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15 Developing Teachers' Transformative Digital Agency through Invention Pedagogy In-Service Training

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Introduction

Research on teachers' professional learning and development guides the orientation of national-level teacher education strategies and practices in Finland. Lavonen et al. (2020) synthesized these studies and highlighted four factors supporting teachers' professional development strategies identified in the previous research: the long-term nature of the professional learning (Oliveira, 2010), teachers' active role in their learning (Garet et al., 2001), the connection between learning and classroom or practical context, and collaboration and reflection with colleagues (Avalos, 2011; Van den Bergh et al., 2015). Lavonen et al. (2020) also emphasized that in the Finnish context, teachers are expected to actively regulate their own professional learning by setting goals, reflecting, and self-assessing their own learning processes.

There are various opportunities for professional learning through in-service training for Finnish teachers. National and regional institutions such as the National Agency of Education, universities, and private entities provide professional learning possibilities for teachers. In addition, municipalities are obligated to support teachers' continuous professional learning. Despite these affordances, participation in in-service training is occasional and lacks long-term learning plans and continuity (Husu & Toom, 2016; OECD, 2020). Participation in in-service training is voluntary in Finland, apart from a few obligatory training days a year. Twenty percent of teachers do not participate in any in-service training for various reasons, and participation varies across the country. Barriers to participation include organizing substitute teachers and their funding as well as motivating teachers to undertake continuous professional learning (Ministry of Education and Culture [MEC], 2016). With regard to in-service training in digitalization, teachers have mostly participated in training that covers basic information and communications technology (ICT) skills and the use of specific programs (Tanhua-Piiroinen et al., 2020). Thus, there is need for training that supports teachers' creative use of technology (Korhonen et al., forthcoming) and innovative orientation toward teaching and learning (Lavonen et al., 2021). As solutions to these challenges, it has been suggested that in-service training be developed so that it is tied to the everyday work of schools and utilizes networks and sharing best practices (Lavonen et al., 2021; OECD, 2020).

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In this chapter, we depict how the invention pedagogy approach supports teachers in their professional learning and learning transformative competencies needed in the 21st-century era. We first define the concept and the need for transformative digital agency and draw connections to the aims of the national curricula in Finland. Second, we depict the Everyday Technology in-service training course context and development of teachers' transformative digital agency during the course and through the implemented invention projects with students. Finally, we reflect on the course's impact in the light of Finnish national-level teacher education strategies and practices and theory of transformative digital agency.

Teachers' Transformative Digital Agency

The digital transformation of education and society calls on teachers to cultivate their *transformative agency* (Markauskaite & Goodyear, 2017; Stetsenko, 2017), a term understood here to indicate teachers' proactive pursuit of pedagogical and professional innovations. Transformative teachers do not merely cope with changing environments (Emirbayer & Goodwin, 1994) but invest in deliberate collaborative efforts to exploratively develop professional innovations as epistemic objects (Knorr Cetina, 2001). Integrating novel socio-digital tools with activity requires a developmental process of instrumental genesis (Rabardel & Bourmaud, 2003; Ritella & Hakkarainen, 2012)—that is, active personal exploration with the goal of appropriating the tools as part of a distributed cognitive system and adapt these tools to one's system of professional practices (instrumentation). Teachers explore and try these creative activities that will later engage students. Such "fiddling" has been proven to strongly deepen teachers' level of innovation (Frank et al., 2011). The co-appropriation of novel socio-digital practices and the joint building of an innovation-oriented educational culture develop teachers' professional capabilities (Daly, 2010; Korhonen et al., 2014; see also Chapter 16 of this book). Teachers' self-confidence and experience-based empowerment play essential roles because participation in nonlinear learning processes is challenging for students and their peers. Teachers should provide students the "gift of confidence" (Mahn & John-Steiner, 2002) to assist them in trying out their wings before they have learned to fly.

Lund and Aagaard (2020) highlight the digital dimension's role in teachers' transformative agency. According to them, technology has been traditionally viewed in the educational field as a tool that mediates and serves people in certain contexts and in specific ways. There has been less focus in looking at the change potential that digital technology has and how to change educational settings and practices. Lund and Aagaard found that the impact digitalization has on changes in the environment, social practices, and concept of knowledge and thus to the individual and community, create a special need for teachers and teacher-educators to look at transformative agency through digitalization and the digital realm. They state trends like how phenomena are digitally represented, how communicative spaces emerge, how problem-solving becomes collective and collaborative, how suspending constraints in space and time to explain why digitalization impacts our epistemic practices. Digitalization is here understood as the overall process of moving toward a digitalized society and using digital technology in changing practices (Tilson et al., 2010).

Moreover, Lund and Aagaard (2020) characterize *transformative digital agency* through the competence requirements pertaining to agency. The key issue facing teachers' and teacher-educators' agency is their capability to identify educationally challenging situations and use digital resources to transform these situations into constructive teaching. We argue that from the perspective of teachers and teacher-educators, transformative digital agency plays a central role in recognizing the epistemic changes brought by digitalization. Equally important is recognizing competencies related to digital technology and technology itself, as well as the adaptive competence of using digital technology pedagogically in teaching and interaction. How technology is situated in the goals and aims set for learning and teaching goals is also pivotal. Is technology viewed as merely a tool for learning, or are technology and digitalization also objects of learning? We hypothesize that teachers need guidance and support to understand digitalization and the ubiquitous nature of technology so that they can adapt these elements to their teaching. In this way, they can meaningfully situate both the instruments and content of these elements into their multimodal teaching and interaction.

The Finnish National Core Curriculums for early childhood education and basic education (compulsory education) express two themes that are especially relevant to teachers' transformative digital agency in the 21st century: transversal competencies and multidisciplinarity. Transversal *competencies* refer to globally known 21st-century competencies (Binkley et al., 2012; Trilling & Fadel, 2009; van Laar et al., 2017) that manifest as a set of seven skill areas that prepare students for their future lives and work (for more, see the current book's introduction). These competencies are instructed and evaluated as parts of subjects across the curriculum. In the basic education curriculum, teaching is structured via traditional subject areas, but the renewed National Core Curriculum breaks from this centuries-old tradition and includes transversal competences, as well as multidisciplinary learning modules. Each school is expected to plan and implement a learning module at least once per academic year that connects a compatible set of content from separate school subjects as an interdisciplinary project or entity. These multidisciplinary learning modules are considered good opportunities to teach and learn transversal competencies.

Although both National Core Curriculums for early childhood and basic education are clear on transversal competencies and multidisciplinarity and examine in detail their underlying pedagogical ideals, they do not provide actual examples, scripts, or lesson plans to help with their classroom-level implementation. The Everyday Technology course introduced in this chapter was designed as a platform for teachers to experiment, design, learn and share new school practices for transversal competencies and multidisciplinary learning modules, thus supporting teachers' transformative digital agency. For the participating teacher, the course provided an opportunity to learn about digitalization and everyday technology, how to run multidisciplinary learning modules embedding invention pedagogy and technological content and tools, teach and assess transversal competencies and learn from—as well as remodel—other participants' projects.

The Everyday Technology Course as Teachers' Professional Learning Context

During the 2019–2020 academic year, the national Innokas Network organized the Invention Pedagogy: Everyday Technology—professional development course for early childhood, primary, and lower secondary school teachers. The course was a blended learning experience that included an online course module, two full days of face-to-face workshops, a daycare or school project with participants' students, and a final reflection meeting online. The targeted learning outcome was expressed in a single sentence: "Participants are able to plan, implement and evaluate creative Innovation Pedagogy projects on the topic of everyday technology and understand how the projects are linked to the Finnish National Core Curriculums."

A focal aspect of the training was that during the course teachers received an orientation to digitalization, and they were guided to reflect on the aspects of digitalization in relation to their own professional learning, teaching, and students' learning. Teachers were acquainted with various technologies starting from everyday technologies (e.g., simple machines, structures and electronics) and ranging to programmable technologies (e.g., Micro:bit controllers). More than 200 teachers from schools and daycare centers across Finland participated in the course. Due to the first COVID-19 outbreak in spring 2020, many enrolled teachers faced challenges in completing the course. Seventy-one participants ultimately completed the course and permitted their course materials and questionnaire answers to be used for research purposes (see Table 15.1).

The course was differentiated based on teachers' grade levels as Everyday Technology for primary and lower secondary teachers and Technology Crafts for early childhood education teachers. For both groups, the course's objectives, pedagogical approach, and structure were similar, but the hands-on technological content differed slightly: Everyday Technology included programming with microcontrollers, while Technology Crafts covered simple electric circuits.

The aim of the course was to familiarize participants with the concepts, methods, and tools of invention pedagogy presented in this book's introduction. Technology competence development was supported during the online learning period by using a variety of independent study and communication platforms (e.g.,

Table 15.1 Participant summary (*n* = 71)

Background variable	*Groups*	*n*	*%*
Gender	Female	59	83.1
	Male	10	14.1
	Unavailable	2	2.8
Grade level	Early childhood education	31	43.7
	Primary and secondary school	40	56.3
Region	Metropolitan area[a]	22	31.0
	Southern Finland	6	8.5
	Western Finland	11	15.5
	Eastern Finland	6	8.5
	Northern Finland	26	36.6

[a] *Metropolitan area*: The capital of Finland, Helsinki, and its surrounding municipalities, Espoo, Vantaa, and Kauniainen.

an e-learning platform and videos) and by focusing on everyday technologies during the hands-on meeting. The technological environment surrounded us, and invention pedagogy was approached through video and supplemental materials about maker culture, the history of technology, crafting and tinkering, curriculum reflections, innovation education theory and practice (see more in Chapter 16 of this book), and 21st-century competencies. Additionally, hands-on workshops included programming and computational thinking. Teachers could then apply their learning, in a pedagogically relevant way, to their own teaching.

Another central aim of the course was to introduce teachers to the innovation process model (Figure 15.1), which teachers can use to organize multidisciplinary invention projects and employ everyday technology tools in their classrooms. The model relates to the pedagogically oriented invention process models introduced in Chapter 9 of this book and was co-developed with Innokas Network teachers. During the hands on part of the course, participating teachers formed small teams and were guided through the innovation process step by step. They selected a problem, practiced creative techniques to generate ideas, designed a solution, built a prototype, and presented it to the other teams. Many participants later observed in their learning diaries that this practical exercise was the most fruitful part of the course. It provided a model with which they could start building their own multidisciplinary learning modules, and it offered a chance to reflect on and understand the process from students' perspectives.

Another important part of the course was participants' planning, implementation, and sharing their multidisciplinary projects. Project plans were presented and discussed among course groups. During the reflection session, implemented projects were presented and reflected on. Later, they were published as professional learning material for all teachers via the Innokas website.

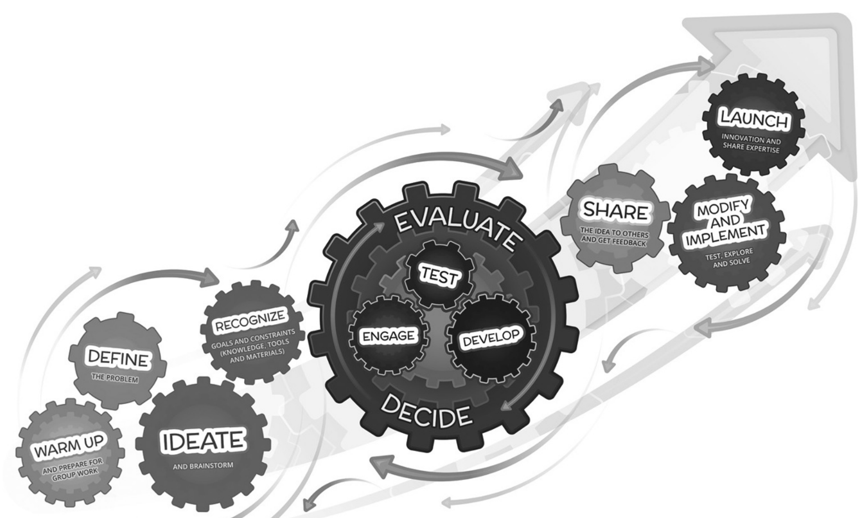

Figure 15.1 The innovation process in basic education.

Development of Teachers' Transformative Digital Agency during the Course and through Implemented Invention Projects

Participating teachers responded to surveys about their competence and needs at the beginning and end of the course. Additionally, teachers wrote structured learning diaries during the course. These diaries were used to map teachers' thoughts and competence development from the course's themes. Teachers were also asked to reflect on invention projects that they had implemented with their students. In the next subsection, we discuss teachers' development from four perspectives: technological and invention pedagogical awareness, technological competence, implemented adaptive practice, and teachers' reflection. Our discussion is based on a qualitative content analysis (Saldaña, 2016) of teachers' learning diaries and augmented by the quantitative analysis of our survey results.

Technological and Invention Pedagogical Awareness

Participating teachers depicted and reflected on transformative digital agency as an increased sense of technological awareness. An essential component of this development was the course's support and guidance regarding the definition of *technology* as a concept and understanding the ubiquitous nature of digital technology. Teachers also described developing an interest in technology during the course. Some reported having always had an interest in technology but no time to pursue it meaningfully. Some also mentioned that they had not previously understood the broad definition of *technology* to have a meaning in their own and their students' technological awareness. Several teachers mentioned that the course materials, which were pedagogically formulated, guided and motivated them to consider the challenges holistically and opportunities of digital technology and digitalization in everyday schoolwork:

> The more you did the assignments, watched videos, and read about it, the more you got into the technological world and thoughts started to form. I felt motivated to think about the impact of digitalization in my own everyday life and read about other participants' thoughts about it.
>
> (Teacher 18)

Teachers reported that the course content clarified how invention pedagogy supports the realization of curricular goals. Participants got to revise familiar processes and learn new content. Problem-solving was approached through the innovation process, and teachers learned how to use programming and robotics tools in invention projects. Teachers' technological and invention pedagogical awareness grew. Moreover, teachers found clarifying parallel concepts related to invention pedagogy and the innovation process important:

> The most motivating thing was to revise the concept of maker education and related concepts, such as STEAM [science, technology, engineering, arts, and mathematics], the innovation process, and invention pedagogy. Thinking about

> making from the perspective of my own work was also especially fruitful, and I got an idea for the spring semester activities from the course assignment.
>
> (Teacher 33)

This increasing technological and invention pedagogical awareness presented various options and dimensions to participants. Practical examples of multidisciplinary learning modules and projects embedded with developed technological awareness increased teachers' competencies in realizing invention pedagogy's possibilities and dimensions. Several teachers also observed that their increased awareness of the aims, methods, and implementation of invention pedagogy made them reflect on their previous practice:

> The content about learning by doing and innovation education were a good reminder for me about how the aims and schedules should be presented openly. Naturally, I have gone through them with the students at the beginning of the course, but they could also be visible as a reminder in the classroom throughout the process. Equally important is to have work samples on display.
>
> (Teacher 35)

Technological Competence

Teachers describe in their diaries that the course had supported the development of their technological competencies. The support was needs-based and augmented each participant's competence gaps. As with technological awareness, teachers here also brought up the relevance of developing epistemic knowledge. Introducing new ideas and content to teachers such as health technology innovations or artificial intelligence supported the development of their technological awareness and competencies.

Teachers' academic, artistic, and computational digital competencies were surveyed at the beginning and end of the course (Table 15.2). Here, *academic digital competencies* refer to basic technological knowledge-processing and knowledge-building practices, such as word processing, multimedia presentations, joint knowledge-building, and communication. *Artistic digital competencies* refer to using creative and visual technologies or software, such as image processing, video editing, or animation. *Computational digital competencies* encompasses creative problem-solving and designing and implementing complex technological systems and artifacts, such as building devices in invention projects that use programming, robotics, and automation.

To examine the extent to which the participants' self-reported digital competencies developed during the in-service training, paired samples t-tests were used to compare the post-questionnaire's digital competence components one by one with the pre-questionnaire's competence components (see Table 15.2). The survey results show that teachers found themselves to have already been proficient in academic digital competencies before the course but reported the lowest proficiency in computational digital competencies. There were statistically significant

Table 15.2 Teachers' academic, artistic, and computational competencies before and after training on a proficiency scale from 1 to 5 (1 = not at all; 5 = very fluently)

	Pre-questionnaire		*Post-questionnaire*		*t*	*df*	*r*
	Mean	*SD*	*Mean*	*SD*			
Academic digital competencies	4.17	0.76	4.33	0.64	2.90**	62	0.82***
Artistic digital competencies	3.03	1.01	3.16	0.97	1.48	62	0.76***
Computational digital competencies	2.15	0.99	2.50	1.05	4.66***	62	0.83***

*p < .05 **p < .01 ***p < .001

changes ($p < .01$) in both perceived academic and computational digital competencies during the course. All mean levels of competencies grew with computational digital competencies growing the most.

Pearson's correlation coefficient (*r*) was used to enable the assessment of rank-order stability. The correlation for all competencies were strong, indicating that the participants' relative level of competence did not change much. This finding may indicate a homogeneous competence development trajectory.

The teachers' learning diaries also told a story of competence trajectories. Digital academic and artistic competencies were mentioned in a few diary entries, but computational digital competencies and a lack of programming and robotics skills relevant to invention pedagogy were mentioned the most. Participants felt that the course's material and content supported their learning, helping them better understand the connections between computational digital technology and curricular aims and concepts. Also, participants found the hands-on guidance on combining technology competencies with invention pedagogy and multidisciplinary learning modules to be the most valuable. This guidance was realized through the course's hands-on activities, project examples, and collaborative work:

> The Innokas hands-on meeting was very productive, and I got a lot of tools for my own work from them as a teacher-educator. Especially visual programming with Adafruit was so interesting and fun.
>
> (Teacher 33)

Bravery and courage were also mentioned in participants' learning diaries. Participants noticed that, by following other teachers' work and hearing examples from other classes, other teachers faced similar challenges in computational digital competencies. By revealing teachers' varying competence levels, the course encouraged teachers to consider computational digital competence development as a step-by-step process for themselves and their students:

> Programming is interesting. Directions and guidelines were clear, and through that, I was increasingly excited. I still can't write hard and complicated command sequences, but I take small steps forward. It was truly great to see different innovative solutions that teachers had made. They reflected teachers' own previous know-how and motivation. It is great that the teachers' projects were of different levels. It gave confidence that this can also be started with small things with students.
>
> (Teacher 35)

Technological awareness, competence and epistemic knowledge about digital society established a foundation and motivated teachers to ponder the need for continuous learning about technology. Teachers recognized that, during the course, they established a strong foundation on which to develop their technological competence and that, after internalizing the basics it would be important to develop their digital competence independently:

> It was especially important to get motivation and courage to familiarize working with Micro-Bit and Arduino independently, now that the basics of programming are somewhat mastered.
>
> (Teacher 11)

Adaptive Practice

During the course, teachers conducted projects with students using invention pedagogy and the innovation process. These projects varied in duration from a few hours to several months, and they related to challenges that arose in students' daily lives, such as their learning environment, well-being, sustainable development, or home activities. Some projects dealt with specific themes, such as climate change or safety. Other projects were purely based on play or fantasy, and some derived their content from a specific school subject. All these projects used the innovation process that participants had become familiar with during the course. Teachers also targeted multidisciplinarity and crossing subject boundaries when planning and implementing these projects.

During these projects, and in line with the innovation process, students produced tangible artifacts such as scale models or miniatures, toys, games, computer models, escape rooms, or prototypes related to the themes of their projects generally. These artifacts were either advanced tangible products or product designs in nature. Students used the technological dimensions described in Chapter 8 of this book to document their processes and design and implement their artifacts. They used technology in both designing (3D printing), engineering (levers, cranks, cogwheels, syringes), programming (Micro:bit, Adafruit, Lego-robots, Bee-Bot, and Scratch), and making products by crafting (electronical components, recycled materials, craft materials). Cloud services and video production served as a means to document and share during this process. Several teachers also considered evaluating activities when planning these projects. During these projects, teachers guided students in self-assessments and peer assessments. A few projects used portfolios as evaluation tools (see Chapter 13 of this book for more detail). In all projects, teachers conducted continuous assessments.

Through their projects in schools and daycare centers, teachers described understanding the practical preparation required for multidisciplinary invention projects and the way in which students are guided during the innovation process. Equally, the understanding of the scope of the projects and the size of the target group also expanded: the experiences shared by the teachers about the projects led the teachers to understand that multidisciplinary learning entities can vary in scope and duration depending on the teaching objectives and students' level of competence. Also, the project does not always have to be aimed at the whole group to be taught, but can also be tailored to smaller groups as needed.

From a pedagogical perspective, these projects' innovation process, implemented with children and students, also supported participants' technological awareness and technological competence development during the course. For example, having the courage to try was mentioned in this learning diary entry: *"Electrical engineering is not rocket science. It can be easily mastered if you just dare to try."* The use of low-threshold materials is also highlighted. In addition to planning and leading the innovation process, some teachers described pondering student learning and specifically the skills students learned during their project. Alongside content knowledge, participants discussed teamwork skills, problem-solving, and teaching students thinking skills.

Guiding the development of thinking and creative problem-solving skills was also reflected in the teacher survey results. Even before participating in the course, participating teachers reported having guided students toward inquiry-based activities, learning by doing, creativity, and expressing ideas on a weekly basis. To examine the extent to which the participants' invention-pedagogy-related adaptive teaching practices developed during the in-service training, paired samples t-tests were used to compare the post-questionnaire's teaching practice components with the pre-questionnaire's teaching practice components (see Table 15.3). All mean levels of teaching practices grew slightly with encouraging students to share their ideas and be creative growing the most ($p < .05$). After the course, the teachers reported they encourage their students' sharing of ideas and creativity daily as opposed to weekly before the course.

Pearson's correlation coefficient (r) was used to enable the assessment of rank-order stability. The correlation for all practices was moderate, indicating that the participants' relative teaching practices did change and there was varying development among participants.

Reflective Practitioner

In the survey conducted at the end of the course, teachers pondered the course's impact on their previous practice and considered issues related to teaching methods, teaching situations, tools and materials, and collaboration. They rated items based on perspectives implementation and perceived importance (Table 15.4). Almost all responding teachers felt that they were allowed to develop teaching and teaching methods during the course, and they reflected on their past activities.

Table 15.3 Teachers' invention-pedagogy-related adaptive teaching practices before and after training on a scale from 1 to 5 (1 = less than monthly; 5 = several times a day)

	Pre-questionnaire		*Post-questionnaire*		*t*	*df*	*r*
	Mean	*SD*	*Mean*	*SD*			
I guide students toward inquiry-based activities	3.30	1.02	3.41	0.99	1.02	63	0.64***
I use the principle of learning by doing in my teaching	3.70	0.94	3.81	0.87	1.21	63	0.69***
I encourage students to share their ideas and be creative	3.77	0.94	4.02	0.93	2.12*	63	0.49***

*p < .05 **p < .01 ***p < .001

Table 15.4 The implementation and perceived importance of transformative digital agency during the course

Item	*I was able to do this (% of "yes" answers)*	*I felt this was important (% of "yes" answers)*
I developed my teaching and teaching methods	98.4	100.0
I pondered and reflected on my previous practice	96.9	98.4
I solved problems relating to new teaching situations and tools	90.6	98.4
I used new tools and materials	87.5	95.3
I collaborated with other teachers	75.0	85.9
I supported other teachers	68.8	85.9

Both the implementation and importance perspectives were viewed positively (100% and 98.4%, respectively). Teachers were able to solve problems in new teaching situations and use new tools. Moreover, teachers felt that their ability to use these new tools was important. Cooperating with other teachers and supporting other teachers were also considered important, but they had been carried out slightly less than other transformative activities (75% and 68.8%, respectively).

Teachers also considered the themes presented in Table 15.4 in their diary entries. They reflected both on their conception of teaching versus earlier conceptions and their ways of developing their teaching and related emotions. Respondents described their transformative role through their enthusiasm and desire to learn (or desire to learn more), and they identify factors that supported transformations during the course.

Changes to teachers' conceptions of teaching were influenced by both their newfound or strengthened epistemic awareness of technology and of invention pedagogy, as well as related theory and practice (including practical examples). Teachers' thinking was particularly influenced by the nonlinearity of invention pedagogy and its permitting trial and error:

> I also recall (the idea of) a non-linear working process from the videos, as I had never heard of that term before. I understood it to mean a process of working that is unique and no one can know the exact result in advance. From the examples given by others' projects and the views shared by the professor, it is possible to draw ideas and thoughts about teaching in general and not only about projects and multidisciplinary learning entities.
>
> (Teacher 18)

The course's practical examples of multidisciplinary learning entities prompted several teachers to consider the opportunity to implement the entities they had previously found to be too challenging in their own schools. Daring to try and a playful attitude were mentioned in this discussion. The course content related to invention processes made participants reflect on their own teaching concepts and methods, contributing to hesitation as to whether their own skills and courage to try something new would be sufficient to incorporate similar projects in their own teaching:

> Maker culture seems inspiring and interesting. The internet seems to be full of materials, but at the same time, I am struck by being spoiled for choice and the fear that my own skills might not be enough to guide the students. It seems that such an experiment would require the ability to just dive into it and not think about the end result, as well as tolerate the fear of failure.
>
> (Teacher 36)

Teachers also described their doubts about increased awareness and sharing experiences from a perspective based on students' skills or schools' operational structures. Some teachers wondered whether students' competencies would suffice to work on the artifacts that were an essential part of the course's invention projects. Issues were also raised related to the structure of school activities, such as adapting a subject-based syllabus to multidisciplinary, multihour, or longer-term projects or allowing teachers time for joint planning. Participants also discussed the evaluation of multidisciplinary learning modules using invention pedagogy. Teachers wondered how to build encouraging feedback that supports learning into their process so that students have opportunities to reflect on their own activities and at the same time, receive feedback from their teachers that can guide and develop this learning process.

The course also led teachers to reflect on their own teaching methods, practices, their development, as well as how to apply the knowledge and skills they learned in new ways across different contexts. Good examples of this reflection were given in a wide range of subjects; adapting and brainstorming were not only related to STEAM subjects and interdisciplinary learning but also to physical education, religion and ethics, and special needs education. Increased epistemic awareness of technology—and applying this new awareness and competence to one's own students—was also discussed. The experience of defining things previously taken for granted during the course made one participant consider their own teaching activities from the same perspective:

> Defining technology—understanding what is being done. When considering the definition of technology, I found that, in many cases, it can be surprisingly challenging to define / explain exactly the obvious. This is also good to remember in teaching. It is easy for a teacher to assume that students understand something that is difficult for the teacher themselves to define or explain.
>
> (Teacher 46)

During the course, and as part of the invention projects, several teachers reflected on tolerating uncertainty, failure, and trying by mirroring their own transformative agency. Diving into new challenges and the permission to fail were viewed from perspectives based on both teaching situations and students' skill development:

> The teaching situation must be seen as a training ground where there is an opportunity for failure. You can't learn something new without trying it, in comparison to a children's soccer practice, in which a player who avoids mistakes minimizes their own involvement and learns nothing.
>
> (Teacher 34)

> A reminder of how throughout my career, I have already been ready to dive into the new and unknown; this needs to be maintained, and the promotion of children's thinking and creativity needs to be more boldly integrated into every lesson.
>
> (Teacher 26)

Collaboration with other teachers and peer learning rose to occupy a special position in participants' learning diary entries. According to these teachers, the organized sharing of competencies with peers or colleagues during the course played an essential role in their development of transformative agency. Discussions about course content and the projects implemented in schools and daycare centers, as well as the joint planning sections of the course projects and the encouraging feedback received from fellow participants, deepened teachers' epistemic knowledge, self-efficacy, and ability to direct their own activities. The joy of working together and the importance of successful experiences were also mentioned as factors that influenced participants' desire to learn something new and develop their own teaching activities:

> The joy of working together, sharing information, and discussing what you learn really deepens learning.
>
> (Teacher 46)

> In the smallest steps, both the instructor and the student start in cooperation with the teachers. Doing things together and helping others, sharing information, these things accomplish a lot. Students in our schools have a lot of competence, as long as it is presented in a meaningful way, all the while inspiring and supporting the student.
>
> (Teacher 29)

Conclusions

The implementation of the Everyday Technology course and teachers' experiences of this training reflect the factors presented in the introduction of this chapter and support professional development of teachers: the long-term nature (Oliveira, 2010) and teachers' active role in their professional learning (Garet et al., 2001), the connection between learning and classroom or practical context, and collaboration and reflection with colleagues (Avalos, 2011; Van den Bergh et al., 2015). Teachers also regulated their own learning by setting goals, reflecting, and assessing their own professional learning process (Lavonen et al., 2020). The course was designed as a long-term entity emphasizing teachers' own agency and teacher interaction, alternating between course content and jointly planned classroom experiments. Participants' experience revealed that interaction and peer learning, organized discussions, and hands-on co-development—as well as the opportunity to plan projects at schools and daycare centers with colleagues—were important factors supporting teachers' professional development.

Additionally, teachers' awareness of digitalization, technological development, technology itself, and invention pedagogy as a method were important factors that supported participants' innovation orientation and professional development. The increased awareness and increased competence in innovative technologies inherent to invention projects led participants to reflect on their epistemic knowledge and capabilities as instructors in invention projects. Some teachers expressed having the courage to try and developed a new or strengthened sense that they were also allowed to fail and, through failure, learn something new. Some participants, in turn, reflected on their own and students' competence levels, considering whether their own skills or their students' skills were sufficient to carry out invention projects.

Teachers' course experiences (recorded in their learning diaries), hands-on project experiences, and reflections on teaching, self-efficacy, and student competence seemed to reflect Lund and Aagaard's (2020) main goal for transformative digital agency: *the ability to identify educationally challenging situations and utilize digital resources to transform these challenges into constructive situations*. The survey results, for their own part, supported these results. They also strengthened our view of digital and epistemic knowledge's relevance to teachers' transformative agency. Ever-evolving digital technology and digitalization require teachers to have a strong awareness of both technology's development and its impact on our actions. It appears that epistemic knowledge of digitalization is among the factors that enable teachers' transformative digital agency while simultaneously serving as a cornerstone of invention pedagogy. Awareness and competence development will enable teachers to understand the relevance of invention pedagogy projects from the perspective of both curricular objectives and necessary skills for the 21st century and will support them conduct invention pedagogy projects.

Finnish teachers are viewed as autonomous implementers of the curriculum who make independent decisions about teaching methods and tools. Some boundaries are set at the municipal level, but implementations vary extensively (Lavonen et al., 2020). Teachers' experiences with the Everyday Technology course reinforced our earlier understanding that autonomous and highly educated teachers need more tailored, participatory training that includes embedded, practice-oriented activities alongside guidance in understanding digitalization and invention pedagogy's opportunities to support students' 21st-century learning.

However, the teachers who participated in the course and provided data for this chapter represent a very small sample of Finnish teachers. We need more extensive research into factors that influence the development of teachers' transformative digital agency. From the educational equality perspective, we should find ways to motivate the teachers who are less eager to participate in training in invention pedagogy or technological competencies to also develop their innovative orientation toward teaching and learning. Through a comprehensive study of educational institutions' entire teaching staff, we will obtain more information on factors that hinder the development of teachers' transformative digital agency, and this information will enable us to target support measures for teachers more effectively. Our aim is to give Finnish students more equal opportunities to learn 21st-century skills by supporting teachers and inspiring their participation in invention projects.

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