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Broadening the Horizons of Technology Education: Using Traditional Cultural Artefacts as Learning Tools in a Swedish Sámi School

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Abstract

The aim of this case study was to explore the nature of technology education in a Sámi school setting and to examine how knowledge about traditional cultural artefacts can contribute to broadening the horizons of technological literacy. The participants (teacher and pupils) in the study were all from the same Sámi primary school in Northern Sweden, and the activities connected to the artefacts took place with year 2 and 3 pupils. The method employed was participatory observation, and field notes, recorded conversations, photographs and children's drawings were analysed using a qualitative content analysis. The findings show that technology education in this school was connected to specific artefacts that are important in Sámi culture. Using these traditional cultural artefacts as a starting point, the pupils were given the opportunity to see that technology is more than modern high-tech; it is an age-old tradition of problem-solving, modification and adaptation to fulfil human needs. Technology education in this school was grounded in a holistic view of knowledge and was largely integrated with other school subjects. Myths and storytelling were frequently used to contextualise the technological content, and the historical aspect of technology was clear since connections between older and newer technological solutions were frequently made. The knowledge system embedded in the technology teaching can be described as collective and related to both artefacts and activities. Technological knowledge, activities and specific artefacts were not only attributed a practical value, they were also given a symbolic value, since a common knowledge base in technology contributes to strengthening the children's cultural identity. This study confirms that artefacts can play an important role in technology education and that an understanding of the relationship between technology and culture can be regarded as a critical part of technological literacy. A cultural context, in combination with a holistic perspective on learning, gives artefacts meaning and provides a context within which they are used. Including indigenous technological knowledge can thus not only prevent a marginalisation of indigenous knowledge, it can also provide opportunities to broaden pupils' perspectives of what technology is, how it evolves, and the driving forces behind technological change.

Keywords

Technology Education, Technological Literacy, Sámi School, Technology, Culture, Indigenous Technology

Introduction

Technological literacy – essentially the capability to understand and use technology (e.g., ITEA, 2007; Jenkins, 1997) – is an increasingly central goal of technology education worldwide. Definitions of technological literacy vary from comprehensive to vocational, but most definitions rely primarily on Western knowledge systems (Gumbo, 2018; Marshall, 2000; Williams, 2009). Hence, students in many countries perceive the content of technology education in a narrow sense as being mainly about modern, Western artefacts such as computers, tablets and TVs (Dakers, 2006; de Vries, 2005; Gumbo, 2017, 2018; Svenningsson, Hultén & Hallström, 2018).

However, since technology is a global phenomenon, it is important that knowledge about it includes technology from different cultural contexts and not merely technologies produced and used in limited parts of the world (Edgerton, 2011; Gumbo, 2015; Ihde, 1990). Narrow conceptions of technological literacy are misleading when it comes to the global magnitude of technological culture, and could potentially marginalise indigenous knowledge systems (e.g. Gumbo, 2012; van Wyk, 2002; Williams, 2009).

Indigenous knowledge can be described as "the complex set of activities, values, beliefs and practices that has evolved cumulatively over time and is active among communities and groups who are its practitioners" (Owuor, 2007, p. 23). Consequently, one difference between Western and indigenous technology is that the latter is often based on knowledge developed over many generations (Bondy, 2011; Gumbo, 2018). It is generally transmitted from one generation to the next through oral narratives, storytelling, music, symbols and art, as a way of maintaining societal continuity (Owuor, 2007).

The importance of including different cultural perspectives on technology is highlighted in research into technology education, where scholars suggest that indigenous technology and knowledge systems can contribute to broadening the horizons of technology education and technological literacy (e.g. Ankiewicz, 2016; Bondy, 2011; Gumbo, 2015, 2017, 2018; Lee, 2011; Marshall, 2000; Seemann, 2000, 2010; van Wyk, 2002). Other researchers argue that including indigenous knowledge and culture in education would be beneficial not only for indigenous students, but for all, since it could enhance understanding of indigenous cultures and alternative world views (e.g. Gumbo, 2015, 2018; Johansson, 2007; Lee, 2011; Svonni, 2015).

The Sámi are an indigenous people spread over four countries: Sweden, Norway, Finland and Russia. Altogether, there are about 100,000 Sámi people and the Sámi population in Sweden is approximately 20,000. In 1981, the Swedish Government established a Sámi School Board, with the mission to give Sámi children an education with a Sámi orientation and teaching in the Sámi language. Sámi schools have the formal power to implement Sámi culture, and today, there are five Sámi Schools in Northern Sweden (Johansson, 2007, 2009; Svonni, 2015). However, despite the fact that Sámi are the only indigenous people in Sweden (and the only indigenous people of the European Union), Sámi themes have been given limited space in the central content of the compulsory school national curriculum in Sweden (Svonni, 2015), to a lesser extent than indigenous knowledge in countries such as South Africa (Vandeleur, 2010).

The Sámi curriculum in Sweden is equal to the general compulsory school curriculum. However, the Sámi curriculum emphasises that Sámi pupils should be given the opportunity to become familiar with Sámi cultural heritage (Balto & Johansson, 2015; Swedish National Agency for Education, 2018). The Sámi knowledge system is holistic, place-bound and based on inherited wisdom and knowledge. It is also often linked to practical applications and skills (Keskitalo & Määttä, 2011; Keskitalo, Määttä & Uusiatutti, 2012; Svonni, 2015).

The aim of this case study was to explore the nature of technology education in a Sámi school setting and to examine how knowledge about traditional cultural artefacts can contribute to broadening the horizons of technological literacy. The purpose was to identify:

- *Which* specific artefacts play a central role in technology education in a Sámi school, and
- *How* these artefacts are implemented in technology education to convey technological knowledge.

Background

Keirl (2006) describes technological literacy as having three important dimensions: *the operational* (students learn to use and do the technology), *the cultural* (students contextualise their learning) and *the critical* (students learn about and how to be with technology). Hence, technology can be described as having both physical and intentional properties. The physical properties interact with other physical things in the world, whereas intentional properties relate to human beliefs, desires and purposes (de Vries, 2005; Kaplan, 2009; Kroes & Meijers, 2002). A technological artefact is thus a result of both physical and intentional conditions (Kroes & Meijer, 2002; Vermaas, Kroes, van de Poel, Franssen & Houkes, 2011), and can be described as having a function to extend human capabilities (Lawson, 2008, 2010). Artefacts play an important role in teaching and learning about technology. Exploring their composition, their materials, their design and their possible functions can support students' interest and knowledge in technology (de Vries, 2005; Frederik, Sonneveld & de Vries, 2011).

Since technology involves something that people have made or done, it also involves human values and is therefore always inherently situated within a culture and its values. Culture gives the artefacts meaning and provides the rituals within which they are used. Values are also closely connected to the objects and thus reflected in their form and function (Lee, 2011). The fact that technologies are linked with humans-in-culture implies that technologies have no 'essence' in themselves; they are only what they are in their use (Ihde, 2006).

However, *culture* is a complex concept. James (2015) defines it as "a social domain that emphasises the practices, discourses and material expressions, which, over time, express the continuities and discontinuities of social meaning of a life held in common" (p. 53). James (2015) explains 'culture' as being connected to *how* and *why* we do things. 'How' is about our material practice, while 'why' is connected to the meanings.

Since the cultural aspect is central in this study, Ihde's (1993) broad definition of technology is used when analysing the data, i.e. that technology has some concrete components, that humans use these components in praxes, and that there is "a *relation* between the

technologies and the humans who use, design, make, or modify the technologies in question" (p. 47). According to Ihde (1990, 1993), technologies cannot be understood as an independent power since they are always interwoven with culture. Since technologies provide a framework for human actions, they have a certain influence on those actions.

A problem highlighted in previous research is that when a teacher presents a limited view of technology, there is a risk that students will adopt a narrow view of what 'technology' is, and of the school subject technology (e.g. Mawson, 2010). Gumbo (2017) defines technological artefacts as expressions of culture, and argues for not restricting teaching technology to a Western perspective. Gumbo notes that multiple culture perspectives can facilitate and broaden students' understanding of technology and its connections to culture. A limited understanding of indigenous technological artefacts easily leads to 'museumisation' and shallow conceptions of artefacts (Gumbo, 2015, 2017). Lee (2011) agrees with Gumbo when suggesting that traditional cultural examples can support contemporary technological concepts and create opportunities for students to develop a broader understanding of technology. Knowledge of indigenous cultures can support the contemplation of technological developments, not least from a sustainability perspective (Lee, 2011; Utsi, 2007).

There is also research indicating that pupils are often not given the opportunity to analyse technology in a meaningful context. Too strong a focus on using and making artefacts can lead to the connections between artefacts and humans, and the artefacts' implications in a societal/cultural context, being disregarded (Mawson, 2010; Siu & Lam, 2005; Turja, Endepohls-Ulpe & Chatoney, 2009).

Based on this background description, this study focuses on using traditional cultural artefacts as tools in technology education in a Swedish Sámi school.

Methodology

Qualitative research was conducted in the form of a case study, since the aim was to explore technology activities in a specific context including several participants (Fraenkel, Wallen & Hyun, 2019). The method employed was participatory observation. Marshall and Rossman (2011) define observation as "the systematic noting and recording of events, behaviours, and artefacts (objects) in the social setting" (p. 139). Participatory observation facilitates the researcher's involvement in a variety of activities over an extended period and therefore provides a deeper understanding of the studied field. It is a method for understanding what is happening in a specific context, and the experience is connected to a specific place and time (DeWalt & DeWalt, 2002). The observations can be of different degrees: non-participation, passive participation, active participation, and full participation (Spradley, 1980). Participant observation gave the researcher a personal experience of the studied phenomenon.

This case study was conducted at a Sámi compulsory school in Northern Sweden. The school provides education from preschool class to year 6 (ages 6 to 12). There is also a Sámi preschool at the same premises.

The study followed the Swedish Research Council's (2017) ethical considerations and guidelines, and the participating pupils had their guardians' consent to take part in the study.

The data was collected over a period of two years, during five visits to the school. Each visit lasted four to six days.

The data consists of observations of daily activities with pupils, as well as teacher meetings and other events during the school day. The participating observations varied depending on the activity, and they were recorded via field notes, photographs, audio-recorded interviews/conversations and children's drawings. The field notes were written in narrative form.

In the classrooms, both Swedish and Sámi were spoken, as the pupils' knowledge of the Sámi language varied. However, when teaching was carried out in Sámi, the teacher translated and explained to the author afterwards.

The material was analysed using a qualitative content analysis inspired by Erlingsson & Brysiewicz (2017), i.e., a repeated and interpretive process in which the meaning of a part can only be understood when related to the context. Based on the study's aim and research questions, the objective was to identify recurring themes in the empirical material. The first step was familiarisation with the data, which meant reading and re-reading field notes and the transcriptions of recorded interviews/conversations. The text was condensed into smaller parts and categorised by content. According to Erlingsson & Brysiewicz (2017), a category manifests obvious and visible content in the data and is characterised by answering the questions *who*, *when*, *where*, or *what*. Finally, similar categories were grouped into themes. A theme can be described as expressing underlying (interpretive) meanings, answering questions like *how*, *why*, or *in what way* (Erlingsson & Brysiewicz, 2017). In this study, the process of identifying themes relates to Keirl's (2006) dimensions of technological literacy: operational (how), cultural (why) and critical (in what way).

Findings

The initial analysis of the material revealed specific traditional cultural artefacts that provided starting points for various technology-related activities, including:

- A temporary Sámi dwelling, *lávvu*
- Sámi winter footwear, *nuvttagat*
- Sámi shaman drum, *goavddis*

The following description of the activities is based on the questions Erlingsson & Brysiewicz (2017) suggest relate to the step in the analysis process termed *categorisation*: *Who* are the participants in the activity? *When* is the activity taking place? *Where* is the activity taking place? *What* kind of technology activity? (Descriptive.)

The activities connected to these artefacts took place in the same class, years 2 and 3 (pupils aged 8-9). In the following descriptions of the technology activities, field note extracts and photographs have been selected to illustrate what was seen as significant for how the artefacts were implemented in the technology teaching. The quotations are representative illustrations of discussions that frequently arose during the activities. The quotations have been translated into English by the author.

Technology Project 1: A temporary Sámi dwelling (lávvu)

The teacher informs the researcher that there are different types of traditional Sámi dwellings. The *lávvu* is a mobile, lightweight dwelling, consisting of poles and tent fabric. The *lávvu* is used as a temporary shelter and is similar in design to the Native American tipi, but is more stable to cope with strong winds. The foundation consists of three forked poles that form a tripod – the basis of all Sámi building constructions, according to the teacher. Each member of the family and each item has its own specific place in the dwelling. In the middle is a fireplace (*árran*). Opposite the door, on the other side of the fireplace, is the kitchen – a sacred place to which a specific goddess is connected, and where the most valued items are stored. The fireplace is surrounded by larger stones and the floor of the *lávvu* is covered with birch rice with a reindeer or elk skin on top. The birch rice is replaced weekly.

The teacher explains to the researcher that life in a *lávvu* largely involves: "Hand me [something]", "send me [this/that]". She summarises her description of the *lávvu* by explaining: "The *lávvu* is our caravan. It is portable."

Figure 1. Models of the lávvu.

The *lávvu* project starts with a visit to the Sámi museum, followed by a lesson in one of the Sámi dwellings in the school yard. This includes teaching about the unwritten rules connected to being in a *lávvu*.

The pupils draw pictures of a *lávvu* based on what they learned about its different parts and spaces, the name of which are written in Sámi.

The next step in the project is to construct a model of the *lávvu*. This begins with a lesson in the forest.

1. The lesson is about different kinds of trees, and the pupils were asked to cut willow branches using secateurs. The branches were then cut into three forks using knives. The pupils also scraped the branches and collected the bark. Back in the classroom, the bark was

put into boiling water and an experiment was conducting by putting a piece of paper in the decoction to see what happened. (The paper was dyed.)

2. Each pupil received a wooden plate. Three holes were made with a hand drill and the three poles were fastened. Glue was used to stabilise the structure.

3. The fireplace was created by gluing stones in a circle in the middle of the wooden plate. Pieces of birch twigs were also glued to the "floor" of the *lávvu* (Figures 2 and 3).

Figures 2 and 3. Construction of the fireplace (árran).

4. The pupils made storage vessels using modelling clay made from flour, salt and water. Used tea lights were used to create a pot for cooking over the fire.

5. The final step in the construction of the *lávvu* was to put canvas over the structure. This consisted of two halves which were laid from behind and forward towards the door opening. The door was made from a piece of cloth which was held in place by wooden slats and hung using string from one of the bars over the door opening (Figure 4).

Figure 4. The door.

The pupils discuss their *lávvu* models with the teacher and the researcher:

> ***Teacher:*** *"Where do you want to place your lávvu?"*
> ***Pupil:*** *"Close to a brook, because then it is like in reality."*
> ***Teacher:*** *"Is close to the reindeer round-up site, then?"*
> ***Pupil:*** *"Yes."*

The researcher and a group of pupils look at their *lávvu* models and the researcher asks them how a *lávvu* is constructed.

> ***Pupil:*** *"These are the ones you start with* (points at the wooden poles) *three big ones… this one is kept up like this… like a crutch* (points at the forks)*. Then you take those smaller ones…"*
> ***Researcher:*** *"Ah… the forks make it stable… and stick together…"*
> The researcher and the pupils discuss what the *lávvu* looks like inside.
> ***Researcher:*** *"Where do you sleep in the lávvu?"*
> ***Pupil 1:*** *"At the sides."* (demonstrates using the *lávvu* model)
> ***Researcher:*** *"And what do you bring into the lávvu?"*
> ***Pupil 2:*** *"A sleeping bag."*
> ***Researcher:*** *"[Do you bring] a sleeping mat?"*
> ***Pupil 2:*** *"Well, you can also use a reindeer skin."*
> ***Researcher:*** *"And here [on the lávvu's floor], is it birch rice?"*
> ***Pupil 2:*** "*Yes, so it doesn't get so wet."*

Figure 5. Different stages of the lávvu model.

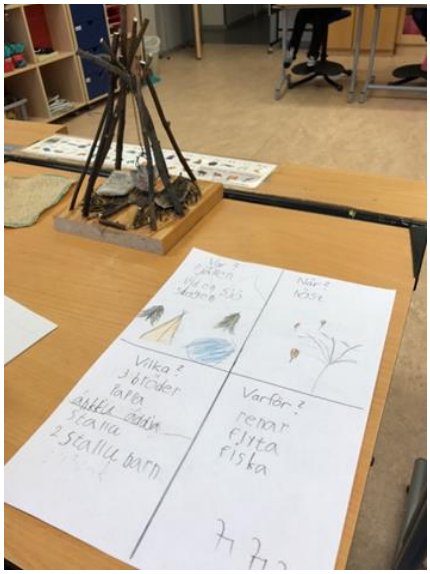

Figure 6. Preparing to write a story.

The pupils were also asked to write a story about the *lávvu*. They were given a sheet of paper divided into four fields with a question in each field: *Where? When? Who? Why?* The pupils filled in who lived in the *lávvu*, where the *lávvu* was situated, when the story took place and why the main characters were in the *lávvu* (Figure 6). The pupils then wrote their own stories. They are the main characters themselves in their stories.

> ***Teacher:*** *"What season is it? How did you get there [where the lávvu is placed]? By ski or by snowmobile? Who are you with… and what are you going to do there?"*
> ***Pupil 1:*** *"We are going to be at the reindeer round-up site… to mark the calves… and to fish."*
> ***Pupil 2*****:** *"We are going to hunt."*

Most of the children wrote that the characters are in the *lávvu* because they are going to hunt, fish or take care of their reindeer. Several of the children draw dogs or other animals like hares, and some draws bear tracks. *Stallo,* a common figure in Sámi mythology and folktales, was also present in one of the pupils' stories.

Technology Project 2: Sámi winter footwear – making threads from reindeer sinews

In the staff room, the teacher informs the researcher that the traditional Sámi winter shoes are made of hide from the legs of the reindeer. Since the hide is thicker in different places on the reindeer's legs, it is important that each piece is put in the right place. Many small pieces are put together. Underneath, the fur pieces are placed in two directions so the wearer does not slip (Figures 7 and 10). The toe hook was originally for putting on skis.

> ***Teacher:*** *"We [the Sámi] have almost invented the ski. It belongs to our history. It goes without saying that we should do work with skis and skiing [at school] … We talked about getting those old skis, with just one strap… and [talk with the pupils about] why our shoes look like they do with this 'beak'. It is a skiing bond… [It is important] that they [the children] understand why things are [constructed] as they are…"*

According to the teacher, Sámi culture includes *"a lot of things that are very old, but we still can and still do"*, such as baking bread on a flat stone over a fire, traditional Sámi ice fishing methods, Sámi handicraft (*duodji*) and how to tie and use different knots.

Figure 7: A Sámi winter shoe

Narratives such as fairy tales and myths are often used in the teaching in this school, and the teacher introduces the activity to the pupils by reading aloud in Sámi from a Sámi picture book, *Silbamánnu, "Silver Moon*" (Horndal, 2016). The story is about a Sámi girl who is very good at spinning threads. One day, she is captured by *Stallo,* a well-known character in Sámi mythology. *Stallo* is a giant troll who eats people. However, the girl outwits *Stallo* by unravelling one of her threads, all the way to the place she is held captive. She is rescued and *Stallo* is killed. The book contains illustrations of artefacts with ancient histories: Sámi clothing, Sámi shoes, a wooden spindle, a wooden milk bowl, a walking stick and longbows. However, modern artefacts such as a quad bike, binoculars, a walkie-talkie and electric power lines are also depicted.

The teacher gathers the pupils in a circle on the floor. She has brought an old Sámi wooden spindle, like the one depicted in the book (Figure 8).

Figure 8: A Sámi wooden spindle.

The teacher shows the spindle to the pupils and uses its Sámi name. She has also brought a bag of sheep's wool, and takes a wad of wool and rolls it against her leg (Figure 9).

Figure 9: The teacher rolls the wool

> ***Teacher:*** *"You soak it a little bit like this [with water] … and put the threads over each other. Look, now it becomes a little bit longer! I can use these threads to knit a sweater … But if I'm going to sew shoes… I need a strong thread."*

The teacher shows a Sámi winter shoe made of reindeer hide (Figure 10). She has also brought an object that looks like a bunch of thick yellow threads.

> ***Teacher:*** "*What is this? Banana peel?"*
> ***Pupil 1:*** *"Sinews!"*
> ***Teacher:*** *"Where are they from, the reindeer sinews? Where can you find them?"*
> ***Pupil 2:*** "*Behind somewhere."*
> ***Teacher:*** *"Yes, they are on their legs, so they can move."*

The teacher puts sinews on a wooden board and starts to process them with a rubber hammer (Figure 11).

> ***Teacher:*** *"Look, now I have loose threads… When they are this small, I soak them… (*she soaks the threads with some water from a cup*), and then I spin them like this, against my leg."*

Figure 10. A Sámi shoe made of hide.

Figure 11. The teacher works the reindeer sinews.

She puts several threads together and rolls them back and forth on her leg.

> ***Teacher:*** *"Now it's finished. Look, how nice! There are 12 threads… I got these from my mother [the sinews]."*

The teacher passes some sinews to the pupils. She repeats the Sámi word for "sinews".

> ***Pupil:*** *"I have sewn with sinews at home."*

The teacher repeats what reindeer sinews are called in Sámi. The pupils are then divided into two groups. One group is going to make sinews threads and the other goes to the classroom next door to make yarn braids.

All pupils are given the chance to work the sinews with the rubber hammer and then twist the threads with help from the teacher. The challenge is to split the threads. The pupils explore the

structure of their threads. One of the pupils pulls the thread to see how strong it is and realises that it is very hard to break:

> ***Pupil:*** *"You can use it as dental floss!"*
> ***Teacher:*** *"Yes, if you don't have sinew threads, you can use dental floss [to sew the shoe]."*

Most of the pupils want to use the sinew threads as bracelets, and the teacher helps them tie the threads around their wrists.

In the afternoon, the class watches an old documentary (from 1923) about the lives of the Swedish Sámi people: "In the Land of the Mountain People". It is a black and white silent movie, and the teacher acts as narrator. While watching the film, the teacher points out things that can be linked to the activity with the sinews, for example a scene showing how tendons from reindeer are hanging on drying racks, and when women process sinews and then use them to sew. She also points out the Sámi shoes that people are wearing.

> ***Teacher:*** *"Look, they used shoe hay instead of socks in the past."*
> One of the pupils immediately responds to what the teacher says:
> ***Pupil:*** *"I've seen that!"*

During the film, the teacher also refers to another technology activity they had previously carried out, the *lávvu* project. Examples of other technological solutions mentioned in the discussions between the teacher and pupils and between the pupils during the lessons include knives, fishing and hunting gear/methods, artefacts connected to traditional Sámi handicraft, fire-making methods, traditional food technology methods, snowmobiles, motorbikes, quad bikes and helicopters.

Another day, in the staff room, the teachers and the researcher discuss the importance of using stories in all teaching, including technology teaching. The teacher tells the researcher that when the pupils were in year 1, they were told a story about a man named *Juffá.*

> ***Teacher:*** *"Juffá gets a walking stick from a Noajdde woman* (Sámi shaman) *and this stick helps him when he gets into trouble, since it is then transformed. Sometimes it turns into a hook, and sometimes it can fly. And then we made walking sticks. They [the pupils] have their own walking sticks now."*

Through stories, and by comparing the past with the present and confirming what the children say, the teacher makes clear links between older and newer technological solutions.

Technology Project 3: The Sámi shaman drum – goavddis

According to the teacher, the Sámi shaman drum has never been a "magic drum", even if it was given that epithet by those who intended to eradicate the Sámi religion. The use of the drum was forbidden, and the drums were collected and burned. Not many have survived, but according to the teacher it is still a strong and important Sámi symbol.

The Sámi shaman drum, *goavddis*, had two functions in the past: 1) a tool that helped the Sámi shaman (the *Noajdde*) to enter a trance and travel to other worlds, and 2) an instrument to

help foretell the future. Common motifs on the drums are ancient Sámi gods and goddesses, reindeer, hunting, quarry animals and encampments (Kuoljok & Utsi, 2009).

The participants in the technology project about the Sámi drum are the year 3 pupils (aged 9). The Sámi drum project starts with a visit to the new town hall, and the teacher asks the pupils to memorise what the handles of the doorway look like. They are made of birch wood and reindeer horn. In the town hall's assembly room, a large decorative carpet on the wall depicts a drum, which the teacher asks the children to observe. Back in the classroom, the teacher introduces the technology project by showing pictures on the smartboard. The first is a photo of the town hall door handles (Figure 12).

Figure 12. The town hall door handles.

> ***Teacher:*** *"Why do the handles look like this?"*
> ***Pupil 1:*** *"Drums."*
> ***Teacher:*** "*That's right! They are made of birch and the white is reindeer horn, and there are engraved signs. They look like the bottom of an old drum, which the Sámi used. And what did they use them for?"*
> ***Pupil 2:*** *"To know where to find reindeer grazing."*
> ***Teacher:*** *"Yes… every family had a drum… it was used to see where to go with the reindeer, to make sure that childbirth went well, and where to find elk to hunt. With the help of the drum, they talked with the gods. Then there were those who were exceptionally good at it, the Noajddes [the shamans]… Then people from outside arrived. They were Christians and they said that [the Sámi] should not believe in this. The drums were collected and burned. One man was also burned when he refused to give up his drum. Some [of these people] thought the drums were nice… they brought them to Rome, Paris… to museums… Today only 71 remain. But last year they found one behind a stone. Someone had hidden it there. It had begun to rot."*

The teacher shows a picture of a drum decorated with bear teeth.

> ***Teacher:*** *"The bear was sacred. If you slaughter a bear and remove the skin, it looks like a human… every symbol [on the drumhead] means something… Here's a beaver, a reindeer corral, an elk, a hunter, a boat… What's in the middle is the sun symbol, this cross. The symbols are popular today, they put them on mugs and on candles because think they are nice… but [people] do not know what they mean."*

The teacher presents pictures of drums decorated with illustrations of Sámi gods and goddesses and talks about the different roles they had in the mythology. The pupils receive a sheet of paper on which the gods' symbols are depicted (Figure 13). They are asked to write down facts about six gods. Three goddesses live in the *lávvu*. In the conversations about the drum, the teacher and the pupils make connections to the *lávvu* project: the goddess who lives at the entrance to the *lávvu* and prevents evil spirits from entering the *lávvu*, the goddess who lives by the fire and protects the family and childbirth, and the goddess who lives in the sacred part of the *lávvu* and brings hunting luck, and who you ask for help if you want your unborn child to be a boy. (The teacher has told the pupils that the Sámi once thought all unborn children were girls.)

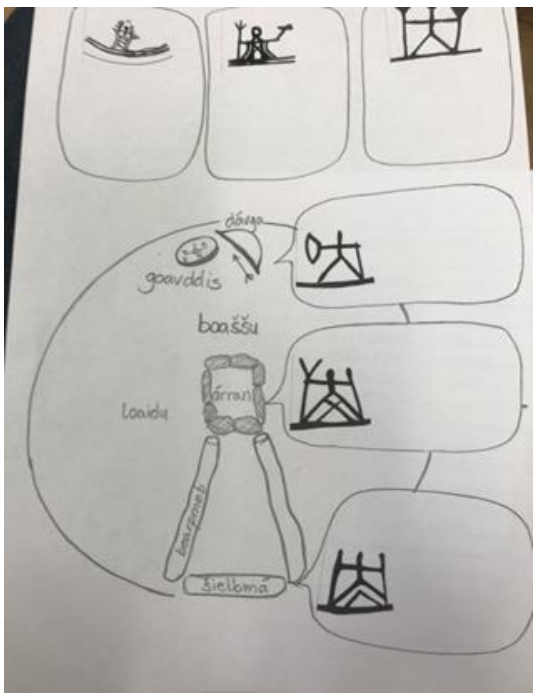

Figure 13. Sámi symbols of gods and goddesses.

Figure 14. Preparing the Sámi drum.

The teacher has prepared 12 concrete frames to form cylinders.

> ***Teacher:*** *"We'll be stretching hide tomorrow, but you have to prepare. Paint any colour you like. When you have finished and it has dried, you can paint symbols."*

The teacher gathers the pupils around a table and shows them how to mix colours, and they start painting their drums (Figure 14). She has brought a hairdryer to dry the painted drums faster.

> ***Teacher:*** *"Here, I have a technical solution!"*
> The researcher assists the pupils and discusses the function of the drum.
> ***Researcher:*** *"Is the drum… technology?"*
> ***Pupil:*** *"Yes, [it's technology] because they [Sámi people in the past] used it to find grazing for the reindeer and to see how you could get well if you were sick."*

While decorating the drums with symbols, the teacher and the pupils discuss the historical illustrations (Figure 15). Just as with the sinew thread activity, the teacher links the past with the present.

> ***Teacher:*** *"They depicted things that were important to them. What symbols could be on the drum if it was used today? A car? A computer…?"*

At the end of the lesson, the pupils are asked to write "a technology logbook", where they will write down examples of technology they use during the course of a day. The teacher explains:

> ***Teacher:*** *"Yesterday, when I left school, I put on my shoes and my ice grippers… Is that technology?"* (She asks the pupils to think quietly) *"… And before I went to sleep, I turned on the tap and brushed my teeth with my toothbrush."*

The following day, it is time to attach the drumheads to the drums. The teacher has brought 12 circular reindeer hides. She gathers the pupils in a circle on the floor and demonstrates how the reindeer hides have been scraped with a specific tool and tanned in a decoction of water and sallow bark.

Figure 15. The pupils decorate their drums with symbols

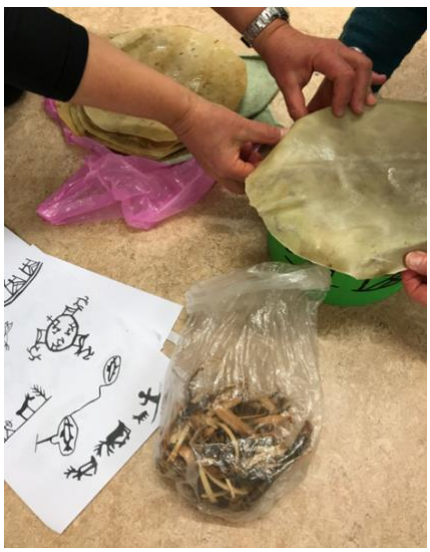

Figure 16. The pupils explore the structure of the hides and the sallow bark

The hides are wet and are kept in a plastic bag, and the teacher explains that this is to stop them from drying out. The pupils explore the structure of the hides and how stretchable they are (Figure 16). The teacher then helps the pupils to attach the drumheads to the frames using a staple gun (Figure 17).

> ***Teacher:*** "*But you will probably also have to fasten [the hides] with bolts and screws, and attach a ribbon over it. They will tighten as they dry.*"

While waiting for help to fasten the hide, the pupils are told to draw a drum on paper. The teacher says they are free to decorate it with old symbols, but they can also draw things that are important to them personally.

> ***Teacher:*** *"It was probably how they thought in the past, too."*

Some pupils draw pictures of Sámi gods and goddesses, reindeer and Sámi dwellings, while others write the names of relatives and pets. The drums are then left to dry (Figure 18).

Figure 17. A staple gun is used attach the drumheads.

Figure 18. The drums are left to dry.

When constructing the shaman drums, as in the other two described activities, the teacher instructed the pupils and they imitated what the teacher did. However, the teacher also confirmed the pupils' alternative suggested solutions and encouraged them to personalise their drums by decorating them with illustrations that symbolise what is important to them personally and today. During the drum activities, the teacher and the pupils discussed both older and modern technological solutions to meet the same human needs and wants. For example, there is hospital technology today that can save mothers and children during complicated births. In the past, people had to rely on using their shaman drums and asking the

gods for help. In the past, reindeer herding used skis as the only means of transport. Today, modern technology such as snowmobiles, quad bikes, motorbikes and helicopters are used.

Identified themes

Through an interpretive analysis process of underlying meanings, based on Keirl's (2006) dimensions of technological literacy, and answering the questions *why*, *how* and in *what* *way* (Erlingsson & Brysiewicz, 2017), six themes emerged*:*

- Meaning-making through cultural artefacts
- Creating links between the past and the present
- Contextualisation through myths and storytelling
- A holistic view of technological knowledge
- Collective technological knowledge
- The symbolic value of technology

Meaning-making through traditional cultural artefacts

Technology education in this Sámi school can be described as being strongly connected to specific *traditional cultural artefacts*, exemplified in this case study through technology projects with the *lávvu*, the Sámi winter shoe and the shaman drum. By using artefacts with a strong connection to culture and a focus on 'how' the artefact is used and 'why' (James, 2015), the activities become meaningful for the pupils. The artefacts were presented as having both physical and intentional properties (de Vries, 2005; Kaplan, 2009; Kroes and Meijers, 2002), and as being a result of cultural conditions (Ihde, 1990, 1993; Kroes & Meijers, 2002; Vermaas et al., 2011). By using specific artefacts as a starting point for technology teaching, both historical and cultural perspectives were made clear.

This confirms that artefacts can play an important role in technology education (de Vries, 2005; Frederik et al., 2011). Previous research indicates that too strong a focus on artefacts can result in the connections between artefacts, humans and culture being disregarded (Mawson, 2010; Siu & Lam, 2005; Turja et al., 2009). However, the findings in this study demonstrate the opposite.

Creating links between the past and the present

In the teaching, there was a strong *link between the past and the present*, for example by comparing the *lávvu* with a caravan, shoe hay with socks and sinew threads with dental floss. The message was that although some knowledge is old, it remains important and relevant even today; new and old technology is often used side by side. Cultural artefacts mentioned during the technology lessons which have a long history but are still used include skin shoes, skis, reindeer skins as sleeping mats, traditional food technology methods, Sámi fishing methods, the traditional Sámi knife, and other artefacts connected to Sámi handicraft.

By using the cultural artefacts as a starting point in the teaching, the pupils were given the opportunity to see that technology is not only modern high-tech; it is an age-old tradition of problem-solving, modification and adaptation to fulfil our needs (Lee, 2011). The function of a technological artefact is often to extend our human capabilities (Lawson, 2008, 2010). Even if new technological solutions emerge and others disappear, there are also technological

solutions that remain and continue to be used (Edgerton, 2006; Kelly, 2010). In this way, technology's enduring dimension was highlighted (Axell, 2015).

The connections between older and newer technological solutions created opportunities for the pupils to develop an understanding of the driving forces behind technological development and change (Swedish Agency for Education, 2018).

Contextualisation through myths and storytelling

Myths and *storytelling* were important teaching elements in this Sámi school, and were frequently used to contextualise the technological content. For example, stories about *Stallo*, a common mythical figure in Sámi folklore, were a recurring element in teaching. The stories were largely conveyed orally by the teacher, but were sometimes already known by the pupils. These findings are in line with Owuor (2007), who notes that indigenous knowledge and skills are often transmitted from one generation to the next through narratives, symbols and art. The pupils also created their own fictional stories. This also confirms previous research suggesting that stories can be used in technology education to contextualise the technological content. Narratives and stories can act as springboards for discussions about the nature of technology and the driving forces behind technological change and its impact on society, people and nature in the past and the present (Axell, 2015, 2017, 2018).

A holistic view of technological knowledge

Technology education in this Sámi school was implemented using a thematic approach. In all three technology projects included in this study, the context was central and included both historical and present perspectives, with clear connections to other subject areas, such as science, religion, history and crafts, as well as other teaching activities. The fact that each technology activity was linked to many different perspectives and subjects indicates that technological literacy in this Sámi school is grounded on a *holistic view of knowledge*. It also confirms that indigenous knowledge systems are holistic (Keskitalo & Määttä, 2011; Keskitalo et al., 2012; Svonni, 2015).

Collective technological knowledge

During the activities, the teacher and the pupils frequently referred to contexts outside school. For example, several of the pupils testified that they knew how to build and use a *lávvu*, what reindeer sinews are used for, how the Sámi winter shoe is constructed, and what a shaman drum is. In the activities, the teacher also noticed and took advantage of the pupils' own experiences and knowledge. Additionally, the teacher's pedagogy was characterised by a "show-and-copy" strategy. This can be regarded as a natural choice in this context, since the technological knowledge linked to the specific cultural artefacts is passed on from one generation to the next.

The technological knowledge mediated in this Sámi school can thus be described as connected to inherited knowledge, but also linked to practical applications and skills (Keskitalo & Määttä, 2011; Keskitalo et al., 2012; Svonni, 2015). This confirms that indigenous technology is collective and based on knowledge that has been developed over many generations (Bondy, 2011; Gumbo, 2018). The fact that children bring their own technological knowledge and

understanding is an important aspect to be recognised by teachers in order to create relevant and authentic learning (e.g. Mawson, 2013).

The symbolic value of technology

In the activity with the shaman drum and in the *lávvu* project, connections between technology and religious beliefs were made clear. One example is when a pupil explained that the shaman drum is technology since the Sámi people previously used it to find grazing for the reindeer and to cure diseases. Historically, there has been a relationship between technology and religion. This aspect is highlighted by Cheek (2018), stating that if by *technology* we mean human activities that seek to meet human needs and wants by creating "the ever-evolving, human-designed environments" (p. 52), we can identify an interaction between religious traditions or practices and the goals, skills and methods of the technological world. Both technology and religion seek to solve human problems, fulfil human needs and improve human conditions. Even if the technological development is independent of any specific religion, religions have inspired technologies that support different belief systems (Cheek, 2018).

The teacher also pointed out the symbolic value of technology when she noted that the Sámi previously depicted things on their drums that were important to them, and suggested that a car or a computer could be possible decorations on a drum today.

Hence, technological knowledge, activities and specific artefacts included in technology education in this Sámi school are not only attributed a practical value, but are also given what can be described as a *symbolic value*. Artefacts are created to satisfy human needs and wants, but they also say something about us as individuals or as a group (Axell, 2015; Ellul, 1978; Kroes, 2012). The symbolic value of technology can also be linked to a sense of community and contributes to strengthening the Sámi children's cultural identity.

Conclusions

In accordance with Keirl's (2006) three important dimensions of technological literacy – *operational*, *cultural* and *critical* – the technology teaching described in this study included all three aspects. The pupils learned to use and do the technology, and their learning was contextualised through different kinds of narratives and references to their lives outside school and to Sámi culture. The critical dimension was also present. Using specific cultural artefacts as a starting point, comparisons were made between older and more recent technological solutions. However, modern technology was not portrayed as superior to older technology. The focus was rather to emphasise that the same human needs and problems can be solved with different kinds of technology, and that much of the technology that is still in use has a long history. By including indigenous knowledge in technology education, it is possible to avoid the technological version of the 'Whig theory of history', where the past is portrayed as an inevitable progression, driven by human progress where everything has only improved (Lee, 2011).

The three examples of technology projects in this study include aspects which are generally regarded as part of technology education, as well as aspects that are less common: indigenous technological solutions and the connection between religion and technology. In conclusion, this study confirms that artefacts can play an important role in technology education and that an

understanding of the relationship between technology and culture can be regarded as a critical part of technological literacy. A cultural context, in combination with a holistic perspective on learning, gives artefacts meaning and provides a context within which they are used. Including indigenous technological knowledge can thus not only prevent a marginalisation of indigenous knowledge, it can also provide opportunities to broaden pupils' horizons of what technology is, how it evolves, and the driving forces behind technological change.

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