) (Figure 3).

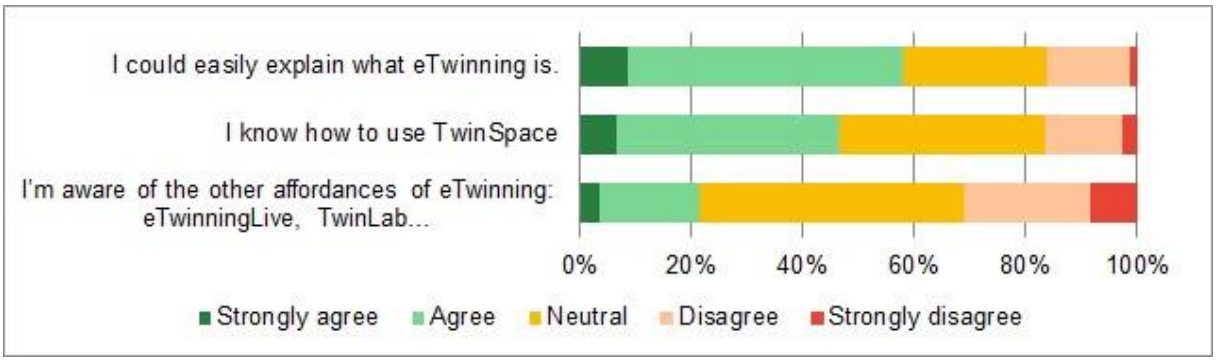

Figure 3. Percentage of Students' Agreement on Categories of Knowledgeability of eTwinning.

Learning in eTwinning

eTwinning, which was primarily intended to foster transnational communication and collaboration, also has great potential to increase other transversal or soft skills.

Considering other transversal knowledge acquired through project development, such as nature, culture or social issues, 63% of pre-service teachers (considering 'a lot' and 'some' categories) stated that they had learnt about the nature of their country, and 59% about the nature of the other two countries. A lower perception was attained concerning culture and other aspects (49%) (Figure 4).

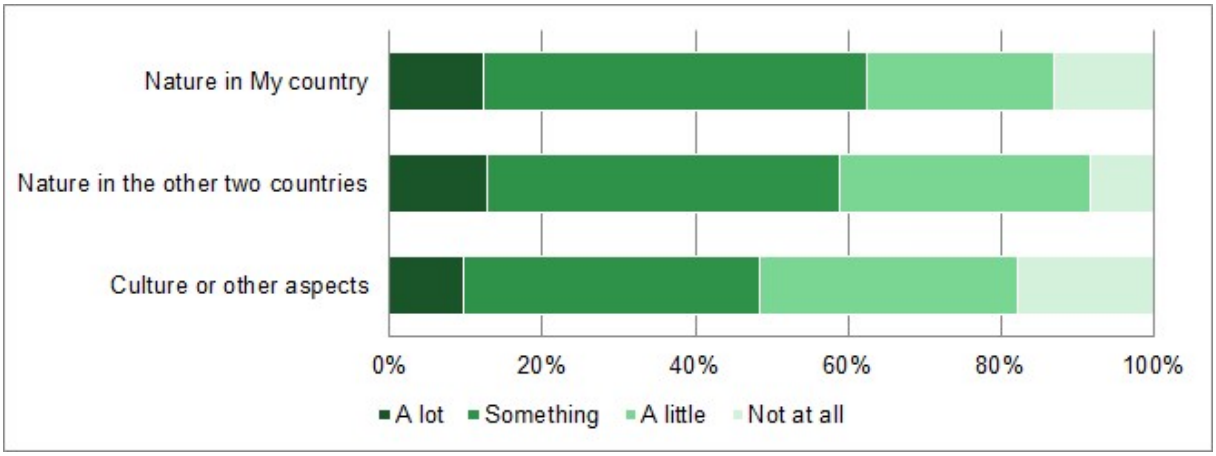

Figure 4. Percentage of Students' Agreement With the Items Related to Learning of Transversal Issues.

Participation in eTwinning projects may have a positive impact on trainee teachers' ability to communicate and collaborate online. Students considered that online communication and collaboration were 'hard' (31% and 20%, respectively). Of those who pointed to communication, 23% reported that they recognized the importance of effective communication and 41% of giving clear instructions when working in groups. Of those who talked about collaboration, around half of the students used positive adjectives, such as useful, enjoyable, fun (45%), and 52% stated that they learned to collaborate.

The ultimate goal of the ITE, and thus of the projects carried out within it, is to shorten the lag for using eTwinning when trainee teachers reach a school. After participating in this eTwinning project, 46% of the pre-service teachers would like to try eTwinning with their students in future, and 31% would like to participate in other similar projects as part of their teacher training. Only 29% had an idea for a prospective eTwinning project with students (Figure 5).

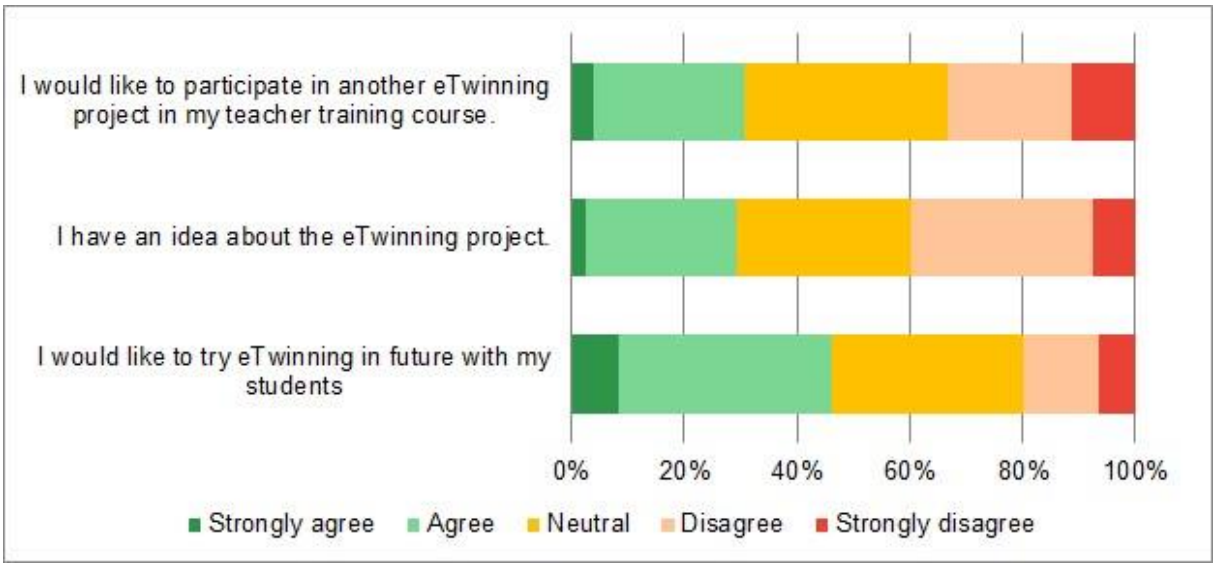

Figure 5. Percentage of Students' Agreement with the Statements on Future Uses of eTwinning.

As final remarks, 42% of the students who answered the open-ended question (n=55 valid answers) were grateful for the project. 24% mentioned that the COVID-19 pandemic was a high obstacle to the development of the project, and 15% mentioned the difficulties of collaboration between some groups.

The semi-structured interviews confirmed that students liked the project (5 out of 7 interviewees), mainly because it brought them into contact with foreign people. The following excerpts illustrate some of their answers (HE: highly engaged student; ME medium engaged student; LE: low engaged student).

(HE) 'You meet new people, broaden your horizons, and make new friends.'

(HE) 'Yes, I like the project because we interacted with foreign people even though it was online.'

(ME) 'In a way, I liked it because I gained some new experiences: how to keep in touch with students from another country.'

In the interviews, some students also mentioned that the project allowed them to learn science through an active methodology.

(LE) 'I like it because it was a different way of learning. We did a really scientific work which is different from traditional exercises.'

Most of them also highlighted that working in groups was challenging but also enriching. Common difficulties were the pandemic situation and the English language, although they recognized that an eTwinning project was a good opportunity to improve their English language skills.

(HE) 'I think one interesting thing is that communicating with people from other countries, in addition to performing a science project, you can improve your fluency in a foreign language, and you can work on two things at the same time. For me, this is something attractive about the platform.'

The greatest difference between high (HE) and low-engaged (LE) students was their perception of the difficulty of using the platform. Highly engaged students considered that the platform was easy to use; however, Low engaged considered it was too difficult, and required too much time to handle. As a result, highly engaged students would use eTwinning in the future, while low engaged students expressed mixed views about engaging in collaborative projects.

(HE) 'For executing this project successfully it was really important that we were familiar with how TwinSpace works. We spent an hour in class learning about posting on TwinSpace, sending messages, and so on.'

(HE) 'I think TwinSpace is well organized. I've been checking the different spaces and I consider that it is easy to browse through it.'

(LE) 'As a platform, eTwinning seems confusing to me, which bothers me [...] Once it took 1 hour to find where and how to submit data. [...] Would you like to lead a project with your (future) students? Of course, but I don't think I would choose eTwinning to start it.'

(LE) 'Honestly, we had problems. In my group, only one member had access to the platform; we don't know why the rest of the group couldn't get into the project; it was a mess because he was the only one who could upload things and that forced us to coordinate more. [...] I'm sure that in my future work as a teacher I would lead an eTwinning project.'

From the interviews, it can be concluded that the HE students involved emphasize more positive aspects than other students (ME, LE), although all of them expressed that they enjoyed doing something different (eTwinning activities) and improving their language skills. However, the LE students had difficulties with the platform, which was also reflected in their project work.

Discussion

The main research questions were to what extent an immersive experience with eTwinning, which included a collaborative scientific research project, impacted on the trainee teachers' self-assessed pedagogical knowledge and the technical affordances of the eTwinning platform, and what the main barriers to practical implementation were.

First, we would like to emphasize again that for the majority (95%) of the pre-service primary school teachers eTwinning was the new environment and that the presented research fills in a way the gap mentioned in the study by İzgi Onbaşılı et al. (2022).

Approximately half of the students liked the eTwinning project, and this positive evaluation was attributed to both the topic (learning science through active methodologies) and to the opportunity to develop transversal skills, such as communicating and collaborating remotely, as noted in previous studies (Camilleri, 2016) in a language other than their mother tongue. As such, the eTwinning project was found challenging but enriching by the participating trainee teachers.

From the participants' perspective, the eTwinning project was useful for learning in several ways. First, and although not the primary focus of this paper, students acquired basic knowledge of the steps and procedures of the scientific method. Indeed, it was science activities (asking questions, collecting data, etc.) where students found the greatest learning gains (even if they were not necessarily the most fun). Many prospective teachers who have not followed a science specialization in Secondary School have only very basic knowledge and therefore lack confidence in teaching science (Murphy et al., 2007). In turn, the best way to learn science is to practice the different ways of doing, talking and thinking about science in the classroom and consistently the students interviewed valued the opportunity to participate in the research project. Moreover, the results of this study, which deals with the improvement of the pre-service teachers' knowledge of the pedagogical affordances of the platform, are in line with the conclusions of the study by Acar and Peker (2021), in which in-service teachers from different subject areas report on the contribution of eTwinning to their professional development and collaboration as well as to their personal development.

Another remarkable outcome was improved knowledge of how to communicate and collaborate remotely with foreign people. This was not just about new tools for online communication, but also practical tips to follow (e.g., clarity in instructions, timely follow-up, etc.). Indeed, up to 47% of students reported that they worked well together (cooperatively), despite the limitations imposed by the lockdown and suspension of face-to-face activities.

This shows some challenges in implementing eTwinning projects with trainee primary school teachers due to the pandemic, which are related to the communication and collaboration issues also highlighted in the qualitative study by Delen et al. (2021) with 8 primary school teachers who explored eTwinning experiences and challenges in projects before and during the pandemic. Similar to us, it was found that connections between participants decreased, which affected the quality of students' work to some extent, despite their best efforts.

Moreover, the live event was the most motivating and enjoyable activity (despite the lack of confidence in English). And yet, students faced noticeable barriers to communication (it was rated as "hard" in the open-ended questions and emerged strongly in the semi-structured interviews). The regular teaching profession requires one to be able to communicate and collaborate with peers, and even teachers are increasingly expected to participate in professional development networks (Vangrieken et al., 2015), but very often they feel uncertain about how to behave outside the confines of their close community (Tum, 2012). Considering that many students pointed out the difficulty of having to communicate in a foreign language (Aichhorn & Puck, 2017), it might be helpful to expose pre-service teachers to situations where English is a medium and not an end in itself, thus focusing on communicative intent rather than action. For many of these students, this was their first opportunity to use their English for authentic communication. As reported

in Lázár (2015), despite the learners' initial communication difficulties, by the end of the project the participants had an increased understanding of how to communicate successfully with people from different cultural backgrounds.

Finally, it can be stressed that this project helped the students to acquire basic knowledge about the platform (49% of the students reported that they understood what eTwinning is, and 40% knew how to use the TwinSpace). This is relevant - especially considering that this project was inserted into the ITE initiative and thus one of the main goals was to get students acquainted with eTwinning - and suggests that this initiative can indeed help to shorten the lag between first employment and starting to use the platform. More than half the participants said they would use the platform in the classroom and some even had ideas for potential eTwinning projects. Accordingly, the pre-service teachers themselves stated that they had developed the specific digital skills, as reported in other studies (Huertas-Abril & Palacios-Hidalgo, 2023; Kostas & Ioannidou, 2023).

Outside the direct scope of the study's research questions, but nevertheless an interesting finding, is that learning about culture and nature was more modest in other countries and at home, although this could be attributed at least in part to COVID-19-related mobility restrictions, including the complete lockdown and closure of schools and public places during the time of the project.

Nevertheless, the initiative was far from reaching its full effect on all participants, for several reasons. First, the level of autonomy granted: students were expected to work largely independently of their teachers, although there were frequent deliveries to control and scaffold progress, as this can be challenging even for undergraduate students (Kaur et al., 2020). This is of concern in the current scenario of increasingly virtual or hybrid learning scenarios that require a high degree of agency on the part of learners (Simonson et al., 2019).

A second reason may be found in the structure of the platform. One of the most salient features of TwinSpaces is that they are intended as safe contexts for interaction between underaged schoolers, where no personal data is revealed or shared. However, this advantageous attribute also makes them not very functional for live communication, especially when compared to other alternatives that are widely used among youngsters (e.g., Facebook, WhatsApp, Instagram, etc.). Some of the groups found it much more convenient to contact their mates via one or various of these apps, and it is not unlikely that younger participants would end up doing the same. To avoid this potential leakage of personal data, it would be advisable to make the interaction tools in eTwinning (online meetings, chats, direct messages, forums) more flexible and, above all, to offer the possibility of linking them to personal e-mail so that new events can be more easily noticed.

It must be conceded that the difficulties in collaboration and coordination mentioned above could also be attributed to intrinsic features of the activity. In fact, following the scientific method was challenging for the participants, most of whom (62%) had not specialized in science during secondary school, so identifying independent, dependent, and control variables; identifying, collecting and arranging data; specifying experimental conditions and so on were intrinsically very demanding activities (Herranen et al., 2019; Schmidt & Fulton, 2016). Science processes often imply a specialized, precise technical vocabulary, whose meanings may differ from everyday denotations (Polias, 2016; Wellington & Osborne, 2001), so codifying (putting experiences into words) or de-codifying (understanding written instructions) implies for students a two-fold process of translation (Dewi et al., 2020).

Indeed, the activities involving scientific skills (hard skills) were found to be the most difficult and time-consuming, while the rest of the general activities (farewell or connection activities) were found to be the easiest and most enjoyable. This is one of the features that made this project special: while the vast majority of projects in eTwinning are dedicated to language teaching and interaction in foreign languages, *Science across Europe* focused on scientific investigation. This can also be understood to mean that the acquisition of scientific skills is more demanding than the connection activities, which also served to familiarize students to a certain extent with the eTwinning platform.

Over 60% of students coped well with technology and over 85% had a good internet connection, so material conditions did not appear to be limiting for trainee (and presumably in-service) teachers (Falloon, 2020).

Despite these difficulties, this initiative proved effective in facilitating the future implementation of eTwinning projects, as more than 50% of participants were keen to enroll in another project in the future, and yet some students (especially the least engaged) showed reluctance to future applications, mainly citing the difficulties they had experienced. This highlights the permanent dichotomy that afflicts trainee teachers, in their dual role as trainee teacher and student (Kang et al., 2013), two roles that are inextricably linked and difficult to disentangle. In this case, it became apparent that there is a need to understand and learn to use the platform (as students) before they can feel eager and ready to take it to school (as teachers), and this presents an additional challenge for trainers: to propose to the students' activities that are achievable as students, and thus neither discourage nor deflect them, while also being relevant as future teachers (Melville et al., 2008). However, teachers implement in the classroom what they have experienced, and the approach has been meaningfully presented and explored in the context in which it is later introduced, so it is a difficult task that teacher educators face to bring about change in pedagogical practice.

Conclusions

The paper presents an eTwinning project, in which pre-service primary school teachers conducted collaborative research projects and assesses the extent to which the experience improved their knowledge of the pedagogical possibilities of the eTwinning platform and what where the main barriers and challenges to its practical implementation.

All in all, our results show that the objectives of the project have been successfully achieved, especially in terms of familiarizing trainee teachers with eTwinning, as formulated in the research question of the present study, making them aware of the possibilities of the platform for fostering collaboration between schools and motivating them to incorporate it into their routine teaching, which is in line with the objectives of the TTI/ITE initiative (Gilleran, 2019; Tosi & Baptista, 2023). It should be said that their responses in the questionnaire showed some improvement in their knowledge of the pedagogical aspects of the eTwinning platform and that they indicated to a considerable extent that they were aware of the platform, as they expressed the intention to include eTwinning activities in the classroom as well.

Obstacles to implementation were also identified, namely in the area of communication.

The main positive and negative points of the proposal are summarized in Table 5.

Table 5. SWOT Matrix of the Project

	POSITIVE (+)	**NEGATIVE (-)**
INTERNAL	STRENGTHS	WEAKNESSES
	Increased motivation	Lack of confidence/ barriers with English
	Realistic, significant	Workload (tolls of the project) that compromise scientific activity
	Other interests: culture, knowing other people that can increase the appeal	Limited science content knowledge and low scientific skills development.
	Purposeful (learn to do science): a means, not an end	Distance learning[a]
	Adoption of a new platform	
EXTERNAL	OPPORTUNITIES	THREATS
	International collaboration	Usability of the platform
	Opportunities for future interaction	Organizational issues: Not perfectly overlapping schedules, oversized or unbalanced groups, limited time.
	Training in other areas (language, digital competence)	Evaluating student work: alignment of assessment with the curriculum.

[a]*Due to COVID-19, the number of contact hours at the faculty was limited.*

Recommendations

Based on the research findings of this study, which relate to improving trainee teachers' knowledge of the pedagogical affordances of the eTwinning platform and the obstacles to its practical implementation, there are some practical considerations/recommendations that may be useful to ensure a satisfactory and effective eTwinning experience in order to achieve higher levels of expertise of the pre-service teacher, namely for practitioners (host teachers):

- Be specific about instructions and deadlines, to facilitate maximum agency and regulation on the part of the student.
- Balance the presence of follow-up and farewell activities: they imply an increased workload (toll of the project) involved but can be the most fun and, thus, a source of pleasure and motivation.
- Make it as interactive as possible: The importance of video conferencing to get to know individual teachers and group members.
- Have pre-service teachers work together from the beginning, in mixed groups.

To minimize the barriers in the practical implementation of the eTwinning platform and projects, we suggest that pre-service teachers receive introductory training on how to use the platform and its features through case demonstrations and in real-time face-to-face where all participants are familiar with the obstacles. In addition, the context of successful implementation of eTwinning projects in other subject areas (not language) and regular live meetings of participants could also be helpful.

Other suggestions concern the improvement of the eTwinning platform, which in the study carried out comes to the fore as an obstacle to a more fruitful practical implementation. It is therefore suggested to the managers:

If the platform was originally conceived for Primary schoolers – it is worth expanding to accommodate older students (Secondary and even Vocational Training or undergraduate); it might be useful to redesign it to be more intuitive, flexible, and easier to integrate with external tools for communication and collaboration. In particular, the chat and videoconferencing tools for live interaction are barely functional.

It would, therefore, be worthwhile supplementing the presented study and repeating it under regular conditions in order to determine the knowledge acquired about the eTwinning platform and, moreover, the development of scientific and digital skills.

Limitations

The conduct of the research during the COVID-19 period and the method of data collection partially limit the conclusions.

Ethics Statements

All the participants of this investigation were informed of the objectives of the same and agreed with participation. Likewise, all data have been anonymized, guaranteeing the privacy of the participants.

Conflict of Interest

The authors declare no conflict of interest.

Authorship Contribution Statement

Napal-Fraile: Forming initial ideas, conceptualization, methodology, formal analysis, writing-original draft, supervision. Zudaire: Methodology, formal analysis, writing-review & editing, visualization. Pétursdóttir: Methodology, formal analysis, writing-review & editing. Pavlin: Forming initial ideas, conceptualization, methodology, formal analysis, writing-original draft, final editing, supervision.

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