Learning to Create - Creating to Learn

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5 Learning to Create

Creating to Learn

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Learning to Create

Invention projects engage students in nonlinear, multifaceted hands-on processes, through which they collaboratively generate creative solutions to open-ended, real-life design challenges. The aim is to support students in learning to be curious problem finders and solvers and to enhance their confidence to act in creative ways (Goldman & Kabayadondo, 2016). Furthermore, several future competencies linked with creativity and considered essential for well-functioning future societies, such as empathy and collaboration, can be developed in invention projects (Noweski et al., 2012). Within invention pedagogy, creativity emerges as a form of sociomaterial action as the material world is explored by students through collaborative generation of shared artifacts (Clapp, 2017; Mehto et al., 2020).

Throughout its history, creativity has been given multiple definitions. A widely accepted definition focuses on creative outcomes that need to have both novelty value and be appropriate or useful for their purpose (e.g., Stenberg, 2022). However, these elements are always determined in particular social, cultural, and historical contexts (Beghetto & Kaufman, 2014). In schools, teachers and students are the experts who recognize the creativity in students' solutions, and novelty value means that a solution is new to students or exceeds what can be expected from them (Clapp, 2017). In education, it is essential to understand that anyone can be creative at a certain level and can develop from one level to the next (Beghetto & Kaufman, 2014; Clapp, 2017). Creativity can be seen "as a capacity to imagine, conceive, express, or make something that was not there before" (Durham Commission on Creativity and Education, 2019, p. 3).

Sawyer (2021) suggested that the goal of teaching for creativity could be for students to understand creativity as an iterative, improvisational, and nonlinear process. Helping students to navigate in such uncertain and undetermined contexts cannot be guided by fixed instructions (Sawyer, 2018); instead, a creative approach to teaching is required both in terms of pedagogical methods and simultaneously enhancing competencies for creativity in students (Patston et al., 2021). Despite the significant role of creativity in the future society, there is the lack of research on pedagogies in nurturing learners' competencies for creativity in K–12 education (Cremin & Chappell, 2021).

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In this chapter, we explore how students' and teachers' *competencies for creativity*, that is, a dynamic set of knowledge, skills, and attitudes (Noweski et al., 2012), can be applied and developed through participation in invention projects. We present a case, an invention project called We Design & Make, in which the design thinking approach was used for teaching and learning competencies for creativity. In the project, eighth-grade students (ten girls aged 14–15 years) co-created e-textile products for local preschoolers according to their wishes and needs. The class met 12 times in weekly lessons facilitated by a craft teacher (later referred to as the teacher) and a researcher (the first author of the present chapter). The project engaged the students in a collaborative, open-ended design and making project which emphasized textile craft practices, new e-textile technology (programmable microcontroller), and development of a certain type of we-can-do attitude. In what follows, we first describe how the design thinking approach was used to structure and facilitate the creative process and practices in the project. Second, we explore the teacher's and researcher's roles and pedagogical practices in building a classroom culture for creativity and in supporting students' creative confidence. Finally, we provide an overview of the competencies for creativity applied and developed in the project and highlight how several types of competencies are involved in creative learning projects.

Learning Competencies for Creativity through Design Thinking

Design thinking is an approach to creative problem-solving in which several cognitive and affective processes, skills, and mindsets are applied (Goldman & Kabayadondo, 2016; Noweski et al., 2012). The process is dynamic in nature; processes of defining the challenges and generating solutions are simultaneous, and they require sustained, iterative efforts and various domain-specific and domain-general skills and competencies from students, as well as teachers (Sawyer, 2018). Both creative and critical thinking skills can be enhanced with methods and activities that encourage divergent (widening the solution space) and convergent thinking (narrowing the solution space) (Noweski et al., 2012; Razzouk & Shute, 2012).

Design thinking is characterized as a human-centered and collaborative process that generally involves five steps: empathize, define, ideate, prototype, and test. These steps support novices in the process, as they provide them orientation and stability (Noweski et al., 2012). However, learning through design thinking aims at not simply following the process steps but also developing a change of mindset through participation in an action-oriented collaborative problem-solving process (Goldman & Kabayadondo, 2016). Further, hands-on exploration with materials and tools has a fundamental role in many fields of designing, and embodied practices are a significant part of learning creative ways of working (Groth, 2016). In invention projects, students practice and develop several competencies for creativity in close collaboration with peers using a variety of materials, while they explore the context, generate solutions, prototype, receive feedback, evaluate, and refine their designs. Perseverance and coping with uncertainty and failure become necessary aspects of the iterative process (Goldman & Kabayadondo, 2016).

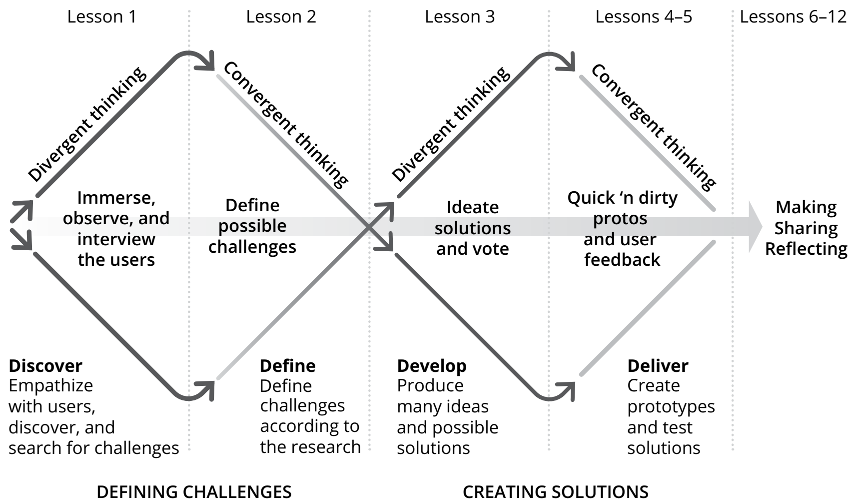

Figure 5.1 The creative process in the We Design & Make invention project.

Adapted from British Design Council, 2004.

Our case example, the We Design & Make project, followed the Double Diamond design model (British Design Council, 2004). The model is used in professional design, particularly human-centered design, and was slightly adapted to better suit the needs of a school project (Figure 5.1). The model consists of two "diamonds" (i.e., process phases): (1) defining the challenges, and (2) creating the solutions. Both phases involve divergent and convergent thinking, but in practice, the phases and modes of thinking are partly parallel. In our case example, the first phase or "diamond" focused on discovering the context of designing (divergent thinking) and defining the challenges to be solved during the invention process (convergent thinking). In the second phase, the aim was to develop many ideas and solutions (divergent thinking), and to deliver prototypes and to test the solutions (convergent thinking).

During the process, the Double Diamond model was shown to the students at the beginning of each lesson to visualize how the creative process was evolving, what steps needed to be taken, and why and how these steps were taken. This exercise helped the students to understand the iterative and lengthy nature of the process. In the following, we describe the use of the model as part of the pupils' co-design process and explain its theoretical pinnings using practical examples from the project.

Defining Challenges

The foundation of an educational invention project can be laid out in a design brief created before the project, which outlines the project's overall goals and constraints but does not predetermine the challenge for the students. Setting up the brief for students' demands constantly seeking to balance the openness and constraints of the task. Too much openness or a lack of constraints may lead to unrealistic ideas or recycling already familiar patterns, whereas tasks with balanced constraints help the students toward more advanced conceptions (Sawyer, 2018). In the We Design & Make invention project, the design brief was formulated as follows: "*Co-design and make an e-textile product for preschoolers according to their wishes and needs*." This brief emphasized collaboration between team members, consideration of the ideas, feelings, and needs of others, and creative and critical thinking about how technology could be used in the products. Yet, the brief was open-ended enough to leave space for students' explorations around the theme before defining the final challenge. Although educational invention projects do not encounter all the constraints of professional design projects, it is essential that students learn to understand the complexity of working with open-ended challenges, communicate initially vague ideas and challenges, and deal with the ambiguity of the process.

The invention process generally begins by exploring the design context to discover the challenge and discussing to build shared understanding of the design context and its dependencies. It is critical that the student team shares the same understanding of their challenge or problem (Noweski et al., 2012). The We Design & Make project began with the eighth-grade students discovering the context, which entailed empathizing, observing, and interacting with the preschoolers. At the beginning of the process, students recalled their own preschool experiences, wrote memories on Post-it notes, and made empathy maps. In this way, the students were more able to empathize with the preschoolers and to become attached to the We Design & Make project theme. The students also visited the local preschool to conduct observations and user research, using the interview forms and other supportive material prepared by the researcher. They were encouraged to observe the space with all the senses; they took photos and asked questions of the preschoolers and preschool teachers to understand the end users' needs and perspectives better.

Discovering the context helps students recognize and define the challenge they want to solve during the invention project. Defining the challenge and the related constraints takes place at the beginning of a project but continues in the later phases through iterative efforts. Students simultaneously elaborate the challenge at hand and create ideas for its solution, constantly alternating between divergent and convergent thinking. In our case example, the definition phase was strongly interrelated with the development phase. Based on the insights from the user research, observations at the preschool, and the preschool teacher's suggestions, the researcher put together various "how might we …" questions, such as "*How might we make dressing up more fun*?" By brainstorming solutions for the needs identified in the preschool, the students were also able to further define the challenges to work with. Many innovative ideas for challenges and solutions were on the table, and the students voted for their favorite ideas and started to work with the chosen idea.

Creating Solutions

The second main phase of the Double Diamond model focuses on creating solutions to the defined challenge, including developing ideas and solutions, and delivering prototypes to test those ideas (see Figure 5.1). The first stage emphasizes divergent thinking and seeing beyond the obvious, and when students generate and play with several ideas, they develop an understanding that there is more than one solution to a problem (Goldman & Kabayadondo, 2016). During the delivery stage, students evaluate ideas from several perspectives and develop appropriate solutions through prototyping, feedback, and other testing strategies. Invention projects involve reflective practices in all stages, and sociomateriality has an essential role in helping students to think and communicate their ideas verbally and non-verbally through sketches, prototypes, and other design artifacts (Mehto et al., 2020; see also Chapter 6 of this book).

In the We Design & Make project, different methods were offered to support the students' creative ideation and critical evaluation of ideas. In the ideation phase, inspirational visual materials, idea maps, and supportive questions about the use and the users of the preschool space were placed on the walls and tables of the craft classroom. Various solutions were discussed and enriched by the students, and the goal was to develop adequate plans for starting the prototyping and testing phase. In addition, the student teams were given large pieces of cardboard on which they could write ideas, draw models and shapes, and visualize proportions, measures, and materials so that they were visible to everyone. This practice supported communication and evaluative and reflective discussions among all the group members, the teacher, and the researcher.

In our case example, the process then continued with the delivery phase and prototyping. The ideas were further developed and materialized with rapidly constructed prototypes made from recycled cardboard and fabrics, felt, and other cheap and easy-to-manipulate materials, which were available in the craft classroom. In addition, to support idea development, prototyping helped the students visualize their ideas to others, as the preschoolers visited the school for presentations and a feedback session. According to the comments and feedback from the preschoolers and their teachers, the students elaborated their designs and continued toward the making phase.

Making the Inventions

The making phase in invention projects is strongly interrelated with the earlier stages, and many competencies for creativity are applied and developed during this phase. Students need to modify their ideas according to the constraints posed by materials, tools, and their skills to use them, as well as the restrictions of time and space at school. By making finished products, students also learn many craft skills, such as implementing an entire craft process; using materials, tools, and machinery; understanding craft concepts, signs, and symbols; and perceiving and anticipating risk factors related to work safety (Finnish National Agency of Education [FNAE], 2016). In addition, students can assess the novelty and usefulness of their own inventions and those of their peers and evaluate and acknowledge their limits. Moreover, students usually find the finished inventions to be meaningful and anticipate presenting them to wider audiences in the final stage of the invention project. This was also the case in our example project, to which fully functional needs-based products were brought to the enthusiastic preschoolers (see Bosch et al., 2022).

Creative Confidence and Classroom Culture for Creativity

Kelley and Kelley (2014) suggested that the focus of teaching for creativity should be helping people rediscover their creative confidence, that is, the ability to produce novel, unexplored ideas, and the courage to try them out without fear of failure or shame. People with creative confidence challenge the ways of doing, cope well with uncertainty, trust their intuition, and are curious and interested in others. Young children display many aspects of creative confidence but tend to lose it when they grow up participating in cultures and activities that are more focused on right answers than creative ideas (Kelley & Kelley, 2014).

Creative confidence is reciprocal to a student's creative agency, and their development is strongly interrelated. Student agency is regarded as an essential element in future-oriented learning, and it is conceptualized as a will, ability, and opportunity to act upon and positively influence and transform activities and circumstances in their own lives and the world around them (Rajala et al., 2016). Following Bandura (2001), Karwowski and Beghetto (2019) stressed the importance of people's creative self-beliefs reflecting the degree of confidence that they feel in their ability to act or think creatively. However, they have further suggested that to act creatively, mere creative confidence is not enough; rather, people also need to see personal value in acting creatively.

As students learn and exercise their competencies for creativity in social contexts at school, both personal agency and co-agency are crucial (Clapp, 2017). Co-agency develops in an interactive, mutually supportive, enriching learning community, which supports social and emotional skills, such as empathy (Clapp et al., 2016). Research has shown that creative making with and for a community can be an important way for students to build these identities and abilities, and thus add value to the process (Clapp et al., 2016).

Teachers' Role in Nurturing the Creative Confidence

Many researchers have emphasized the teacher's role in the creative classroom, where students need many social and emotional skills, such as flexibility and perseverance, to cope with unfamiliar and uncertain design processes (e.g., Beghetto & Kaufman, 2014; Davies et al., 2012). Recent research has suggested that social and emotional support may be more important for teaching for creativity than other forms of encouragement (Gajda et al., 2017). According to recent review studies of creative pedagogies and of nurturing creativity in classrooms (Cremin & Chappell, 2021; Davies et al., 2012; Richardson & Mishra, 2018; Sawyer, 2017), the teacher should fulfill the following role:

- Act as a facilitator, guide, and co-learner
- Guide and support students to actively navigate the open-ended, uncertain creative process, and balance between structure and freedom
- Scaffold students' work with open-ended questions by offering several perspectives, modeling, and simplifying

- Demonstrate sensitivity to learners' individual needs and diverse perspectives and stand back when needed to support students' ownership of learning
- Create an open, joyful, caring atmosphere that encourages free ideation, supports risk-taking, and accepts and values new, original ideas
- Base relationships with students on trust, equality, and collaboration
- Organize collaboration with external partners to increase the meaningfulness of learning and to support students' social identity and sense of belonging
- Organize physical spaces, materials, and other resources to support students' free choice, play, and flexibility

Although the teacher's role in supporting students' competencies for creativity, including creative confidence, has been recognized as essential, and the core curricula emphasize creativity in an increasing number of countries, teachers are given little support to turn policy into practice and include practices that nurture competencies for creativity in their classrooms (Patston et al., 2021). Therefore, next we provide a narrative description of how the teacher and the researcher in the We Design & Make project controlled the learning environment dimensions that directly affected the development of classroom culture for creativity and thus the students' competencies for creativity (see Richardson & Mishra, 2018).

Classroom Culture for Creativity in the We Design & Make Project

In the We Design & Make project, various practices were used throughout the process to develop classroom culture for creativity. The teacher and the researcher worked side by side, and both were responsible for addressing the curriculum goals. Together, they built the constraints into the process, organized the time and material resources, and formulated the design brief to collaborate with the preschool. They worked as facilitators in the design and making process, offered a range of ideation methods for ideation and provided support for regulating the process. The teacher and the researcher also acted as peers for the eighth-grade students in figuring out the programming and sewing e-textile components with conductive thread.

The teacher and the researcher sought to create a safe, caring classroom culture suitable for creative work in which the eighth-grade students could practice and develop their competencies for creativity. To do so, they used multimodal methods, such as pedagogical talk and practices (e.g., explaining), dialogic teaching/moves (e.g., questioning, suggesting), embodied support (e.g., modeling), and emotional support (e.g., encouraging). The teacher and the researcher emphasized explanation, collaboration, experiential and experimental attitudes, process orientation, and multiplicity. They also built connections outside the classroom and paid attention to the students' experiences and own explorations.

During the process, the teacher and the researcher explained the overall project plan, learning goals, assessment practices, and reasons behind each design task for the eighth-grade students, so everyone had an idea of what would happen in the coming three months and why. Creative confidence and we-can-do attitude were supported when the researcher emphasized that there was no one way to do things. The students were supported to envision new ways of doing things, take risks, and make mistakes.

RESEARCHER: Let's be brave in exploring. You are allowed to make mistakes because you can learn from them. Without mistakes, you cannot really learn much. And then let's try to think outside the box—not how things are supposed to be or that there is only one way to do things because that is not true.

The teacher's statement in the first lesson that "We don't know how these technologies function, but let's try to solve it together" made the teacher, the researcher, and students equal learners in the situation. The teacher and the researcher had a low authority position, and this offered the students autonomy within the open-ended challenges, as well as freedom to use the material resources and tools as they wanted. As one student explained, "We were allowed to work as we wanted to. The teachers were supportive and tried to help if something went wrong."

The teacher and the researcher continuously walked around the classroom, made themselves available, and offered the students empathic support and encouragement. They observed which students and groups needed help, stayed close to students by sitting next to them, and offered help by suggesting, re-voicing, and simplifying. The teacher and the researcher offered embodied support with materials, tools, and programming.

RESEARCHER: You know, you learn these things [refers to the microcontroller] much faster than I or Mia [the teacher].

TEACHER: It's so great.

RESEARCHER: Which is great. Marvelous.

TEACHER: You can teach us.

The process strongly emphasized collaboration and peer support. As a student on one team learned to program certain functions, the researcher shared this knowledge with all the class and invited other students to come over to learn. The students also had to collaborate with students with whom they were not familiar. The teacher aimed to mix established groups of friends and encouraged the students to work on diverse teams. A student reflected, "I learned to collaborate with people other than just my friends. It is useful anywhere, for example, here at school, at work." Moreover, the students were given predefined team roles (e.g., leader, documenter, programmer), but the roles were not necessary as the students offered peer support within and between the teams. As one student wrote down in a post-questionnaire:

SOFIA: My role was to be a leader, but I think the roles were unnecessary as we did everything together anyway. I always helped others on my team and contributed ideas, and the team also helped me. Our team shared work well, and we all designed and made the product together, and no one did just one thing.

The design brief and the methods used had a role in motivating and engaging the students in the creative process. The process included designing for a specific group of people, so empathy, perspective-taking, and meaningfulness were built into the design brief and the process. Preschool is obligatory in Finland, so every student had experienced it, making it easier to step into preschoolers' lives and build relationships with preschoolers. Working with real-world challenges motivated the students, and students' engagement became visible when they discussed their own preschool experiences. As one student explained in the post-questionnaire, "I learned to observe various challenges and to think how these could be solved."

The process involved challenges and failures that required perseverance. The teacher and the researcher praised the students' work, encouraged students to ask peers to help, and suggested that students try new ways of solving challenges. The parents' help was sought; for example, one student invited her father to help with programming on the school's open day. Humor and laughter were important in building an easy-going, encouraging classroom environment and sometimes served as a useful tool to overcome a difficult moment.

From the teacher's point of view, the most significant challenge was changing the mindset of a teacher to a facilitator, sharing authority, and letting students try and fail on their own. From the students' point of view, the most inspiring and important aspects of the project were the collaboration with the preschool children and the sense of purpose in making functional things for those children. Students also said that planning their own work and collaborating with their own teams were important aspects of the project. The students referred to the importance of helping each other and trying out new ideas with an open mind. Students used technology creatively, rather than following step-by-step instructions.

VIOLA: I felt that I could have a say in the way the process progressed, and all ideas from our team members were happily received. Our team had an encouraging atmosphere, and the teachers knew how to support and help when needed. The freedom to explore was obvious in our work. For example, we did diverse designs for the appearance of the product.

This experimental project was challenging but rewarding in many ways. As in all open-ended, undefined design processes, the beginning is generally messy and uncertain, and it might feel difficult to get down to work. Both the students, the teacher, and the researcher had to overcome elements of uncertainty, roll up their sleeves, and start working. They worked together in a community of practice in which every member was invited to join, interact, and co-construct.

SENJA: Being a designer was difficult at times as we had to design everything ourselves, for example, how the product would be durable and how to even make the product. It was also a lot of fun to let your creativity run free, but, as I said, it was difficult at times.

Nevertheless, we want to point out that the project was organized in Finland with its low-hierarchical school culture, where relaxed teacher–student relationships might have supported the co-construction of ideas and artifacts. Although the teacher and the researcher tried to sustain an easy-going, flexible design process, the time limits and school structure posed challenges to the process. Several classes had to be rescheduled due to various school happenings or other events, such as a climate strike. Although the Finnish curriculum emphasizes the importance of such open-ended multi-disciplinary projects that develop transformative competencies in all school subjects, it is challenging to adapt them with the rigorous schedules of formal education.

Creating to Learn

In this chapter, we have described the nature of creative processes and practices and illustrated how several competencies were entangled in a creativity-supportive invention project. Our aim was to explore how the students', the teacher's, and the researcher's competencies for creativity can be applied and developed in invention projects. In this concluding section, we provide an overview of these competencies with three broad but overlapping themes (Figure 5.2), following loosely the three innovation skill categories by Vincent-Lancrin et al. (2019). The overview emphasizes that design thinking processes involve many cognitive, affective, and embodied capabilities and practices (Goldman & Kabayadondo, 2016), that are all important building blocks when learning competencies for creativity.

The students applied and developed *creative and critical thinking* as they discovered the design context and its constraints and defined the design challenges through inquiry. They brainstormed various ideas, generated and evaluated several solutions, and continuously reflected on their ideas, solutions, and the process. The Double Diamond model provided structure for the iterative, nonlinear, and sometimes messy design thinking process, supporting students in shifting between divergent and convergent modes of thinking. One of the outcomes of going through such creative processes can include the new mindset that enables students to approach problems in more experiential ways, learn from failures, and be more confident in their ability to create (Goldman & Kabayadondo, 2016).

During the project, the students practiced several *social and emotional skills*, such as empathy and perspective-taking. Working in groups demanded ongoing collaboration and communication, and the students peer-supported and encouraged each other in many moments. Both individuals and the group had to regulate their work to be able to complete the products within the given constraints, although some students with predefined leadership roles paid the most attention to co-regulating the process (see Chapter 4 of this book). The openness of the design brief offered many uncertain paths to follow during the process, which demanded flexibility, but the students exercised a responsible and perseverant attitude to finish the products. Total frustration was close many times, but confidence could grow as challenges were resolved with the help of teachers, peers, and parents, and the students expressed pride in the results.

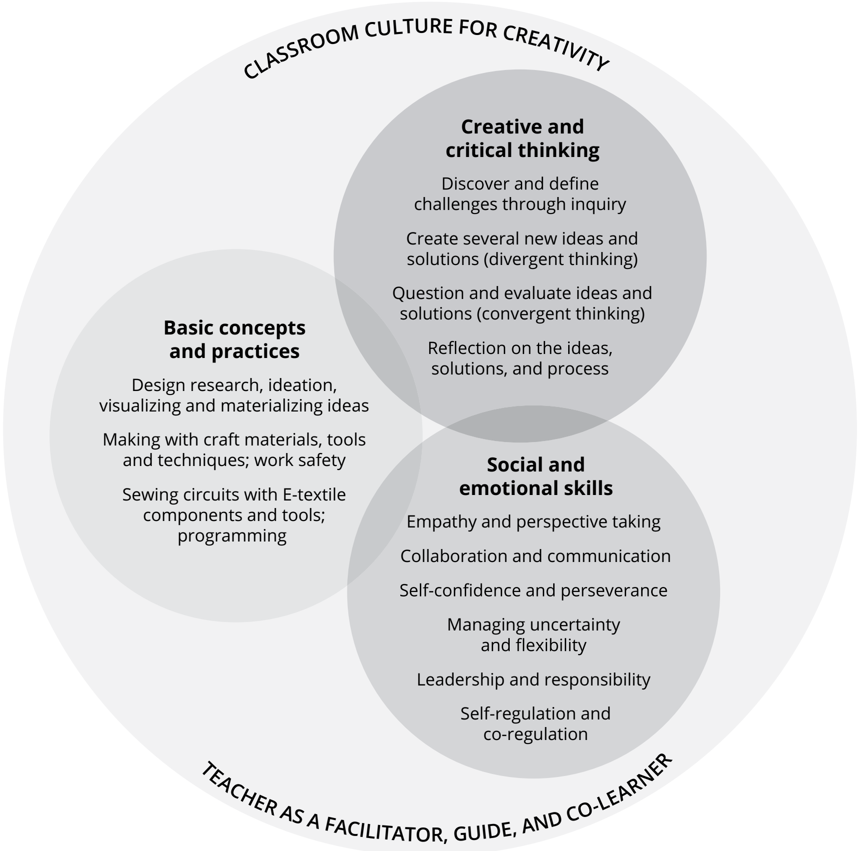

Figure 5.2 Competencies for creativity applied and developed in the We Design & Make invention project.

Adapted from Vincent-Lancrin et al., 2019.

Besides domain-general creative and critical thinking and socio-emotional skills, some more domain-specific *basic concepts and practices* were also introduced to students. These were related to design, craft, engineering, and programming. Design concepts and practices were used as the students iteratively developed their shared ideas for the e-textile products by using various ideation methods, and by visualizing and materializing their ideas through sketching, drawing, model making, and prototyping. Familiar craft concepts and practices were reinforced, and new ones learned through the use of textile craft materials, tools, and techniques, for example, in patternmaking and sewing with conductive thread. E-textile technology itself introduced many new engineering and programming concepts and practices into the process, while the students became familiar with circuitry, e-textile components, and tools, as well as programming and troubleshooting.

The project engaged the students in a collaborative, open-ended design and making project, which emphasized human-centered design, new e-textile technology, and development of a certain type of we-can-do attitude. Moreover, we want to highlight that many of the skills and competencies for creativity concerned both the students, the teacher, and the researcher. As co-learners, the teacher and the researcher developed their own skill sets and creative confidence while guiding this uncertain, multidimensional project. New digital technology introduced in the invention project caused significant demands and challenges in the process, but in the post-questionnaires, many students said that their most important learning outcomes were related to new digital technology and its wide range of uses.

Invention projects can focus on developing many competencies for creativity if they are carefully implemented in the process. Competency development is both a learning process and a learning goal, and it requires teachers to have extensive knowledge of creative learning processes and creative learning environments. For example, it is important for teachers to understand how both individual and social factors play roles in creative processes (Beghetto & Kaufman, 2014) and that students need various means of support to unleash their creative capabilities. Moreover, as suggested by Sawyer (2021), we should emphasize creativity as an iterative process, a journey, more than an outcome of the process. Instead of educating kids "how to be creative," we should emphasize "how to participate in creativity" (Clapp, 2017).

We believe that in our project, designing for a community (preschoolers) offered the students an opportunity to take part in meaningful creative work and build their creative confidence to act as designers and makers, creating minor changes in the world around them (see Clapp, 2017; Clapp et al., 2016). The students, as well as the teachers, learned to create, and simultaneously, they created to learn.

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