# Preparing students for the future: multidisciplinary perspectives on pedagogical activities and their spatial embeddedness

Katri Sarkio, Tiina Korhonen & Kai Hakkarainen

Published online: 06 Dec 2023.

Submit your article to this journal ↗

Article views: 154

View related articles ↗

View Crossmark data ↗

Routledge
Taylor & Francis Group

# Preparing students for the future: multidisciplinary perspectives on pedagogical activities and their spatial embeddedness

Katri Sarkio ⬤, Tiina Korhonen ⬤ and Kai Hakkarainen ⬤

Faculty of Educational Sciences, University of Helsinki, Helsinki, Finland

**ABSTRACT**

To implement educational transformations that prepare young people for the future society, it is valuable to deepen scientific understanding of socio-cultural, psychic, and physical aspects of learning environments. Towards that end, in this case study we examined educators' and construction specialists' perceptions of pedagogical activities and how design of physical learning environments intends to reciprocally support those activities in the context of constructing a new school building during the national renewal of general upper secondary schools in Finland. The study relied on multidisciplinary interviews ($n = 22$), observations and outcomes of participatory workshops, teachers' free-form notes on benchmarking visits to recently occupied learning environments, and the operational requirements and goals that architects had prepared for the new building. Our analysis resulted in a framework comprising spatio-pedagogically interrelated themes of collaboration and community building, teaching and learning transversal competencies, supporting students' wellbeing and inclusion, and digital instruments and technologies in support of teaching and learning. The results appear to indicate that pedagogical activities and their spatial embeddedness would have interrelations when constructing new learning environments that aim at collaborative knowledge creation, creative problem-solving, and teaching practices that build on the learners' knowledge and active roles in learning.

## Introduction

Improving our abilities to explain school spaces response to pedagogical needs, could help educators and construction specialists to build learning environments that foster achieving schools' pedagogical goals. The novel national core curriculum (EDUFI, 2019) forces Finnish general upper secondary schools (GUSSs) to turn their subject-specific and teacher-oriented practices towards cross-curricular and inter-organisational collaboration. To support the required collaborative practices, many schools are renewed. Closed classrooms along corridors are bygone, and teachers need to adapt to increasingly open learning environments and use digital instruments

**CONTACT** Katri Sarkio ✉ katri.sarkio@helsinki.fi 🖥 Faculty of Educational Sciences, University of Helsinki, Siltavuorenpenger 5 (P.O. Box 9), Helsinki 00014, Finland

and technologies in achieving their pedagogical goals. From multidisciplinary perspectives, we aimed to examine pedagogical practices and social interactions, and their spatial embeddedness in relation to GUSSs' national pedagogical renewal. With spatial embeddedness we refer to how design of physical learning environments intend to support a certain pedagogical need. The investigation was conducted within the construction of a new school building, where the educators and the construction specialists collaborated throughout the process towards flexible, multifunctional, and increasingly open learning environments that would foster achieving the GUSS's pedagogic goals. In addition to physical layout, the process was to address social and psychical aspects of learning environments, which build upon values and learning goals of individuals and society (Leinonen & Mäkelä, 2022).

The Finnish educational system is highly regarded (Hargreaves & Shirley, 2009; OECD, 2020; Tse, Daniels, Stables, & Cox, 2019) and is continuously being improved. In Finnish educational system, after a nine years compulsory comprehensive school, adolescents apply either to a GUSS or a vocational school. Those both provide possibilities for applying higher educational institutes (HEIs). The Finnish educational system is inclusive from its offset and hence, in most cases students with special needs study in regular schools. Only few continue their studies with tailored study trajectories in special vocational schools that have very limited intake. Main stream of adolescents apply to GUSSs, to which in 2019 thereupon compulsory comprehensive school 54% of all adolescents were admitted (Statistics Finland, 2020). GUSSs aim to help students become competent and flourishing members of the society, and to provide them with knowledge and skills for engaging in working life, lifelong learning, and continuous personal development. Recent GUSSs reform that entered into force in 2021 (EDUFI, 2019; Finlex, 2018) a) increased the age of compulsory education from 16 to 18, b) stressed integrative cross-curricular studies, c) obligated to working life and universities collaboration, and d) altered selecting main stream of students to HEIs on school grades basis. The matriculation examination, which is the only high-stake test in Finland, was also gradually digitalised between 2016–2019.

The reform entails pedagogical renewal. The novel core curriculum (EDUFI, 2019) seeks to develop students' creativity and transversal competencies. It emphasises personal learning trajectories, cross-cutting collaboration, wellbeing, and counselling. For example, student counsellors assist students in constructing timetables, and special needs teachers support them with learning difficulties. Integrated to the subject teaching, teachers need to equip students with transversal competencies that the curriculum names as multidisciplinary and creative, wellbeing, global and cultural, ethical and environmental competencies, and civic and interaction skills (EDUFI, 2019). GUSSs strive towards learning centricity, which we refer to pedagogic practices and social interactions that holistically accentuate collaborative knowledge creation, creative problem-solving, and teaching practices that build on learners' knowledge and active roles (Bransford, Brown, & Cocking, 2000; Everhart, 2006). The sought pedagogical renewal challenge prevailing teacher centricity and single subject-focus, and place teachers under time-content pressure. Concurrent to the called transversal competencies and cross-curricular collaboration, the subject-specific curriculum requirements are heavily loaded and examined in the final examinations. Nonetheless, developing transversal competencies is recognised globally central in educational improvement (UNESCO, 2020). The competencies reflect so-called 21$^{st}$ century skills related to globalisation,

creativity, innovation, wide-ranging core and contextual skills, and information and communication technologies (van Laar, van Deursen, van Dijk, & de Haan, 2017).

## Pedagogical activities interconnected with learning environments

The above-described educational reform engenders a need to reconsider school spaces; traditional classrooms, corridors, and inflexible pieces of furniture dominate numerous schools hindering collaborative activities. Practices, however, shape the innovativeness of a space. Teachers can use simple spaces innovatively, and learning environments that are progressive in their digital-spatial designs can be used conservatively. Many Finnish schools have been renewed so that they are more open and flexible learning environments with digital instruments and technologies supporting teaching and learning. Flexibility in physical learning environments is understood diversely from having adaptable furniture to prevailing openness (Dovey & Fisher, 2014; Woodman, 2016; Woolner & Stadler-Altmann, 2021). The spatial flexibility is to be achieved with convertibility of building elements, such as folding walls and lightweight furniture, and with fluidity involving capacity for flow and change between pedagogical activities (Dovey & Fisher, 2014). Reflecting Dovey's and Fisher's (Dovey & Fisher, 2014) notion of fluidity, we draw from Woodman's (2016) perception of flexibility that it comprises time-wise availability, suitability for pedagogical purposes, spatial design taking individual needs into account, and digital instruments and technologies increasing teaching, learning, and collaboration opportunities. We use the term an innovative learning environment (ILE) to refer to an emerging digitally and spatially renewed pedagogical environment that makes learners and collaboration central, and promotes cross-curricular and inter-organisational activities (Benade, 2021; Deppeler & Aikens, 2020; Imms, 2016; Mulcahy & Morrison, 2017; OECD, 2013; Silander et al., 2022; Stahl & Hakkarainen, 2021). Pedagogical activities are inseparable from and reciprocally shape school spaces and mediating technologies (Tse, Daniels, Stables, & Cox, 2019; Woolner, McCarter, Wall, & Higgins, 2012), the kind of interrelations that the stakeholders involved in this study focus in the construction of the new school building in pursuit of learning centricity. Researchers have suggested that the material facets of digital instruments and technologies and alterations in school spaces entail transformation in ways of teaching and learning, and in a school's operational culture (Daniels, Tse, Stables, & Cox, 2019; Gislason, 2018; Pettersson, 2021; Stadler-Altmann, 2015).

A central issue in educational improvement is the systemic understanding of educational environments (Avelar, Da Silva-Oliveira, & Pereira, 2019) that provide educational leaders with the capability of responding to a school's operational environment in order to achieve sustainable educational change (Fullan, 2002; Leithwood, Harris, & Hopkins, 2020; Osborne, 2016). In addressing desired learning centricity, we considered a school to be a holistic operational environment (Sarkio et al., 2023), consisting of an ecosystem of inter- and intraorganizational collaboration practices, digital instruments, learning environments that involve physical, socio-cultural, and psychic environments (Leinonen & Mäkelä, 2022; Nonaka & Konno, 1998), leadership, and operational culture. A school culture comprises organisational structures and processes, shared beliefs and values, and basic underlying assumptions (Schein, 2017) that guide how the school community works towards attaining educational goals. Gislason (2018) suggested approaching learning environments as

a combination of a school's physical design, educational culture, organisation, and student dynamics. Correspondingly, Imms (2016) suggested examining learning environments as a summary of their physical designs and the occurring pedagogical practices within the context of the potential measurable learning that teaching facilitates. We drew on socio-materiality (Orlikowski, 2007), with the view that social and material in everyday organisational life is inherently entangled. We approached the social as human actions and interactions, and the material as physical school spaces and digital instruments and technologies.

Researchers have indicated that taking a spatial perspective to learning environments in educational research can provide novel insights (Benade, 2021). In examining educational phenomena, the influences of materiality are, however, often disregarded and are considered to be background contexts for educational activities (Decuypere & Simons, 2016; Fenwick, 2014; Fenwick, Edwards, & Sawchuk, 2011). Davies et al. (2013) identified common spatial and pedagogical environment factors that support creative skills development in ILEs. The spatial factors addressed the flexible use of space and time, the availability of materials, and the use of outdoor environments. The pedagogical environment factors related to inter-organisational partnerships, respectful relationships, peer collaboration opportunities, non-prescriptive planning, gamification, and playfulness with a degree of learner autonomy and an awareness of learners' needs. Investigations also indicated that students, educators, and architects emphasise collaborative actions when assessing the affordances of ILEs (Reinius et al., 2021; Young, Cleveland, & Imms, 2020). Moreover, earlier findings suggested that to understand forms of pedagogical activities that are enacted within school spaces, the collaboration of educators and architects is vital to make better decisions concerning the design and the use of school spaces (Daniels, Tse, Stables, & Cox, 2019; Deppeler & Aikens, 2020; Gislason, 2010; Woolner, Hall, Wall, & Dennison, 2007; Young, Cleveland, & Imms, 2020). Jindal-Snape et al. (2013) findings indicated that creative learning environments comprising physical flexibility, creativity-enhancing pedagogical activities, and external partnerships have an impact on learner's attainment, confidence, resilience, motivation, school attendance, and problem-solving and interpersonal skills.

## Research aims

Surrounded by the national GUSSs' reform, we investigated how multidisciplinary stakeholders participating in a construction process of a new school building perceived pedagogical activities and their spatial embeddedness in relation to educational transformation heading towards learning centricity. The research questions were:

(1) What kind of pedagogical activities did educators and construction specialists consider reflected learning centricity?
(2) How did they describe spatial embeddedness reflecting and supporting these pedagogical activities?

## Materials and methods

### Participants and setting

We implemented our case study (Yin, 2014) in an early phase of an ongoing long-itudinal 2020–2024 design-based (McKenney & Reeves, 2019) research project. The project traces the participatory efforts of a school community in constructing a new school building as a life-span model. Initially, the municipal education provider's architects had prepared operational requirements and goals (ORGs) for the building that heavily guided its design. Subsequently, the education provider selected in a design contest an architect studio and a construction company to be the implementers. When the winning coalition was announced in late 2020, the implementers initiated partici-patory efforts with the school community, addressing interior design, fixtures, and minor alterations to the floor plans according to the school's pedagogical needs. After the new building is completed in fall 2023, the construction company is responsible for its maintenance for several years.

The investigation built on a research-practice partnership (RPP, Coburn & Penuel, 2016), which is a prominent practice in sustainable improvements of educational systems, as such improvements focus on problems of practice and longitudinal improvement efforts. The RPP stakeholders involved the university as a research partner; the municipal education provider's architects, educational leaders, and experts; architects and construction specialists of the construction company and the partnering architect studio; and the principal and about 50 teachers' community of the case study GUSS. The GUSS is located in Helsinki metropolitan area and has about 650 students.

### Data acquisition

We collected the data from the teachers' perspective during the design contest prior to the participatory efforts. After the winning company coalition was announced, we interviewed the engaged architects, the civil engineer, the educational leaders, and the pedagogical expert. All participants participated voluntarily with informed consent. The data comprised interviews, collective workshops outcomes, fieldnotes, and the ORGs (Table 1) representing the participants' visions on ILEs prior to deployment.

To explore the first research question addressing pedagogical activities, we con-ducted and audio recorded semi-structured interviews. We investigated the teachers' ($n = 10$), the educational leaders' ($n = 3$), the pedagogical expert's, the architects' ($n = 7$), and the civil engineer's perceptions of learning-centric practices, digital instru-ments and technologies, and school spaces supporting those practices. In the inter-views, we first asked the participants to portray GUSSs' operational cultures, and the novel core curriculum and the transversal competences it entails. Then, we asked the participants to describe their perceptions on digitalisation, and digital instruments and technologies in the GUSS context. In addition, we invited the participants to describe school spaces they considered to support pedagogical activities that the novel core curriculum entails. In the teacher interviews we also, in accordance with the critical incident technique (CIT, Butterfield, Borgen, Amundson, & Maglio, 2005; Flanagan, 1954), repeatedly asked them to describe experiences of teacher collabora-tion and teaching of transversal competencies. We sampled the interviewed teachers

**Table 1.** Data triangulation.

| Data | Participants | Description |
| --- | --- | --- |
| Semi-structured interviews | Teachers ($n = 10$) Educational leaders ($n = 3$) Architects ($n = 7$) A civil engineer A pedagogical expert | Total: 23 h 50 min. Length varied between 33–81 minutes. Six men (27%), 16 women (73%). Teachers (about 20% representation) represented various subject domains and digital-collaboration profiles. |
| Collective space-workshop outcome (Padlet) | Teachers ($n = 39$) | Duration: 2 h. Facets perceived important in learning environments. |
| Researcher's vision-workshop field notes | Teachers ($n = 30$) A principal | Duration: 3 h. Discussed pedagogical activities and goals set for the school's pedagogical renewal. |
| Teachers' benchmarking field notes | Teachers ($n = 2$) | Two visits to recently occupied new buildings. |
| ORGs | Municipal educational provider's architects. | 32-page document prepared for the design contest. |

based on a pre-survey that we conducted with them ($n = 31$), where we enquired about their subject domains and digital-collaboration profiles (Sarkio et al., 2023). In the pre-survey the teachers self-evaluated on nine claims their activity in teacher and inter-organisational collaboration, versatile use of digital instruments and school spaces for pedagogical activities. We normalised the total scores of their Likert scale 1–7 responses and created five digital-collaboration profiles of "very low" (0–0,19), "low" (0,2–0,39), "medium" (0,4–0,59), "high" (0,6–0,79), and "very high" (0,8–1). We invited teachers for the interviews with profiles of very high ($n = 0$), high ($n = 1$), medium ($n = 4$), low ($n = 3$), and very low ($n = 2$). None of the pre-survey respondents had achieved the very high profile. In a participatory vision workshop with an external facilitator, we also took field notes on the pedagogical activities that the teachers discussed. The workshop resulted in five main goals concerning the school's pedagogical renewal, which were collaboratively generated and prioritised.

To address the second question regarding the pedagogical activities' spatial embeddedness, we acquired the ORGs and the teachers' free-form field notes on their two benchmarking visits to a recently constructed school and a university of applied sciences. We also organised a participatory school-spaces workshop for the teachers ($n = 39$). We challenged them to consider spatial dimensions that they perceived supported teaching and learning the competencies that the novel curriculum entails. In small groups the teachers recorded on a collective digital Padlet platform what they perceived to be important in learning environments. The Padlet was organised under the thematic headings of community and communal learning, future skills, learner wellbeing and inclusion, ubiquitous learning, digital instruments as enablers of creative learning and teaching, and topics emerging spontaneously. The thematic headings were based on our preliminary qualitative content analysis of the ORGs, the GUSS's pedagogic plan, and the national core curriculum that we had conducted to support the data collection.

## Data analysis

To answer the first question on pedagogical activities, we anonymised and transcribed our interviews and vision workshop field notes. For the qualitative content analysis, we iteratively conducted an inductive descriptive coding in Atlas.ti (Friese, 2012; Saldãna,

2013; Thomas, 2006). In the interview data, we focused on the text segments related to the pedagogical activities. The unit of analysis comprised one coherent educational goal or pedagogical activity.

To respond to the second question on the spatial embeddedness, we conducted in Atlas.ti a corresponding qualitative content analysis of the ORGs, the spaces-workshop outcome, the teachers' benchmarking field notes, and in the interview data the text segments that related to the school spaces. We applied one mention or an idea comprising the smallest coherent unit of meaning as the unit of analysis.

The iterative coding and grouping processes resulted in four spatio-pedagogically interrelated main themes: 1) collaboration and community building, 2) teaching and learning transversal competencies, 3) supporting students' wellbeing and inclusion, and 4) digital instruments and technologies in support of teaching and learning. Whereas the interview and vision-workshop data involved rich descriptions of pedagogical activities, the ORGs, space-workshop, and teachers' field notes data focused mainly on spatial embeddedness. Table 2 presents a framework around the main themes identified and their subordinates, supplemented with example quotations on how the interviewees described the spatio-pedagogical interrelations as translated by us. We edited the excerpts minimally and marked deletions with three dots [...].

## Results

The results are structured according to the presented thematic framework. First, we report pedagogical activities and move from the collaboration and community building theme towards digital instruments and technologies in support of teaching and learning. Thereafter, we describe the spatial embeddedness that the analysis of the data resulted to support these activities. We refer to the architects and the civil engineer jointly as the construction specialists, and to the teachers, the educational leaders, and the pedagogical expert jointly as the educators.

### Pedagogical activities supporting learning centricity

First, we answer the research question addressing pedagogical activities. The results ground mainly on the interviews and accentuate the teachers' perspective, which mirrors the applied CIT, where we repeatedly asked the teachers to describe realised pedagogical activities. The teachers' fieldnotes from their benchmarking visits, the Padlet outcome of the spaces-workshop, and the ORGs are unobstructive, as those concerned almost exclusively spatial remarks.

### Activities supporting collaboration and community building

All interviewees stressed intra- and inter-organisational collaboration in enforcing curricular activities. Regarding intra-organisational collaboration, the teachers reported diverse collaborative practices realised in planning, and in teaching and learning activities within one subject and in cross-subject settings. Some teachers, though, reported cross-curricular studies being contrived in their subject. The teachers reported planning activities that were realised bilaterally, in small teacher groups within and across the subject domains, and among the entire teacher

**Table 2.** A thematic framework: pedagogical activities and their spatial embeddedness.

| Theme | Pedagogical activities | Spatial embeddedness | Example quotations |
|---|---|---|---|
| *Collaboration and community building* | | | |
| | • Collaborative teaching and learning practices<br>• Communal events and<br>• International and organisational collaboration | • Flexible and diverse learning spaces<br>• Tranquil learning spaces for student groups of all sizes<br>• Subject-specific profiling allowing shared use of premises<br>• A staff room and co-planning facilities<br>• Social openness<br>• Multifunctionality for exhibitions, events, and visitors<br>• Physical proximity to other actors in the society | *"I think that spaces that will force a little change in thinking will force cooperation, so they will also take it forward. If you make too many spaces for intensive working, like a class of a certain size with a traditional layout where you can teach your lesson behind closed doors, then it does not support change".* (Educational leader B)<br>*"I think that the students' spaces should be a "passage" – it is easier to join others spontaneously when passing. "One door" spaces easily become used by a group/clique, at least momentarily".* (Teacher B) |
| *Teaching and learning transversal competencies* | | | |
| | • Preparation of students for the society and future studies<br>• Development of critical thinking skills<br>• Ecosocial education<br>• Cross-curricular studies<br>• Phenomenon-based and authentic learning, outreaching a school building's walls | • Block areas conjoining subjects<br>• Facilities for non-regular activities<br>• Surfaces supporting ideation<br>• Support for sustainable lifestyles | *"After all, we cannot predict what will happen in time when they [students] enter working life, what it will be, what skills will be needed. This is an anticipation of something to come that no one knows about".* (Pedagogical expert A)<br>*"The kind of grouping and cellular thinking [...] that [e.g.] science classes are close to each other, which then provides functional synergy, and also this informal teaching space [a common learning area] that connects to those more formal classroom spaces".* (Architect B) |
| *Supporting students' wellbeing and inclusion* | | | |
| | • Students' self-efficacy and agency support<br>• Students' taking responsibility for their own learning<br>• Support for learning and streaming students<br>• Student counselling, individual study paths, and multi-professional student welfare services | • Creative, healthy, and aesthetic environment<br>• Acoustics and illuminated conditions<br>• Accessibility and navigation<br>• Visual connections for social surveillance and security<br>• Nutrition and hydration facilities<br>• Ergonomics and elements increasing students' physical activity | *"I consider the essence of my work that it develops the notion that 'I [a student] am an independent actor and that I [a student] can somehow respond to future stimuli from the world [...]' that in my work I [a teacher] somehow support [the student's own] self-efficacy".* (Teacher C)<br>*"I think about wellbeing, that attention is paid to acoustics, that there are really such acoustic conditions that one can focus on what is supposed to be done".* (Architect C) |

(*Continued*)

**Table 2.** (Continued).

| Theme | Pedagogical activities | Spatial embeddedness | Example quotations |
|---|---|---|---|
| *Digital instruments and technologies in support of teaching and learning* | | | |
| | • Expansion and facilitation of networking and cooperation opportunities<br>• Diversity and availability of educational material<br>• Remote and hybrid teaching<br>• Digital instruments, collaboration and learning environments facilitating daily activities<br>• Usage of innovative technologies | • Adequate and uniform basic equipment, and network connections<br>• Several screens<br>• Implementation and reserves for innovative technologies<br>• Locking, monitoring, space reservations, and general information systems | *"Remote connections certainly allow a lot, but it is not the connection itself, but how to be connected".* (Teacher A)<br>*"I think that (s)he [a teacher] should throw oneself into the situation that if we have such an [immersion] wall where you can project a picture, or these ceiling loudspeakers where students can connect their own cell phones and listen to pronunciation, then how could I [the teacher] get the most out of these things".* (Architect C) |

community. Within one subject in one course, the teachers described typical collaboration occurred between a subject and a special needs teacher, and two or more teachers of the same subject. The teachers described, for example, how they first combined two groups of 40 students each, and then divided them into groups of sizes varying from 10 to 50 students per teacher. In the vision-workshop, the teachers discussed about the importance of students working in pairs. In cross-curricular settings, both in the interviews and in the vision-workshop, the teachers reported jointly organised courses, single lessons, international and inter-organisational activities, projects, and thematic camps. Typically, languages were combined with other subjects. Although to a lesser extent, the interviewed teachers reported activities that concerned remedial instruction, student counselling, multi-professional collaboration related to student welfare services, mentoring student teams, and general functions supporting the school community.

Regarding inter-organisational collaboration, few interviewed educational leaders highlighted the fact that on a national level the obligation for GUSSs to collaborate with HEIs is a major renewal. The interviewed teachers, accordingly, reported courses both organised jointly with HEIs, and HEI courses that students completed during their GUSS studies. The teachers also described company collaboration realised in versatile ways and varying from single visitors to workshops and theme weeks. A novel approach to inter-organisational collaboration was offering some courses remotely to students from different GUSSs.

As to community building, the teachers reported a variety of communal event days and theme weeks in which they had integrated collaboration with HEIs, companies, school alumni, etc. In the ORGs that the municipal education provider's architects had prepared, togetherness enhancement was related to communal events, such as graduation ceremonies.

## Activities supporting teaching and learning transversal competencies

When asked what the interviewees considered to be the transversal competencies that the core curriculum refers to, they reported that they were pedagogical activities that prepare students for society, postgraduate studies, the matriculation exams, and

promote critical thinking skills and crystallise one's own competencies. Transversal competencies were generally described as creativity, skills to use digital instruments and to apply subject-specific knowledge more broadly, and as collaboration and behavioural skills, such as meeting deadlines. They also reported as transversal competencies eco-social education, which was described as practical skills, such as recycling, and awareness of environmental issues like climate change. In the vision-workshop, the teachers considered that GUSSs' purpose is to raise responsible adults who also bear global responsibility. The interviewed teachers described teaching and learning transversal competencies realised in collaboratively organised cross-curricular studies and phenomenon-based learning, where students study generalisable topics within one subject, the same theme from different subjects' perspectives, and large-scale phenomena, such as the COVID-19 pandemic. Some also mentioned cursory laboratory works and gamified activities. One educator noted that in any case the future and the skills needed are unpredictable.

Albeit transversal competencies are central in the novel curriculum, describing them was easier for the construction specialists than the teachers, among whom most hesitated. Both in the vision-workshop and the interviews, the hesitant teachers considered transversal competencies to be an abstract concept that is difficult to teach and evaluate. At the same time, these teachers mentioned that transversal competences had already been a part of GUSS education, although they had not been specifically highlighted in the previous curricula. The construction specialists, on the other hand, listed transversal competencies effortlessly. Half of them, though, found themselves unfamiliar with GUSSs' operational environment.

### Activities supporting students' wellbeing and inclusion

The interviewed teachers considered that developing students' self-confidence and their abilities to set goals and perceive the world supported students' self-efficacy and agency and this in turn enhanced wellbeing and inclusion. Some teachers found it central to impose a sense of purpose to make students understand that, as they study, they accumulate capital for themselves for the future. In the vision-workshop, the teachers described important to focus on how to get students motivated, participate, understand the importance of regular work in studying, and take responsibility for their own studies. Both in the interviews and the vision-workshop, the teachers related students' empowerment to increased learning skills, experiences of success, transcending oneself, and to moments of epiphany. Some interviewed teachers reported that their role was to encourage students to be the best version of themselves and to make their success apparent. This, teachers thought, required the ability to focus on students and build an encouraging atmosphere. Instead of a teacher explaining matters efficiently, teachers found it essential to activate students by asking, providing peer feedback, and giving students the responsibility to explore things for themselves. This activation, however, implied from teachers the ability to liberate themselves from a planned script and to allow

space for discussions. As a mean to promote students' responsibility for their own learning, teachers reported students' engagement in course planning. The teachers had also challenged students to consider for themselves the skills they needed to develop, and how and in what kind of a group they wanted to study, such as how much teacher's support they considered necessary. One teacher discussed this notion of taking responsibility for oneself as follows:

**Excerpt 1.**

Researcher:   What did you do so that it worked?

Teacher A:   Perhaps the fact that in a certain way it [the assignment and instructions] has a structure, but then within the structure giving and allowing [students] to perform in many ways.

Researcher:   Why do you think that this made it work?

Teacher A:   Maybe because then a student also has to take responsibility for it. Of course, you get advice, but when you decide yourself what that [assignment output] contains, so that when you take responsibility for it, then maybe doing the assignment feels more like it's personal and one's own. In particular, if you succeed in that in your own situation, regardless of whatever your prior level [in the subject] is or what you think about the subject, then somehow that success is even greater, it's even more to do with your own work and you taking responsibility.

The teachers attached student guidance and counselling to wellbeing and inclusion. They reported that it comprised both subject teachers and student counsellors introducing fields of studies and professions. One educator described teachers as youth counsellors due to their everyday encounters with adolescents. To support students' individual needs and life situations, multi-professional student welfare group collaboration was briefly mentioned. The teachers reported diverse activities that supported learning and streaming students, such as distinctively communicated course and lesson structures and goals, variation in assignments and verbalising those if students had inadequate language skills, and collaboratively organised remedial instruction workshops. One interviewee also noted that it was central to recognise learning difficulties and organise support for learning and individual guidance in compulsory courses.

Few construction specialists considered that learners' holistic wellbeing would prevent mental health problems, and offer a shield in competitions for postgraduate studies and where there were job insecurity pressures. One architect also noted that teachers' wellbeing and collaborative practices influence students' behaviour and collaborative endeavours.

## Exploitation of digital instruments and technologies in support of teaching and learning

The interviewees conveyed digitalisation in GUSSs primarily as usage and in terms of an increasing number of digital instruments and learning environments. They reported a shift in examinations from paper examinations to digital environments and the diversity and availability of learning materials to facilitate streaming students. In the vision-workshop, the teachers imagined a situation where computers would correct students' exams. The teachers requested usability, reliability, and easiness in the deployment of digital instruments and environments, which they reported often changed. Typically, the digital learning environments were large IT-companies' products and services that the teachers login with their professional username or email. It was reported that to some extent, the teachers may use other technologies, environments, and software than the municipal education provider has pre-selected. One education leader, however, noted that the municipal education provider provided practical support only for those it centrally offered. Some interviewed teachers also reported that the GUSS has locally teachers whose responsibilities include providing IT-support to their colleagues. One construction specialist considered that recordings of lectures would enable students to participate in courses that clashed. The interviewees advocated the importance of approaching digital instruments and technologies in support of teaching and learning from the pedagogical needs point of view, which one educational leader described as follows:

**Excerpt 2.**

Researcher:     How would you describe GUSSs' operations today?

Educational leader A:   If you think about the tools and methods of doing work, while the breakthrough in IT for example has been huge, I still think that in a way we are still in the early stages. Now we have the hardware and software, and some expertise, but now we should also pay attention to the pedagogical side of how to achieve the best possible learning.

The interviewees found digital instruments and technologies essential in expanding and facilitating networking and cooperation opportunities, remote and hybrid teaching having become commonplace during the COVID-19 pandemic. The teachers reported diverse nationally and internationally organised remote collaboration, such as company visits and participation in events. They considered remote connections to be mitigating issues in both scheduling visits and in time saving as travelling was unnecessary. One education leader also considered that remote connections improved schools' geographical equality.

The interviewees referred to innovative technologies only by name, such as immersive walls allowing multisensory collaborative learning activities with digital materials and virtual reality. Accordingly, the teachers lacked evidence of their use in pedagogic activities. One architect, though, challenged the educators to consider what added value innovative technologies could bring to teaching and learning, and how these technologies could advance the achievement of pedagogic goals and learning. Social media activities were only cursorily mentioned. One teacher reported that Instagram was the most important student-targeted

account, Facebook being primarily guardian-targeted. The school also had student-led Snapchat activities.

To summarise, the participants described central pedagogical activities that related to diverse collaboration, preparing students for the future, and supporting student's wellbeing and inclusion. Digital instruments and technologies in support of teaching and learning related mainly to usage and the increased number of digital materials and learning environments.

## Spatial embeddedness of pedagogical activities reflecting learning centricity

Addressing the second research question, we next discuss the spatial embeddedness that the participants perceived to support the discussed pedagogical activities around the four main themes. Overall, the architects' perspective is accentuated in the results. They had also prepared the ORGs, which was rich in spatial descriptions. The spaces-workshop and field notes from the benchmarking visits comprised the teachers' spatial considerations. In the interviews, the educational leaders, the teachers, and the pedagogical expert emphasised more pedagogical activities than spatial arrangements.

### Spatial embeddedness of collaboration and community building

In order to cultivate collaboration spatially, which the interviewees of all professions urged, our analysis indicated that flexibility, diversity, and multifunctionality are central – in compliance with adequate sharing practices, tranquillity, avoided passages, and sizing in relation to the number of students. Few interviewees elaborated that flexibility and diversity differ from dominant openness, which they opposed and attached, for example, to sensory defensiveness and restlessness. One architect encapsulated the favoured spatial embeddedness as follows, indicating, though, that flexibility increases construction costs and restlessness:

**Excerpt 3.**

Researcher: What kind of spatial solutions do you think would support the development of GUSS activities in this curriculum reform direction?

Architect A: Naturally, this is what has already been done in this case. Flexible, adaptable, connectable, separable spaces, so that they can be modified according to the size of the student group or the teaching situation. But whatever that itself is, there are also problems, but of course it has to be customizable and the facilities flexible.

Researcher: You mentioned problems. Would you say a bit more about this?

Architect A: After all, restlessness or sound problems are possible. And then all such [customizable and flexible] solutions are expensive. They are clearly more expensive to build.

In the spaces-workshop, the benchmarking field notes, and the interviews, the teachers related the greater part of the requested flexibility and diversity to spaces for one or two student groups that learn together. Flexibility was to be achieved with adjustable partitions, conveniently usable folding walls and accordion doors, and mobile lightweight furniture, such as desks of different shape and stackable chairs. The need for multipurpose meeting rooms designed for individual encounters and small groups, tranquil spaces of all sizes, and shared facilities that allowed student groups to work outside learning spaces that accommodated the whole group was described in all types of data. For the shared facilities, wall recesses, booths, and partially movable storage furniture were named in the ORGs useful in demarcating areas. The teachers also described storage that would facilitate pedagogical activities when storage is shared and easily usable with students, such as cupboards with lockable glass doors. In the ORGs it was noted that the locking up of storages endorses the shared use of premises. Balancing between the shared use of premises and the subject-specific profiling that is oriented to the subject at hand was found to be central in all typed of data. One interviewed teacher, though, reported a power struggle. Whereas teachers of subjects such as arts and natural sciences typically operate in one space, teachers of younger in-service and more recent subjects that do not need special equipment often work in teaching spaces that vary drastically. With experimental learning, few interviewed teachers reported the need for space to prepare demonstrations in natural science classes, storage space for equipment, and tables that were large enough.

To enhance daily community building, in the spaces-workshop, the benchmarking fieldnotes and the interviews the teachers found important staff premises with separate facilities for social interaction and co-planning. Our analysis also resulted that inviting halls and spaces furnished for social gatherings are vital, while visual connections between spaces that the architects highlighted in the ORGs enhance social openness. The teachers requested multifunctional spaces to organise exhibitions and events, and to receive visitors, spaces like the plaza (Figure 1) that is forthcoming in the case study school. Teachers additionally reported a need for a sufficiently large auditorium, which was also noted in the ORGs along with traditional and digital show cases for students' outcomes, and a gym hall or similar space for ceremonies that accommodates all students. The biannual final examinations concern hundreds of students.

In promoting inter-organisational activities, it was mentioned in the ORGs and some interviewees considered the whole city as a learning environment, and found important easy public transport connections and physical proximity to other societal actors, such as libraries. One interviewed architect also reported a prevalent trend to design schools as multipurpose buildings, combining schools with other societal actors, such as youth services. The forthcoming building serves, accordingly, the surrounding community and, for example, sports clubs are to use the multifunctional hall in the evenings.

### *Spatial embeddedness of teaching and learning transversal competencies*
In addition to the request for greater flexibility to support collaborative activities overall, the spatial embeddedness of teaching and the learning of transversal

**Figure 1.** The plaza of cultures is a meeting place and is suitable for events (virtual image: the architect studio)

competencies limited mostly to the mentions in the ORGs. The spatial needs included the endorsement of ideation, non-regular activities, and cross-curricular collaboration. In the ORGs and the interviews, the architects highlighted block areas where teaching and learning different subjects takes place in spaces that are physically close to each other. Blocks were to comprise a large common learning area, and differently demarcated spaces for intensive and group work. Blocks would be designed to offer spaces for relaxing and concentrating as well as collaborative activities exploring and ideating. Versatile writing and mounting surfaces on the walls were related to enhance ideation, although limiting the implementation of adjustable partitions and other spatial solutions that increase flexibility. One interviewed educational leader considered in general that the school spaces should support and even force collaborative cross-subject problem solving.

In teaching and learning transversal competencies, a few interviewed teachers called for available spaces for non-regular activities independent of the lesson structure. They needed spaces that could be reserved, for example, for multi-day projects and participatory workshops with external visitors. Reflecting the skills needed in the future, the architects had also noted in the ORGs recycling opportunities supporting sustainable lifestyles, learning outside, air quality measurement, and plant growing supporting authentic and experimental learning.

## Spatiality in wellbeing and inclusion promotion

The participants described spatiality supporting wellbeing and inclusion mainly from different perspective than in the pedagogical activities. The data lacked descriptions of spatial embeddedness that the participants considered would support for example, students' self-efficacy, agency, and responsibility taking for their studies. Instead, in all types of data, the teachers emphasised the need for a creative, healthy, and aesthetic

environment. They hoped for inspiring interiors with greenery, connections to nature, healthy indoor air, and a school building that in general had an appealing appearance. Diversity in illumination controls with indirect and direct natural light was perceived to increase wellbeing, learning, and energy levels in general. In the ORGs, the architects also noted ease in cleaning to promote wellbeing. In the ORGs, the architects noted students' nutrition and requested diverse facilities for fetching drinking water, and a large enough canteen for students to buy snacks and have lunch.

Regarding teaching and learning activities, in the ORGs the architects considered interior design colour schemes to have an impact on students' concentration and poor illumination be an issue for students with amblyopia. As to the lightning, a few teachers reported darkened classrooms as necessary in subjects such as arts and physics. In the benchmarking field notes and in a few interviews, the teachers hoped for ergonomic furnishing that was adjustable for physically diverse individuals and provided unobstructed views to screens from students' seats. Whereas only two educators noted students' physical activity, which the national curriculum accentuates, the architects noted in the ORGs physicality in common areas, such as body-exercising gymnastics and table tennis. The architects also noted in the ORGs a need for the multifunctional hall suitable for sports, and separate shower rooms for students and staff after gym classes and commuting, for example, by bicycle. As to physical accessibility for inclusion, the ORGs mainly addressed signs that endorsed navigation, flows between spaces, the practicality of restrooms, students' lockers, and so on. In the ORGs, and in the teachers' benchmarking field notes and reporting in the spaces-workshop acoustics were highlighted vital in addressing different confidentiality and noise levels from bilateral encounters and hypersensitivity to students who made a noise and disturbed others. In the ORGs, the architects pointed out that good sound ergonomics could be achieved with sound-absorbing walls, ceilings, floors, and surface materials, and with silently movable furniture. They also noted in the ORGs that the voice is a teacher's instrument and correct sound ergonomics in a learning environment facilitate the teacher's work and students' learning.

Related to the student counselling and multi-professional student welfare services supporting students' wellbeing, some interviewed teachers reported a need for the services and special needs teachers' offices close to staff premises for individual encounters. In the spaces-workshop and a few interviews, the teachers noted that visual demarcation should be considered so that students could use the welfare services unobtrusively without stigma. The architects addressed in the ORGs the confidentiality of such services by preventing lip reading or direct views to computer screens.

### *Spatial embeddedness of digital instruments and technologies in support of teaching and learning*

In the spaces-workshop and the interviews, the teachers particularly reported the need for adequate basic equipping, including high-quality network connections, up-to-date computers, microphones and cameras for real-time streaming, and plentiful outlets. Should technological, for example, wi-fi and WLAN Internet connections dysfunctionality occur, some interviewed teachers reported the need for backups in presentations, such as document cameras that the classrooms in their current school building are equipped with. The teachers also appreciated uniform equipment. Their classrooms

were usually equipped with a shared computer, to which the teachers login with their personal usernames and passwords. One teacher reported that when the school operated in temporary facilities, constantly moving from place to place with laptops was chaotic and the lessons always tended to start late.

The interviewees called for multiple screens in one learning space. The architects also noted in the ORGs a need for several screens in common areas, and staff and meeting rooms. One interviewed architect reported portable screens to increase learning environments' flexibility and diversity. Although portables required a closer viewing distance, they enabled varied interior layouts, adjustable partitions, and folding and glass walls in the learning spaces. The interviewees reported that laptops were commonplace among teachers and students, which a few teachers and architects connected with the wireless screens that they hoped for. The interviewees also said that wirelessness liberated teachers from static workstations and allow students to make presentations while stationary. One architect described wireless presenting as increased flexibility that simplifies the design of the learning environment; if a teacher shares information on students' laptops, their ergonomic view of screens is not a necessity.

One architect pointed out that a space reservation system permitted a more efficient use of space; it would enable, for example, teachers and students to find unoccupied spaces for meetings and quiet working. Regarding innovative technologies, similar to the lacked descriptions in their pedagogical use, the technical reserves were addressed on a general level primarily in the ORGs. It superficially addressed 3D-printers, audio-visual aids for podcasting, immersive walls, and sound shower loudspeakers sending direct sound to a demarcated area. The architects also mentioned in the ORGs general bulletin boards, camera monitoring, public-address systems, electronic locking systems, and sound reproduction systems.

To conclude, the need for spatial embeddedness that participants reported centred around flexibility, diversity, multifunctionality, and block areas for cross-curricular collaboration and ideation. The participants described physical accessibility to promote students' inclusion, and adequately located student counselling and multi-professional welfare services to promote their wellbeing. Both the teachers and the architects considered sound ergonomics vital and adjustable luminous conditions needed for students with special needs. The participants perspective to spatiality of wellbeing and inclusion to some extent, however, deviated from the described pedagogical activities. The responses highlighted an inspiring environment and lacked, for example, spatiality that would support students' self-efficacy. Regarding digital instruments and technologies, the teachers' needs related to basic functionality and equipping. Instead, the architects described, for example, portable screens and possibilities for wireless presenting to increase flexibility in learning environments' layouts.

## Discussion

We investigated educators' and construction specialists' perceptions of spatio-pedagogical entanglement within a core curriculum renewal in the context of a new school building construction. The first research question concerned pedagogical activities that the participants perceived would support learning centricity. The participants considered diverse intra- and inter-organisational collaboration activities to be crucial,

which supports earlier results suggesting that fostering a collaborative culture is a promising school improvement strategy (Casey, Simon, & Graham, 2021; DuFour & Mattos, 2013; Sigurðardóttir, Hansen, & Gísladóttir, 2021). The reported vitality of collaboration also aligns with Niemi's (2021) findings according to which teachers considered collegial collaboration to be important regardless of the pleasantness of the learning environment. The interviewees considered that transversal competencies concerned activities and skills that prepared students for the future. The described competencies corresponded to earlier judgements of the importance of 21st century skills comprising personal, social, and information management skills (Chalkiadaki, 2018; van Laar, van Deursen, van Dijk, & de Haan, 2017). In promoting wellbeing and inclusion, the participants essentially described activities that cultivated students' self-efficacy and agency, reflecting the centrality of learners' wellbeing and inclusion in Finnish education policy (EDUFI, 2019; Finlex, 2013, 2018; UN, 2006). Concerning the reciprocal reshaping of technology and social activity (Fenwick, Edwards, & Sawchuk, 2011; Orlikowski, 2007), teachers reported that periods of distance education during the past COVID-19 pandemic years had integrated a certain level of digital technology use into their pedagogical practices. Regarding the digital support of teaching and learning, the interviewees considered that adequate digital instrumentation extended inter-organisational and location-independent cooperation, diversity of materials, and flexibility in organising and participating in courses. Use of digital instruments and technologies was reported to endorse schools' geographical equality, engagement with the surrounding community, and the effective use of spaces

An understanding of pedagogical activities guided us towards the second question on the spatial embeddedness of these activities. The participants considered that flexible, diverse, socially open, and multipurposed school spaces improved collaboration and community building. They also believed that these facilities fostered collaborative teaching and learning practices, diverse encounters, and increased possibilities for streaming students. The results align with Dovey and Fisher (2014) suggestion of flexibility being both fluidity in adapting from one learning activity to another and convertibility of build elements. Accordingly, the architects reported block areas conjoining subjects to create functional synergy in physical learning environments for collaborative activities. The teachers also wanted facilities that would help organise non-regular activities, which enhance teaching and learning of transversal competencies. These reports aligned with the collaborative affordances, features and elements that Young, Cleveland, and Imms (2020) found to support deep learning in ILEs, and Davies et al. (2013) considered critical in developing creative skills. The teachers' expectations concerning a healthy and aesthetic school building reflected the defects of their current school building which dated back to the 1960s. The reported need for built quality and comfort echoes Daniels, Tse, Stables, and Cox (2019) similar results on their importance. The use of innovative technologies to promote learning and achieve pedagogic development goals was, however, perceived to require elaboration.

The overarching aim of the present study was to examine pedagogical activities and their spatial embeddedness. In summary, the analysis results appeared to endorse spatio-pedagogical synergy in pursuing the collaborative school culture that learning centricity entails:

- *Collaboration and community building* was reported to comprise diverse daily cross-cutting collaborative pedagogical activities and gatherings, which flexible, diverse, and multifunctional design of learning environments with adequate sizing and sharing practices supported.
- *Transversal competencies* were described to address teaching and learning skills that prepare students for the future. Spatial embeddedness of learning environments was considered to foster conjoining subjects and to support diverse collaborative practices, ideation, and organising non-regular activities.
- *Wellbeing and inclusion* were reported to concern pedagogical activities that highlighted the individuality of learners, their personal growth, and their taking of responsibility. The spatial embeddedness was, however, described differently. The responses highlighted an inspiring environment and lacked, for example, spatiality that would support students' self-efficacy. The spatial embeddedness concerned accessibility of student counselling and welfare services, and adequate ergonomics, acoustic, and adjustable luminous conditions that acknowledge also students with special needs.
- *Digital instruments and technologies in support of teaching and learning* was perceived to extend the availability of learning materials, networking, cooperation, hybrid, and remote teaching possibilities, and was supported by uniform up-to-date basic equipment with several screens and high-quality network connections in learning environments. Digital instruments and technologies, such as portable screens and possibilities for wireless presenting, were to increase flexibility in learning environments' layouts.

The identified main themes, however, remain interconnected (Figure 2). Collaboration as such is cross-cutting to the teaching and learning activities that the novel core curriculum entails. It is embedded in those skills that the interviewees considered to be transversal competencies and were described to comprise inter alia cross-curricular
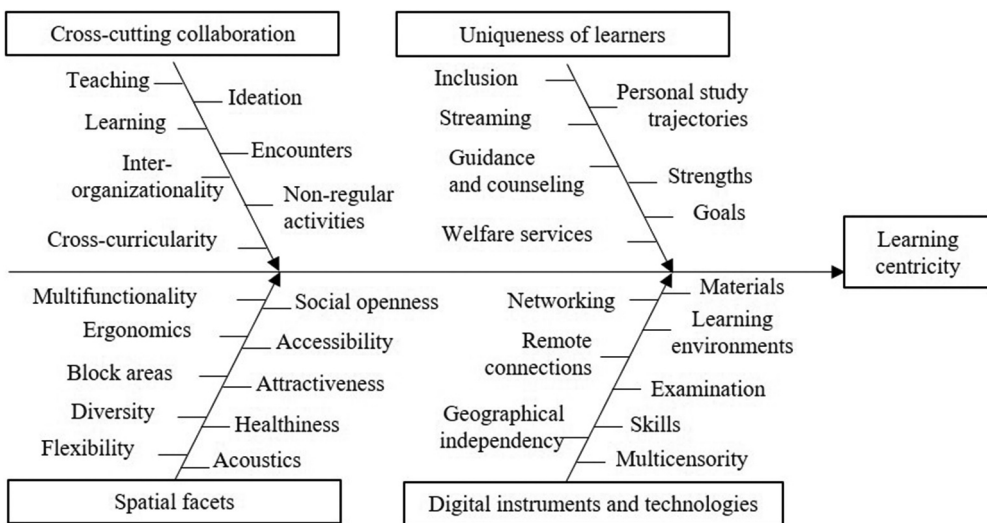
**Figure 2.** Pedagogic-spatiality endorsing transformation towards learning centricity

settings and ideation. It is also innate in inter-organisational activities and welfare services. While the core curriculum highlights uniqueness of learners, richness in digital leaning materials enable, for example, streaming students. Remote connections also facilitate the required inter-organisational collaboration. Individual teachers' and students' skill and interests to utilise the instruments and technologies, though, vary. In addition, the teachers, for example, reported that classroom equipment with several screens assisted in the streaming of students; the architects also highlighted several screens that increased students' ergonomics when there was a direct line of sight. As to the spatial facet, for example, social openness is to foster daily encounters and acoustics conditions to support students with sensory defectiveness.

We addressed a problem of practice that is constructive in a RPP setting (Coburn & Penuel, 2016). The created practice-based understanding highlights educational leaders' ability to respond to a school's operational environment (Avelar, Da Silva-Oliveira, & Pereira, 2019; Fullan, 2002; Leithwood, Harris, & Hopkins, 2020), where economic, political, cultural and societal dimensions shape operations. The present study was, nevertheless, a single case study, which places limitations on the results' generalisability. The case school was privileged, because of the opportunity to support pedagogical needs spatially in the construction of the new school building. Construction of a whole new school building is a huge investment from the municipal education provider and, thus, the case was a quite unique undertaking. Instead of constructing new school buildings most schools are renovated. Accordingly, municipal real estate strategies create opportunities and boundary conditions for pedagogical activities that occur within schools. Compared to new buildings, the old buildings may create constraints on implementing spatial novelty that would support pursued pedagogical activities. For example, it may be essential to preserve architectural features typical of the building's era. As the construction costs of the case school are tens of millions of euros, it provided a unique opportunity to investigate the pedagogical activities and their spatial embeddedness within the construction of the new school building. Another limitation of the study is that it contains only the education and construction specialists, and the students' perspective was omitted. Despite of triangulation of data, it yet is a representation of the participants' perceptions and visions of a single new school building. Moreover, the investigation evokes questions about the actual use of the school spaces. Thus, our next step is to investigate the construction specialists', the teachers', and the students' perceived affordances when deployed.

## Disclosure statement

## Funding

## Notes on contributors

*Katri Sarkio* is a doctoral researcher in the Faculty of Educational Sciences at the University of Helsinki, Finland. She has an interdisciplinary background and holds MSc in Computer Science and Licentiate's degree in Digital Economy.

*Tiina Korhonen*, PhD, is a university lecturer in Learning Innovations in Digital Society in the Faculty of Educational Sciences at the University of Helsinki, Finland. She is also Head of Innokas Network.

*Kai Hakkarainen*, PhD, is a Professor at the Department of Education in the University of Helsinki, Finland.

## Description of ethics

The investigation was conducted with the research permit that the City of Helsinki, Education Division has granted to Growing Mind research project (the Strategic Research Council of the Academy of Finland). The participants were a) informed with the privacy notice https://growing mind.fi/wp-content/uploads/2021/09/Privacy-notice-16.9.2021.pdf and b) participated voluntarily with informed consent. The research aligns with the Finnish national board on research integrity (TENK) guidelines. The investigation did not require an ethical review in research in the humanities and social and behavioural sciences, because ethical review applies only to precisely defined research configurations that the investigation did not represent. The precisely defined research configurations that would have required ethical review are: 1) The study involves an intervention in the physical integrity of subjects (not applicable to this investigation), 2) The study deviates from the principle of informed consent (ethical review is not required if the research is based on public documents, registries or archived data) (not applicable to this investigation), 3) The subjects are children under the age of 15, and the study is not part of the normal activities of a school or an institution of early childhood education and care, and the data are collected without parental consent and without providing the parents or guardians the opportunity to prevent the child from taking part in the study (not applicable to this investigation), 4) The study exposes research subjects to exceptionally strong stimuli and evaluating possible harm requires special expertise (for example, studies containing violence or pornography) (not applicable to this investigation), 5) The study may cause long-term mental harm (trauma, depression, sleeplessness) beyond the risks encountered in normal life (not applicable to this investigation), and 6) The study can signify a security risk to subjects (for example, studies concerning domestic violence) (not applicable to this investigation).

## Geolocation information

Helsinki, Finland.

## Using third-party material

We have obtained written permission to use a virtual photo of the Plaza of Cultures in Figure 1 from the partnering architect studio and the construction company.

## ORCID

Katri Sarkio ⓘ http://orcid.org/0000-0002-4168-714X
Tiina Korhonen ⓘ http://orcid.org/0000-0003-2875-4915
Kai Hakkarainen ⓘ http://orcid.org/0000-0003-3507-7537

# References

Avelar, A. B. A., Da Silva-Oliveira, K. D., & Pereira, R. D. S. (2019). Education for advancing the implementation of the sustainable development goals: A systematic approach. *The International Journal of Management Education*, *17*(3), 100322. doi:10.1016/j.ijme.2019.100322

Benade, L. (2021). Theoretical approaches to researching learning spaces. *New Zealand Journal of Educational Studies*, *56*(S1), 11–26. doi:10.1007/s40841-020-00191-z

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school* (Expanded ed.). Washington, DC: National Academy Press.

Butterfield, L. D., Borgen, W. A., Amundson, N. E., & Maglio, A.-S. T. (2005). Fifty years of the critical incident technique: 1954-2004 and beyond. *Qualitative Research*, *5*(4), 475–497. doi:10.1177/1468794105056924

Casey, J., Simon, S., & Graham, W. (2021). Optimising leadership: Conceptualising cognitive constraints of sociality and collaboration in Australian secondary schools. *Improving Schools*, *24*(1), 19–32. doi:10.1177/1365480220958498

Chalkiadaki, A. (2018). A systematic literature review of 21st century skills and competencies in primary education. *International Journal of Instruction*, *11*(3), 1–16. doi:10.12973/iji.2018.1131a

Coburn, C. E., & Penuel, W. R. (2016). Research–practice partnerships in education: Outcomes, dynamics, and open questions. *Educational Researcher*, *45*(1), 48–54. doi:10.3102/0013189X16631750

Daniels, H., Tse, H. M., Stables, A., & Cox, S. (2019). School design matter. In H. M. Tse, H. Daniels, A. Stables, & S. Cox (Eds.), *Designing buildings for the future of schooling: Contemporary visions for education* (pp. 41–65). Abingdon, Oxon and New York, NY: Routledge.

Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education—A systematic literature review. *Thinking Skills and Creativity*, *8*, 80–91. doi:10.1016/j.tsc.2012.07.004

Decuypere, M., & Simons, M. (2016). Relational thinking in education: Topology, sociomaterial studies, and figures. *Pedagogy Culture & Society*, *24*(3), 371–386. doi:10.1080/14681366.2016.1166150

Deppeler, J., & Aikens, K. (2020). Responsible innovation in school design – a systematic review. *Journal of Responsible Innovation*, *7*(3), 573–597. doi:10.1080/23299460.2020.1809782

Dovey, K., & Fisher, K. (2014). Designing for adaptation: The school as socio-spatial assemblage. *Journal of Architecture*, *19*(1), 43–63. doi:10.1080/13602365.2014.882376

DuFour, R., & Mattos, M. (2013). How do principals really improve schools? *Educational Leadership*, *70*(7), 34–40.

EDUFI. (2019). *National core curriculum for general upper secondary education*. Helsinki, FI: Finnish National Agency for Education.

Everhart, D. (2006). Evolving from course-centric to learning-centric: Portfolios, wikis, and social learning. *Canadian Journal of University Continuing Education*, *32*(2). Article 2 doi:10.21225/D5JC7H

Fenwick, T. (2014). Sociomateriality in medical practice and learning: Attuning to what matters. *Medical Education*, *48*(1), 44–52. doi:10.1111/medu.12295

Fenwick, T., Edwards, R., & Sawchuk, P. (2011). *Emerging approaches to educational research: Tracing the socio-material*. Florence, US: Routledge.

Finlex. (2013). Finnish act on student care 30.12.2013/1287.

Finlex. (2018). Finnish act on general upper secondary education doi:10.8.2018/714

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, *51*(4), 327–358. doi:10.1037/h0061470

Friese, S. (2012). *Qualitative data analysis with Atlas.Ti*. London: SAGE.

Fullan, M. (2002). The change leader. Educational Leadership. May, 16–20.

Gislason, N. (2010). Architectural design and the learning environment: A framework for school design research. *Learning Environments Research*, *13*(2), 127–145. doi:10.1007/s10984-010-9071-x

Gislason, N. (2018). The whole school: Planning and evaluating innovative middle and secondary schools. In S. Alterator & C. Deed Eds., *School spaces and its occupation: Conceptualizing and evaluating innovative learning environments*. (pp. 187–201). Brill Sense. doi:10.1163/9789004379664_012

Hargreaves, A., & Shirley, D. (2009). The fourth way: The inspiring future for educational change. doi:10.4135/9781452219523

Imms, W. (2016). New generation learning environments: How can we find out if what works is working? In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 21–34). Rotterdam, Netherlands: Sense.

Jindal-Snape, D., Davies, D., Collier, C., Howe, A., Digby, R., & Hay, P. (2013). The impact of creative learning environments on learners: A systematic literature review. *Improving Schools*, *16*(1), 21–31. doi:10.1177/1365480213478461

Leinonen, T., & Mäkelä, M. (2022). *Hyvän oppimisen tilat*. Jyväskylä: PS-Kustannus.

Leithwood, K., Harris, A., & Hopkins, D. (2020). Seven strong claims about successful school leadership revisited. *School Leadership & Management*, *40*(1), 5–22. doi:10.1080/13632434.2019.1596077

McKenney, S., & Reeves, T. C. (2019). *Conducting educational design research*. Routledge.

Mulcahy, D., & Morrison, C. (2017). Re/Assembling 'innovative' learning environments: Affective practice and its politics. *Educational Philosophy and Theory*, *49*(8), 749–758. doi:10.1080/00131857.2016.1278354

Niemi, K. (2021). 'The best guess for the future?' teachers' adaptation to open and flexible learning environments in Finland. *Education Inquiry*, *12*(3), 282–300. doi:10.1080/20004508.2020.1816371

Nonaka, I., & Konno, N. (1998). The concept of "ba": Building a foundation for knowledge creation. *California Management Review*, *40*(3), 40–54. doi:10.2307/41165942

OECD. (2013). Innovative learning environments. *Educational Research and Innovation*, OECD; doi:10.1787/9789264203488-en.

OECD. (2020). *Back to the future of education: Four OECD scenarios for schooling*. Educational Research and Innovation, OECD, Paris.

Orlikowski, W. (2007). Sociomaterial practices: Exploring technology at work. *Organization Studies*, *28*(9), 1435–1448. doi:10.1177/0170840607081138

Osborne, M. (2016). What works: Changing practices when spaces change. In W. Imms, B. Cleveland, & K. Fisher (Eds.), *Evaluating learning environments: Snapshots of emerging issues, methods and knowledge* (pp. 35–44). Rotterdam, Netherlands: Sense publishers.

Pettersson, F. (2021). Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technologies*, *26*(1), 187–204. doi:10.1007/s10639-020-10239-8

Reinius, H., Korhonen, T., & Hakkarainen, K. (2021). The design of learning spaces matters: Perceived impact of the deskless school on learning and teaching. *Learning Environments Research*, *24*, 339–354. doi:10.1007/s10984-020-09345-8

Saldãna, J. (2013). *The coding manual for qualitative researchers*. Los Angeles: SAGE.

Sarkio, K., Korhonen, T., & Hakkarainen, K. (2023). Tracing teachers' perceptions of entanglement of digitally-mediated educational activities and learning environments: A practice-oriented method. *Learning Environments Research*, *26*(2), 469–489. doi:10.1007/s10984-022-09442-w

Schein, E. H. (2017). *Organizational culture and leadership*. San Francisco, CA: Wiley.

Sigurðardóttir, A. K., Hansen, B., & Gísladóttir, B. (2021). Development of an intervention framework for school improvement that is adaptive to cultural context. *Improving Schools*, 244–259. doi:10.1177/13654802211051929 *25* 3

Silander, P., Riikonen, S., Seitamaa-Hakkarainen, P., & Hakkarainen, K. (2022). Learning computational thinking in phenomenon-based co-creation projects: Perspectives from Finland. In S.-C. Kong & H. Abelson (Eds.), *Computational thinking education in K-12* (pp. 103–119). MIT Press.

Stadler-Altmann, U. (2015). Learning environment: The influence of school and classroom space on education. In C. M. Rubie-Davies, J. M. Stephens, & P. Watson (Eds.), *Routledge international handbook of social psychology of the classroom* (pp. 252–262). Abingdon, Oxon and New York, NY: Routledge.

Stahl, G., & Hakkarainen, K. (2021). Theories of CSCL. In U. Cress, C. Rose, F. W. A., & J. Oshima (Eds.), *International handbook of computer supported collaborative learning* (pp. 23–43). Springer.

Statistics Finland. (2020). Official statistics of Finland: Entrance to education 2019. Helsinki: Statistics Finland. Accessed Oct 5, 2022. http://www.stat.fi/til/khak/2019/khak_2019_2020-12-10_tie_001_fi.html

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, 27(2), 237–246. doi:10.1177/1098214005283748

Tse, H. M., Daniels, H., Stables, A., & Cox, S. (Eds.). (2019). *Designing buildings for the future of schooling: Contemporary visions for education*. Abingdon, Oxon and New York, NY: Routledge.

UN. (2006). *Convention on the rights of persons with disabilities*. United Nations. https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=IV-15&chapter=4&clang=_en

UNESCO. (2020). Education for sustainable development: A roadmap (p. 73). https://unesdoc.unesco.org/ark:/48223/pf0000374802.locale=en

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, 72, 577–588. doi:10.1016/j.chb.2017.03.010

Woodman, K. (2016). Re-placing flexibility. In K. Fisher (Ed.), *The translational design of schools* (pp. 51–79). SensePublishers. doi:10.1007/978-94-6300-364-3_3

Woolner, P., Hall, E., Wall, K., & Dennison, D. (2007). Getting together to improve the school environment: User consultation, participatory design and student voice. *Improving Schools*, 10(3), 233–248. doi:10.1177/1365480207077846

Woolner, P., McCarter, S., Wall, K., & Higgins, S. (2012). Changed learning through changed space: When can a participatory approach to the learning environment challenge preconceptions and alter practice? *Improving Schools*, 15(1), 45–60. doi:10.1177/1365480211434796

Woolner, P., & Stadler-Altmann, U. (2021). Openness – flexibility – transition. Nordic prospects for changes in the school learning environment. *Education Inquiry*, 12(3), 301–310. doi:10.1080/20004508.2021.1957331

Yin, R. K. (2014). *Case study research*. Thousand Oaks, California: SAGE.

Young, F., Cleveland, B., & Imms, W. (2020). The affordances of innovative learning environments for deep learning: Educators' and architects' perceptions. *The Australian Educational Researcher*, 47(4), 693–720. doi:10.1007/s13384-019-00354-y