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How to shoe an elk? Teachers' reflections on creating a glocal learning community

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Abstract

This design-based case study aimed to depict how teachers facilitate and experience the design-oriented process of creating and teaching in a glocal learning network. The participants in this case study were volunteer teachers from Finland and the United States who designed and implemented glocally-relevant learning projects together with their students. The qualitative data consisted of teachers' interviews supplemented with project reports and students' digital artifacts. The deductive content analysis indicates that the enabling of the glocal community and utilizing technology supported the creation of interest-driven inquiries and reciprocal connections with peers and external expertise. While the teachers perceived how the students could develop novel skills and connections in glocally-networked activities, an apparent need to develop the collaboration between the teachers and the global peers was also recognized.

Keywords: Technology-enhanced learning, Connected learning, Design-oriented pedagogy, Glocal learning network, Case study

Introduction

The ongoing debate about the change in education has concerned both pedagogical methods and the content. How and what should the students learn to succeed in the future? Previous research (Zhao & Watterston, 2021) has highlighted a need for student-centered pedagogy, where learning arises from students' interests and relates meaningfully to their lives. In addition, the students can use skills for the 21st century, which, according to Binkley et al. (2012), include Ways of Thinking, Ways of Working, Tools for Working, and Living in the World. Although the meaning of these skills has been emphasized for long, they still need to be a part of many national curricula for primary education (Care & Griffin, 2022).

As we live in a rapidly changing but also rapidly globalizing world, there is an ever-increasing need for global collaboration and networks that stretch beyond the boundaries of local communities. Globally competent people can bring their knowledge, understanding, skills, attitudes, and values together to collaborate in culturally diverse teams and to solve globally relevant, local, and intercultural problems to improve collective well-being (Caena & Redecker, 2019; OECD, 2016, 2018; Synowiec, 2020). According to Roczen and Kater-Wettstädt (2022), the global competencies encompass 1) the capacity to analyze issues of local, global, and cultural significance; 2) proficiency in examining diverse perspectives and understanding various worldviews; 3) the ability to establish positive relationships with individuals from different national, ethnic, religious, social, or cultural backgrounds, as well as gender; and 4) the willingness and ability to actively contribute to sustainable development and the common good.

When using collaborative inquiry activities, it is good to tie the topic to the student's environment on a local level (Viilo et al., 2011). Through global collaborative activities, the aim is to show how local phenomena or challenges appear on a global and glocal level. In this article, the term glocal refers to learning activities connected to complex challenges that affect both local and global (glocal) scales (Roth & Lee, 2004; Scardamalia et al., 2011; Tobin, 2016).

According to Binkley et al. (2012), incorporating the deliberate advancement of technological skills into education is beneficial because new technologies influence and shape our daily and professional lives. Furthermore, modern technologies have provided new opportunities for people to participate in the knowledge-creative activities of online communities in their leisure time as well as in their workplaces and during their educational pursuits (Deng et al., 2016; Häkkinen & Hämäläinen, 2012; Kangas et al., 2007). Earlier research (Ito, Gutiérrez et al., 2013; Ito, Martin, Pfister et al., 2018) has demonstrated that only a small minority of youth take advantage of such complex, social, and creative opportunities.

There is also an evident need for more knowledge on utilizing different technologies for learning (Tirado-Morueta et al., 2023). According to Al-Ataby (2020), the recent global pandemic has highlighted that in the post-pandemic era, choosing not to use technology in learning and teaching is no longer viable. Many educational institutions continue developing the technological practices they adapted during the pandemic (Daniel, 2020).

The pandemic also revealed the need for additional efforts to narrow the digital divide. According to Gee (2018), those individuals who do not have access to digital communities will be put at a significant disadvantage. The onset of the pandemic resulted in the widespread adoption of video-conferencing technologies, leading to remarkable growth in the sector (Tudor, 2022). While governments and individuals have made considerable efforts to provide innovative technological solutions, materials, and guidance in recent

years, the opportunities are not uniform for everyone (OECD, 2020). Many students worldwide lack devices and access to these technologies (d'Orville, 2020). Students believe integrating technology-enhanced learning could be beneficial, and the students' encounters during COVID-19 highlight the necessity to develop interactive utilization of technological tools rather than merely using technology to share extensive amounts of study material (Al-Ataby, 2020).

To overcome the risk of an emerging equity gap, Ito and her colleagues (2013) argue for the need for connected learning that allows school students to link their academic work with society, family, and community through interest-driven and inquiry-oriented activities. With novel technologies, connected learning is within reach for everyone and spans formal and non-formal learning environments (Ito, Gutiérrez et al., 2013; Ito, Martin, Pfister et al., 2018).

Kafai and Peppler (2011) argue that to build bridges between academic and out-of-school learning, teachers are also recommended to be interested in how and why youth voluntarily participate in these socio-technological communities and activities. According to Kumpulainen and Mikkola (2014), promoting the complex skills needed in the future is very challenging in school environments and learning activities only led by teachers. Another challenge to teachers is integrating the students' existing knowledge and technology skills into classrooms, as the skills have often been acquired in non-formal environments (de Lange, 2011). Non-formal learning may occur outside formal education, in museums, zoos, natural environments, and science centers (Ito, Gutiérrez et al., 2013; Kafai et al., 2014; Sefton-Green, 2012). In non-formal learning environments, teaching is often organized, but participation in these learning activities is voluntary and interest-driven (Sefton-Green, 2012). With the help of novel technologies, non-formal learning environments are accessible to more people, regardless of physical time or place. Technology may be used for communication and collaboration, to collect, organize, and share information (Fields et al., 2015; Ito, Gutiérrez et al., 2013; Sefton-Green, 2012). Previous research (Fields et al., 2015; Ito, Gutiérrez et al., 2013; Sefton-Green, 2012) has provided multiple successful examples of non-formal online communities ranging from gaming to writing fan fiction.

The socio-technological developments promote a participatory culture characterized by low barriers to participation, strong support for creating and sharing one's ideas, and the type of mentorship where what is known by the most experienced is passed along to novices (Jenkins et al., 2015). Gee (2018) uses the concept of affinity spaces to describe the diverse communities where learning takes place. These affinity spaces form around a common interest independent of time or place. Non-formal learning networks or communities have emerged from shared interests throughout human history. However, new technologies have also influenced affinity spaces by providing the opportunity to establish

online communities (Gee, 2018). According to Zhang et al. (2011), developing novel pedagogical practices can best be supported through a principle-based approach, which defines core pedagogical values and principles but encourages and facilitates teachers' reflective interpretations.

To gain knowledge of the demands and potentials of scaffolding the students' global competencies in still virtually uncharted terrain, this design-based case study aims to explore teachers' experiences in facilitating international learning networks by utilizing technology to connect teachers, students, and experts in different countries when studying a glocal phenomenon. Through an empirically designed experiment with two teachers and one assistant teacher and their student groups from Finland and the United States, teachers' experiences in designing and teaching in a glocal learning network are researched. The experiment was built on the model of connected learning and the pedagogical model of design-oriented pedagogy. In both frameworks, the core components are participation in social and cultural practices and utilizing novel technologies for knowledge creative learning (Balacheff et al., 2009; Ito, Gutiérrez et al., 2013; Vartiainen, 2014). The specific research question is as follows:

> How do teachers facilitate and experience the design-oriented process of creating and teaching in a glocal learning network?

The spark for a glocal learning community

Connected learning is rooted in the sociocultural perspective on learning and participation that emphasizes the context-bound nature of our activities (Kumpulainen & Sefton-Green, 2012). The central argument is that our actions and thinking are mediated by cultural means (artifacts and tools) and by other people such as peers, teachers, and (external) experts (Vygotsky, 1978). Accordingly, the sociocultural lens interprets how these elements are connected in emerging glocal (local and global) learning networks. Another related perspective on the theoretical underpinnings of connected learning is broadening learning outside the classroom and utilizing diverse resources and expertise in the surrounding community (Bryan & Henry, 2012; Morrisseau & Kirn, 2012). While connected learning may emerge in physical face-to-face interactions, it relies on various technologies that enable versatile affinity spaces - regardless of place and time (Ito, Gutiérrez et al., 2013). Learning is a dynamic and continuous process that evolves. It occurs in formal educational settings, such as schools and institutions, and various non-formal environments. Learning is not confined to individuals but can also involve collaborative efforts. Advancements in technology have made the transition of learning activities to online platforms possible, enhancing accessibility and flexibility. With technological development, learning environments have expanded from traditional physical spaces to virtual environments. It is typical for these learning environments that the learner works simultaneously in both

physical and virtual space, utilizing versatile tools to support learning (Häkkinen & Hämäläinen, 2012). In addition, learning environments can extend to global communities. The learning environments of the future will form complex entities where collaborative activities and resources can be used to reach common goals (Häkkinen & Hämäläinen, 2012). Technology is somewhat built into connected learning, but it is not obligatory. Technology is seen as a natural tool for widening the learning communities across time and space and gaining access to and sharing information. In learning, technology allows students and teachers to access and organize data, share information, and collaborate with others regardless of the physical place (Bower, 2017).

The advantages of technology to connected learning include interactivity and the possibility to implement different learning activities, easier access to information and resources provided not only by experts but also enthusiasts, interest-driven relationships and peer support, new opportunities to get one's voices heard (Ito, Gutiérrez et al., 2013). Kyza et al. (2009) state that in technology-enhanced learning, "tools serve as objects for thinking, inherently and fundamentally shaping human thoughts, discourse, actions, and interactions." In both connected learning and technology-enhanced learning, engagement in social and cultural practices is considered fundamental for the learning process (Balacheff et al., 2009; Ito, Gutiérrez et al., 2013).

While collaboration with external experts is not a new practice (Bouillion & Gomez, 2001; Jurow et al., 2008), previous research indicates that teachers still do not use these practices as much as expected (Silm et al., 2017), as they are trying to balance between external expectations and existing resources (Correia & Harrison, 2020). In connected learning, the expert's role may vary depending on the task. The experts may provide students with pre-designed demonstrations, access to expert tools, support, feedback, mentorship, or answers to collectively designed learning questions (Ito, Gutiérrez et al., 2013; Seitamaa-Hakkarainen et al., 2010).

Moreover, today's technologies offer ample opportunities and tools for social connection and knowledge co-creation without the members being restricted to the same physical space (Kumpulainen & Sefton-Green, 2012). Ito, Gutiérrez et al. (2013) compress these design principles for connected learning into peer-supported, interest-powered, and academically-oriented principles, which are enhanced through activities that are production-centered, openly networked, and organized around a shared purpose. Figure 1 describes the theoretical framework for promoting connected learning.

In this case study, the implementation of connected learning in international contexts was based on an instructional model of a design-oriented pedagogy (DOP). With a DOP, the students learn by co-creating an extended learning ecosystem that enables their interest-driven inquiry activities (Liljeström et al., 2013). The participating students share an interest in a glocally-relevant phenomenon or challenge that guides the iterative process of

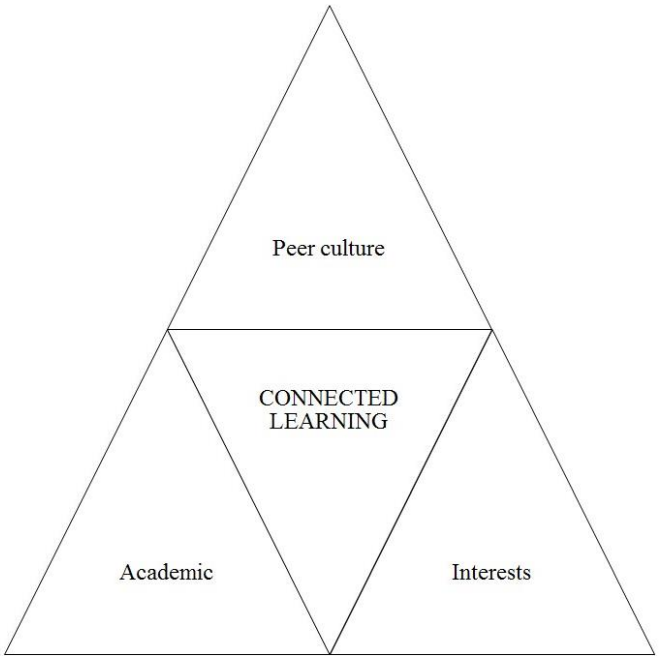

Fig. 1 Model of connected learning based on Spheres of Learning (Ito, Gutiérrez et al., 2013, p. 63)

knowledge creation. The students connect with formal and non-formal communities and environments and utilize versatile resources, tools, and technologies to collect, create, and share knowledge. Through this process, teachers aspire to develop new supporting roles as part of the learning community (Lai & Campbell, 2017; Viilo et al., 2011) and orchestrate situations that allow for a variety of connections and modes of participation to emerge (Nissinen et al., 2019; Roth & Lee, 2004). In this case study, the students' interest-driven activities emerged from their immediate environment: one particular student group expressed curiosity about the local big game and, more specifically, focused on the possibility of shoeing an elk.

Previous research (Nissinen et al., 2019; Pöysä-Tarhonen et al., 2018; Vartiainen, Nissinen et al., 2018; Vartiainen, Leinonen et al., 2019) provides examples of successful development of novel practices as well as collaboration during a teacher's in-service project in Finland, which aimed to design and implement a forest-related learning project with the teachers' school classes or kindergarten groups. Research (Nissinen et al., 2019; Seitamaa-Hakkarainen et al., 2010; Vartiainen, Leinonen et al., 2019) has revealed how teachers have successfully orchestrated learning activities where students have actively collaborated with their peers and experts, designed novel ways to harness technological tools for learning, and finally shared their work for the public. Higher education institutions have adopted technology to support learning more quickly and widely (Herron & Wolfe, 2021). This research presents a novel practical method for implementing technology-

enhanced learning within a glocal learning community composed of elementary education students, teachers, and external experts.

Teachers' collaboration with external experts and students' families has been studied to understand better the larger contextual, cultural, historical, political, and ideological frameworks their students lived in and the potential of the funds of knowledge to support the students' learning (González et al., 2005; Rheingold & Seaman, 2017). Funds of knowledge can be described as resources from the person's family and community (Esteban-Guitart & Moll, 2014), as children often have extensive experiences outside of school (Hogg, 2011). From these examples, novel ideas and practices emerged for connecting the formal and non-formal environments and learning opportunities.

Methodology

This research is part of a larger design-based research project (DBR Collective, 2003) in which the aim is to iteratively co-design connected learning networks and related pedagogical practices and theories (see Liljeström et al., 2013; Nissinen et al., 2019; Vartiainen, 2014; Vartiainen, Leinonen et al., 2019; Vartiainen, Nissinen et al., 2018). Although previous research has provided theoretical and practical research on implementing DOP in schools and kindergartens, the unanswered questions are related to learning from and with glocal learning networks.

Harrison et al. (2017) describe a case study as "a pragmatic, flexible research approach, capable of providing a comprehensive, in-depth understanding of a diverse range of issues across several disciplines." Accordingly, a case study approach allowed us to investigate the participating educators' experiences and insights on facilitating, teaching, and orchestrating collaboration in a glocal learning network.

Research context and participants

The research was conducted in the fall of 2015 during a teachers' in-service project at the University of Eastern Finland. Participation in the in-service project was voluntary and free of charge for all teachers from early childhood education to an upper secondary school in eastern Finland. The participants were required to 1) design, implement, and document a forest-related learning project with their students, 2) attend five related network meetings, and 3) share the project during a children's conference at the end of the in-service project.

This in-service project was designed to support teachers and educators in developing new learning practices that support collaborative project-based learning and develop transversal competencies in a formal and non-formal learning environment (Finnish National Board of Education [Opetushallitus], 2016). The participants were also offered the possibility to collaborate with an American science teacher to design and implement a glocal learning network with international peers by working on open-ended learning tasks. Working with

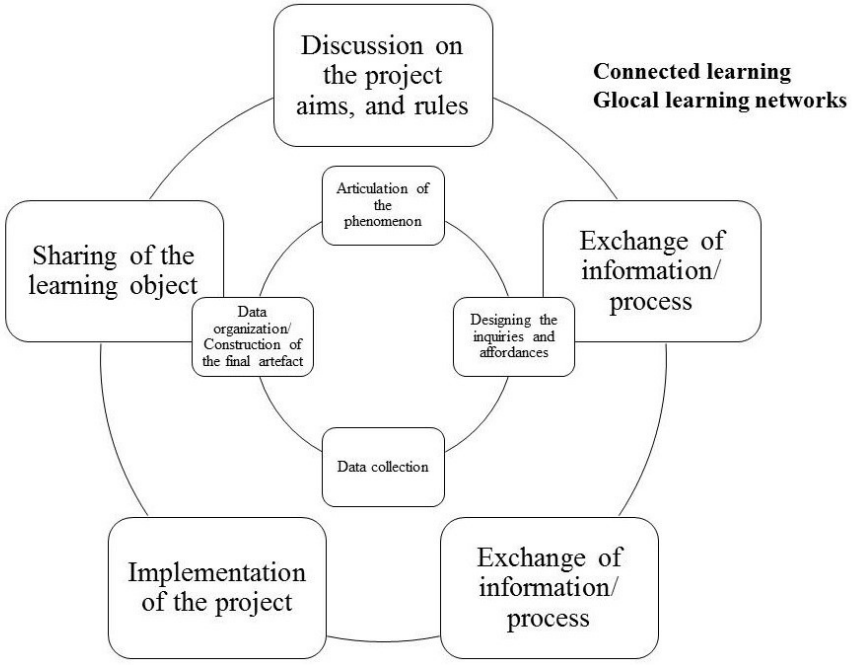

Fig. 2 The instructional model for designing international learning networks and projects

peers from different cultural and geographical backgrounds aims to develop students' lifelong learning skills, global competency, and abilities to succeed in their future professions (OECD, 2016, 2018). The instructional model for designing international learning networks and projects is presented in Figure 2.

The participants in this case study were

1) a science teacher of three 8th-grade classes in the United States (from here on referred to using the pseudonym *Macy*),

2) the class teacher of a Finnish 6th-grade class (from here on referred to using the pseudonym *Aino*), and

3) the assistant teacher (from here on referred to using the pseudonym *Helmi*) working with a group of students in a Finnish 6th-grade class.

The participants volunteered and expressed their interest in implementing glocal learning projects during which the students were given the possibility to work on a chosen local, global, or intercultural topic. The Finnish 6th-grade class and their teacher, *Aino*, formed an extended peer group with the students from three American 8th-grade classes and 40 students and their science teacher, *Macy*. The teachers *Macy* and *Aino* connected prior to the project via email, and the students introduced each other by making short video introductions that were shared online and watched with the teacher. The teachers' interaction via emails concerned the implementation of projects and schedules. However, the collaboration between the teachers during the project was minor, as both teachers

actively worked with their student groups to enable diverse learning experiences and help students find solutions to their challenges.

The assistant teacher, *Helmi*, of the Finnish 6th-grade student group, was chosen for this study as the learning project reflected an interesting intercultural theme emerging from the group's heterogeneous, multicultural backgrounds. *Helmi* was also the adult who mainly worked with this group of students and thus had the best knowledge of the group's activities.

Both peer classes (from the United States and Finland) created blogs, which were the leading technologies for sharing their progress and inquiries. English was used to communicate between extended peers in the Finnish and American classes. The extended peers could follow, comment on, or ask for more information on topics and projects through their blogs. The Finnish students had started studying English in the first grade, and the international collaboration provided a valuable chance for them to apply their English language skills during the project. As they organized their data, the Finnish students translated and exchanged information with their American peers who did not speak Finnish, utilizing a blog for communication.

The children's conference at the end of the project was held on the University of Eastern Finland campus. It was primarily intended for Finnish participants, early childhood education teachers, class teachers, and student groups participating in the in-service teacher's project. The event was streamed online using video conferencing, allowing interested parties, guardians, and experts to participate. The participating student groups could present their project differently, such as a video presentation or a poster/ e-poster. In line with Pedaste and others' (2015) suggestions about the phases of inquiry-based learning, the children's conference allowed children to share information, present their work openly in an open wiki environment (www.openmetsa.fi), and get recognition. The children's conference, organized in Finnish, took place in December 2015 when the American science teacher no longer had the opportunity to work on the project or follow the presentations or outcomes. Due to time constraints, the American peer class did not attend the children's conference.

Data collection

One researcher interviewed Aino and Helmi after the projects had finished, and the duration of the interviews varied from 75 to 90 minutes. In the interviews, they were asked to reflect on the learning activities, extended communities, extended learning environments, practices, participation, and project goals. Macy provided answers to the same questions in written form. The transcribed interviews and the written report are the primary data of this study.

Table 1 Data sources

	Teacher's interview	Teacher's report	Project blog	Digital artifacts published on the Openmetsa portal
Assistant teacher for the Finnish 6th-grade class	X	X		X
Science teacher of 8th-grade classes in the United States		X	X	
Class teacher of the Finnish 6th-grade class	X	X	X	X

The Finnish teachers also wrote reports about the projects. These reports, digital artifacts, and blogs constructed with the students were analyzed and used as supplementary material for the data. This allowed researchers to gain more information about the themes of the semi-structured interviews. Altogether, 96 pages of transcribed interviews and text files were analyzed. Table 1 presents the data sources of this study.

The guidelines for general research ethics were followed carefully (see Finnish Advisory Board on Research Integrity, 2012). The autonomy of the participants was respected, and the participation was voluntary. Consent for participation and publication was sought from the student's guardians. Additionally, they were informed that direct participant identifiers were not to be published. As the study was part of the school's everyday activities, no additional ethical review was needed from the Ethical Council.

Data analysis

This research utilizes qualitative content analysis to study teachers' perceptions of glocal learning networks. Sawyer (2013) argues that qualitative methods are practical in collaborative group activities with no fixed result. According to Mayring (2000), qualitative content analysis is suitable for analyzing different forms of data, including transcripts, videos, and other documents.

The transcripts were read through in the first phase to familiarize the researcher with the data. Second, the data were deductively analyzed and categorized using the Atlas.ti program for qualitative analysis (Mayring, 2000; Potter & Levine-Donnerstein, 1999). The main categories were formed a priori using a DOP as the theoretical basis (Vartiainen, 2014): learning activities (12 subcategories), extended learning communities (3 subcategories), extended learning environments (one subcategory), reflection in, on, and for (5 subcategories), and other (one subcategory). The unit of analysis (see Chi, 1997) consisted of an idea, thought, or suggestion. Also, single words were categorized, for example, when describing the tools used. Here, the analysis was deductive, proceeding from a general to a detailed level (Cohen & Manion, 1994). One researcher performed this phase of the analysis.

Following this, the data were uploaded to free QCAmap software to assess intercoder agreement to increase the reliability of the study (Burla et al., 2008; see Campbell et al., 2013; Krippendorff, 2004). Two researchers independently coded 83 text segments, equaling 13.02% of the data. After the coding, the researchers compared the results, and the intercoder agreement was 70% (N = 58). These researchers then discussed the coding in terms of the categories or category descriptions that caused disagreement. Consensus was reached through negotiation and reasoning, elaborate descriptions, and inductively adding four additional subcategories.

Results

Can you shoe an elk?

The teacher interviews and reports analysis revealed that all three volunteer teachers supported the students' initiatives and encouraged them to design their inquiry activities. For example, *Macy* harnessed students' interest in the learning project through an open-ended task, encouraging students to choose a local phenomenon and develop their inquiry questions. As *Macy* reported: "In each class, the questions that were brainstormed were shared with the entire class, and then the students picked which investigations they were most interested in." *Macy* worked with three classes, meaning the students worked in multiple small groups. Therefore, the American classes conducted studies focusing on multiple topics, e.g., climate change, wildlife activity near human habitat, and tree growth.

Aino's report revealed the difference between teachers' expectations and students' questions of interest: "The questions were much wilder than I expected. I thought they would ask questions you would find in the textbooks, such as what do the elk eat? Instead, they were like, how high does an elk jump? These questions were more problematic." According to *Aino*, the students were primarily interested in finding out: "What would happen if they put a shoe on an elk?" *Aino* also explained that the students' questions challenged the teacher to move away from predefined outcomes: "From a teacher's point of view, it would have been safer to guide them to pick a question like does an elk see colors?" She further elaborated how the students' agency in creating research questions promoted their interest and inquiry activities: "They were so motivated that they started working and thinking about how they could do this; how they could test this." Eventually, the driving question created by the Finnish 6th grade was: "Can you shoe an elk?"

Helmi took her students to the forest, allowing them to explore their surroundings and negotiate the inquiry objects. *Helmi* described the negotiation process of the shared phenomenon as follows: "We took pens and paper to the forest, and the pupils made notes of the things they were interested in. Little by little, choices were dropped, and finally, we had stones and the creek left." As per *Helmi*, the object of their inquiry was a creek

Fig. 3 Inquiry objects and data collected by the students working on the Creek project

(Figure 3), which originated from waterfalls, which was typical in the light of the students' cultural backgrounds. The topic was designed to suit the current local surroundings and curriculum better.

Designing the inquiries and connecting with experts

According to all the teachers, the students started to design their inquiries and affordances by exploring first their personal and surrounding networks and communities. The students were also challenged to ponder how they could find answers, who would know about the topic, and who they could ask for help. *Macy* explained how the students were supported in identifying and searching for expertise outside the classroom: "For each [inquiry] question, the students were encouraged to think of an expert to help them answer their question." *Macy* also reported that the students needed the teacher's help creating these extended connections: "I helped them find local names. They were all shy about calling people, so I suggested they create a questionnaire and email it." As the students were responsible for designing the inquiries, the teachers' role was transforming, as *Macy* depicted: "It was a different role for me as well. I have occasionally had experts come to visit or Skype with my students, but they are usually people I have met before." Likewise, *Aino* explained that connecting with experts was the students' task in addition to finding relevant experts: "One student was looking for farriers online. The other was making a call to a hunting club. Also, the emails [to the experts] were sent from the students' own [email] addresses." Based on the teachers' reports, the experience of finding and connecting with an expert was one of the most important learning experiences for the students.

Collecting data for the inquiries

The students' inquiries continued with the data collection. The collaboration with the experts depended on the students' research questions and types of inquiries. Macy described the collaboration: "The experts either came to the school and met with a small group or answered questions through emails." *Helmi* and her group enlisted a biology teacher, a Finnish teacher, and a photographer as experts for their research. Together, they conducted a series of tests: "At the creek, we stopped to think about what to do next, and the group decided that they will start looking for bugs."

Aino's class connected their funds of knowledge to the project when one father was invited to the classroom to answer the students' questions about hunting: "He [father] was wearing hunting clothes and explained why he had such an orange suit." Furthermore, the expert communities provided learners with resources and tools that would not otherwise be accessible, as *Aino* noted: "He [external expert] showed pictures from a hunt and explained how hunting dogs and GPS equipment could be used to follow the hunt." *Aino* herself brought an elk leg from the local hunting club, and students brought shoes and nails from the local stables for shoeing experiments (Figure 4).

Per *Aino*'s perspective, the connection with experts continued throughout the project: "After the experiments, the students still wanted to confirm what the hunter and the farrier thought about shoeing an elk. Legislation, a hoof's anatomy, and possible animal harm were discussed thoroughly." The experiments and expert reports sparked an interest in continuing their research. One of the students connected with hunters and asked permission to join them on an elk hunt. During the hunt, the experts demonstrated using and utilizing expert tools in data collection in out-of-school environments: "Each student was able to follow the hunt via GPS."

Fig. 4 Students shoeing an elk hoof

Science Wall and blogs

The students organized data during the project by designing a Science Wall or class blog containing pictures and text. *Macy*'s students organized the data by constructing short video stories and blog posts about their research, as depicted in the following excerpt: "Every student needed to create a final project that could be shared digitally. This was so that we could share the projects through our blog." In the blog posts (Figure 5), the students described the data collection, analysis, and the results. The blog was also used to share the created knowledge with *Aino*'s class, who commented on some posts by highlighting similarities and differences between the two countries or asking for more information on the topic.

As reported by *Aino*, her students collected data that needed to be organized (Figure 6): "From this material, the students built a Science Wall. It was filled with maps, drawings, reports, and pictures." Students also had to decide the purpose of its use, as explained in

Fig. 5 The students' blog included text, pictures, videos, and comments

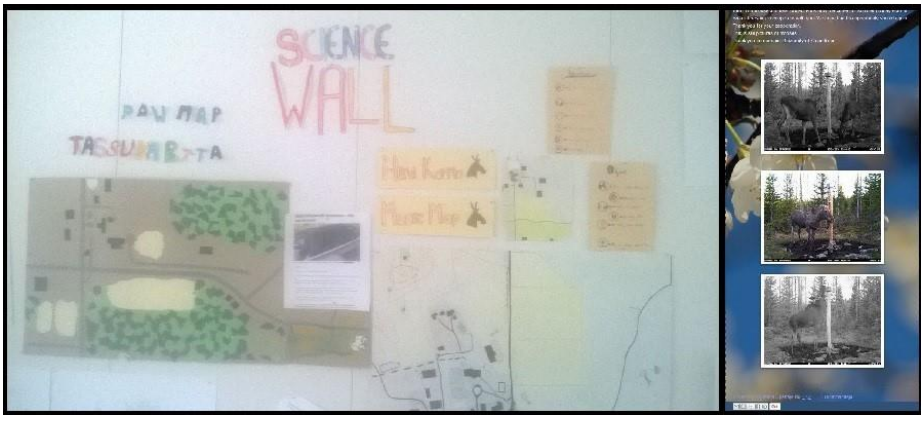

Fig. 6 Data organization in the form of a blog, a Science Wall, and a Paw Map

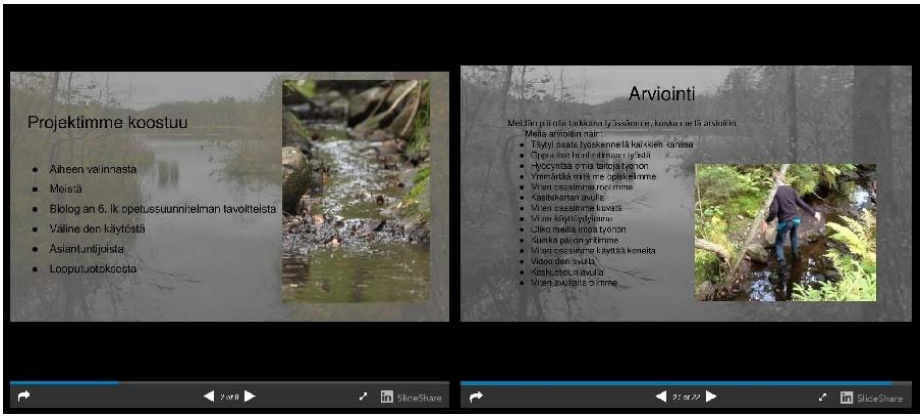

Fig. 7 The Finnish 6th-grade group's final artifact (in Finnish) is available online: https://www.openmetsa.fi/wiki/index.php/Puro

the following excerpt: "Which part of the material would the students use for their blog? Everything was first written down in Finnish and then posted in English." As per *Aino*, communicating with the American peer class was interesting for the learners: "They were excited about this glocal cooperation, and they dared to write to their peers." The blogs were considered a mediator of these connections and knowledge sharing, as *Aino* reported: "It was very important that each student had the chance to put up posts on the blog." The students were also interested in materials produced and shared by their extended peers.

Helmi explained that organizing the data was easy. The students had a precise aim to construct a final digital artifact (Figure 7), which would be presented at a children's conference. She also revealed that the students spent much time on their final product, as described in the following excerpt: "They have thought it out very carefully, learning, and the whole process. Moreover, they are very proud of their accomplishment!" The group shared their progress with their peers who were interested in learning more about the project. *Helmi* stated: "The others [classmates] have been very interested in what this group has done during the project!" At the children's conference, the students could present their project to their peers, teachers, external experts, and family members. *Helmi* said, "The conference was a significant event for the group. It was exciting, and we thoroughly prepared for it. The students were practicing their presentation in front of their class."

Teachers' reflections on the process

The sharing of knowledge and ideas mostly took place among peer students with support from the teachers. *Macy* explained that the data collection and organizing took so much of their time during the projects that her classes did not have as many resources left to share the knowledge as they would have liked: "This is an area I would improve on in the future." In *Macy*'s opinion, the most valuable thing the students learned was the collaboration with

external experts, as depicted in the following: "I think this was the first-time students had to reach out to community experts to help complete an investigation. I hope that they learned the value of this. I also learned the value of having the students make these connections as they seemed to learn more than before." Furthermore, *Macy* highlighted the importance of shared interest: "For them [students] to have an interest in something and then to connect with adults who work in these fields was powerful."

Aino also confirmed these reflections: "I am convinced that the students know much more about elk than if we had just gone through the chapter in our biology book." Moreover, *Aino* noted that the experts seemed to enjoy interacting with the students: "They [hunters] said they enjoyed the collaboration and should collaborate more with schools. In that way, they might find a continuation of their work and possibly even future experts." *Aino* also depicted the relationship between students' interest and engagement: "They [students] are interested in totally different things. Moreover, they are willing to work around the clock when teaching interests them." Furthermore, "They were very excited about this, which improved the class spirit!"

Collaboration between the teachers and international peer students proved challenging to implement in practice. The collaboration between the international peer teachers mostly took place via email before the start of the actual projects. The students' peer-to-peer collaboration was mainly limited to information shared through blogs. Teachers reminded and encouraged students to get to know each other and comment on each other's work through blogs. The blogs were thus mainly utilized as a tool for sharing knowledge rather than deeper-level collaboration. From there, students could see what kinds of topics their extended peers had chosen, how they had collected the data, and what the results of the projects were. In some cases, students also commented on each other's projects.

The science teacher, *Macy*, only worked a few hours weekly with her students. Therefore, they had to focus on the project's progress and on creating connections with experts, primarily working on the local level. *Aino*, the class teacher, had slightly more lesson hours available because the Finnish class teachers teach several subjects per week, and the curriculum is quite flexible, for example, on learning projects. Thus, she could organize the school weeks more freely during the project. However, both teachers had to consider the teaching periods and curriculum framework.

DOP was a novel approach to teaching and learning for both teachers. Thus, the DOP process's ideation, planning, and implementation were challenging for them. The time difference between the two countries was another challenge for active collaboration between teachers and peer students. The school day had already ended in Finland when the American peers started their day. Both teachers stated that collaboration between peer teachers and students requires further development (see Nissinen et al., 2019).

Helmi noted that in addition to the enhanced class spirit, the students had started to see value in themselves: "This has raised their self-esteem. They feel that in this project, they were allowed to be themselves. They did not have to worry about right or wrong answers because there were none, and the atmosphere was encouraging." *Helmi* also described how students began to reflect on the skills needed in traditional schoolwork and in these project activities: "As the project went on, the students started to realize that there are so many different skills that are not usually praised in school. Furthermore, the students started talking about how they had mastered some tasks, for example."

Macy, *Aino*, and *Helmi* saw the benefits of creating and teaching in a glocal learning network. However, they all also provided important insights for developing the practices further. *Macy* pointed out the time resource as one potential challenge in creating connected learning networks: "I think the DOP model works well in science education. However, you need to plan for more time, and it can be difficult to coordinate using community resources." Also, the peer connection and knowledge sharing could have benefitted from better timing, as *Macy* reflected: "I know my students wanted to communicate more with other students."

The teachers also reflected on the challenges of these activities, such as the lack of resources, such as technological tools and support. *Aino* also raised the importance of technical support: "We had the equipment and support. It was crucial that you were able to get support when you faced problems." As reported by *Helmi*, the novel ways of working can be challenging: "Understanding the big picture in the beginning [was challenging], as I thought that we'd never get anything done, that it wasn't proceeding. However, now that I think of it, we spent a lot of time on it because we did not have the competencies."

Despite the challenges, the teachers of this study experienced the activities as a way to: "cross the traditional borders of school subjects and get out of the classroom," as *Aino* reported. She continued reflecting on her positive experiences: "This utilizes the experts in non-formal communities and links teaching to the surrounding society. This is what modern-day education is all about!"

Conclusions

Educational researchers have long highlighted the need for a systematic change in education (Care & Griffin, 2022; Zhao & Watterston, 2021) in which participatory activities, including appreciation of the value of each participant's funds of knowledge (Esteban-Guitart & Moll, 2014; González et al., 2005), open interactions, and creative contributions towards a shared goal prevail (De Haan et al., 2014). This research adds information about how educators experience facilitating and orchestrating learning in an international interest-driven socio-technological learning network.

Table 2 synthesizes teachers' insights into the emerging connections in glocal learning networks. The table's initial column outlines the parties brought together by the teachers'

Table 2 Teachers' insights into glocal connections

Connected subjects	Connected interests	Connecting technologies
Peers	Sense of community	Co-creation of digital artifacts on a local level
Extended peers	Cultivation of interest and inquiries	Connecting via blogs
Teachers	Orchestrating opportunities	Mediating support and tools
Experts	Participation in expert activities on a local level	Collecting data via expert tools

facilitated learning projects. The second column details the connections between the phenomena and the development of the learning community, while the third column elucidates the role of technology in shaping the learning community. Table 2 Teachers' Insights into Glocal Connections is discussed row by row, proceeding from Connected subjects to Connected interests and finally to Connecting technologies.

Regarding peers, the results of this case study experiment revealed that the learning inquiries were negotiated with the local peer community (Vygotsky, 1978). After the initial articulation of the phenomenon, interest-driven local communities started to emerge (Gee, 2018; Ito, Gutiérrez et al., 2013). During the project, a sense of community emerged. The students showed appreciation for the work done by others and were proud of their achievements. However, they also began to recognize skills in themselves and others that they had not noted before (OECD, 2016). The learning communities proved supportive (Ito, Gutiérrez et al., 2013). This part of the project was time-consuming as regards co-creating digital artifacts on a local level. When working on complex challenges, one should be prepared for solutions to emerge slowly, which may take time. According to previous research, tasks like these prepare students well for the future (Seitamaa-Hakkarainen et al., 2010). The students collected large amounts of data (pictures, text, drawings, video) through versatile tools (trail cameras, questionnaires, emails). The experts provided new tools to the school context (Ito, Gutiérrez et al., 2013; Seitamaa-Hakkarainen et al., 2010). The students also devised different ways of organizing the collected data (Science Wall, blogs, presentations). However, co-creating digital artifacts proved relatively straightforward as the students knew the results would be shared within their broader learning communities (Liljeström et al., 2013).

Constructing a learning network between the extended peers was a novel practice for participating students and teachers. According to the teachers, the students were interested in establishing a connection and seeing their peers' inquiries and results. Collaborative and interest-driven activities supported the cultivation of interest and inquiries. The students were interested in communicating with their extended peer network and seeing their peers' accomplishments. In connected learning, peer support and encouraging adults are essential (Ito, Gutiérrez et al., 2013). Peer support can be realized through concrete help, such as

text editing, crafts, or even likes or short praises (Fields et al., 2015; Ito, Gutiérrez et al., 2013). The open-ended task and related learning activities also sparked an interest in further investigating and developing the findings (see Liljeström et al., 2013). The blogs were considered a mediator of these connections and knowledge sharing. While the American 8th-grade and Finnish 6th-grade classes shared knowledge with their peers through their blogs, this collaboration could be deepened toward a joint creation of knowledge around shared objects of inquiry (Hakkarainen & Paavola, 2009). Connecting via blogs was originally orchestrated and mediated by the teachers, as the students did not have direct contact with each other prior to the project. However, during the process, the students maintained blogs and produced content of their choice.

Constructing a learning network between extended peers challenged teachers to rethink their traditional roles (see Rogoff et al., 2016; Seaman, 2001). Furthermore, the teacher's role was to support and orchestrate learning opportunities and help the peer groups navigate the versatile learning activities (Deng et al., 2016). The novel ways of working challenged the teacher's traditional role (Lai & Campbell, 2017; Viilo et al., 2011). Some of the students' inquiries were so complex that they could not be answered with traditional information resources such as schoolbooks or encyclopedias.

Consequently, orchestrating opportunities to connect the students' interests and mediating support and tools for students to implement novel learning projects placed educators in a novel predicament. While the teachers perceived that the students could benefit from the practice connections and competencies in the future (Jenkins et al., 2015; OECD, 2016, 2018), they also reflected on problems that the current school structure creates, such as finding the time and resources (Kober & Rentner, 2011; see Kopcha, 2012; Riverin & Stacey, 2007). Constructing glocal learning networks can be time-consuming and lead to teachers being forced to balance the project and the other curriculum content (see Säljö, 2004). The teachers also need sufficient support to focus on enabling learning instead of, for example, technological problem situations (Lingnau et al., 2007). Collaboration with external experts and other peer teachers in the same situation was important in providing new ideas, resources, and social support. As the learning project and the learning activities emerged from students' interest and the process was not entirely planned, the teachers faced some feelings of doubt and uncertainty (see Viilo et al., 2011; Viilo et al., 2018). However, they also recognized the benefits of interest-driven participatory activities and extending learning to non-formal communities (Ito, Gutiérrez et al., 2013; Kafai et al., 2014; Sefton-Green, 2012).

Furthermore, the skills and ways of creating these connections with external experts were highly important and time-consuming. Here, the teachers not only orchestrated situations that allowed various connections to emerge (see Roth & Lee, 2004) but also supported students in achieving and creating these new connections by themselves. Collaboration

with experts occurred through in-person interactions and virtual environments. Participation in expert activities on a local level was also an essential part of the projects. When the answers could not be found from the existing school resources, it created a clear need to connect with external experts, tools, and information resources (Bouillion & Gomez, 2001; Jenkins et al., 2015).

Regarding the skills and ways of knowing developed during the projects, the teachers reflected on the difference between traditional school objectives and activities. Instead of explicit and replicative knowledge found in textbooks, the project activities emphasized the pursuit of tacit knowledge through participation in the real-life activities of expert communities (see Thomas & Brown, 2011). The collaboration with the experts occurred both in and out of school and with video conferencing technologies. From the teacher's point of view, this collaboration was important, as well as making contacts and cooperating with the surrounding networks of experts interested in the same phenomena. With support from the teachers, the students built connections with their existing networks and external experts through technology and face-to-face interactions in and outside the classrooms. As the experts were invited to participate in the student's research, the students gained access to collecting data and expert knowledge via expert tools. The experts presented the tools and helped or advised how to use them in the data collection.

The pandemic brought out the need for and importance of technological solutions in education. When COVID-19 swept across the continents, causing lockdowns, teachers around the world took action and adopted various technologies in an unprecedented and creative way to provide education in extraordinary and exceptional circumstances (Kouhia et al., 2021; Lepp et al., 2021; Winter et al., 2021). The breadth and depth of adaptation of technology-enhanced learning was extraordinary, as it occurred almost overnight (Al-Ataby, 2020). This indicated great adaptability, creativity, and innovation, as not everyone had access to up-to-date teaching technology or previous skills or experience. The post-Covid era allows schools to adapt novel technologies, develop innovative practices, and design ways of learning for the future in collaboration with governments and institutions (OECD, 2020). The teachers of this study had already utilized technological tools for learning but welcomed the novel ways of connecting the learning to the students' interests and surrounding communities of experts and peers, also on a glocal level.

The insights of the project teachers presented in this article and the project outcomes provide novel perspectives for creating extended peer and expert communities that open opportunities to practice global competencies (OECD, 2016, 2018). The limitation of this study is that the interpretations of emerging learning networks and activities were retrieved from teachers' descriptions of the projects rather than from their direct actions. Also, the number of participating teachers was small. However, clear descriptions of the methods, analysis, data, and research context have been provided to ensure this study's rigor (see

Krefting, 1991; Lincoln & Guba, 1985). An interesting future step would be to pursue learning projects that offer international school groups the opportunity to communicate in more interactive ways towards more glocal collaboration and creation of knowledge and, thus, deepen the insights and practices of glocally connected learning networks.

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All authors contributed significantly to the research and manuscript preparation.

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Declarations

Competing interests
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