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Chapter 17. FINLAND

Kide Science: Play-based science learning

Sarah Lee and Jenni Vartiainen

ABSTRACT

Kide Science is a Finland-based company that offers a technology-enabled and research-backed solution for early childhood teacher professional development to engage young children (primarily aged 3–6 years) in play-based blended learning focused on the acquisition of twenty-first century skills through science, technology, engineering, the arts and mathematics (STEAM) content.

Kide Science was founded on the premise that high-quality digital teacher training coupled with research-backed content is inherently a scalable model. Its vision is to raise children to become the problem-solvers and creative thinkers that future society needs. Kide Science created a full version of its programme for distance learning during the pandemic which could further be adapted for a broader global audience. In this chapter, we aim to show how Kide Science translated its early science education model to answer distance learning needs that arose during the COVID-19 pandemic. More precisely, we will address the question: How can children's engagement be supported in distance learning in the context of science education?

The global pandemic put significant stress on designing new ways to learn science in a distance education mode. Early childhood science education is traditionally heavily dependent on hands-on experimenting in carefully scaffolded in-person learning environments. Due to the pandemic, Kide Science translated its pedagogical model of early science education to be fully remote learning, enabled for educators and for parents in the home environment. In this chapter, we will explore the pedagogical model of Kide Science and describe the transformation process from onsite to online learning. Furthermore, we will consider the characteristics of learning science in a distance mode by reflecting on Kide Science's distance learning model from the perspective of engagement theory. This case study shows that Kide Science's pedagogical approach has remarkable possibilities to scale as an onsite classroom solution but also as a distance learning innovation. Our study demonstrates that the Kide Science distance learning model can effectively support young children's engagement in learning. The fully online Kide Science teacher training programme is critical to further acceleration of scale for this programme.

KEYWORDS

Edtech, early childhood education, teacher training, remote education, distance education, distance learning, international education, science education, emotional intelligence, remote learning, home learning, twenty-first century skills, inquiry-based learning.

BIG IDEAS

Interactive science education is critical to developing twenty-first century skills. With technology, high-quality science education for younger children and accompanying teacher training can be delivered at scale – in multiple languages and across a variety of education and care settings.

INTRODUCTION

This chapter will describe the theoretical perspectives behind Kide Science's innovation, while also examining the practical implementation of the programme at scale. Further, it will describe how Kide Science's early science education model was translated for distance learning for both schools (including childcare centres) and the home environment. Kide Science is an early childhood science, technology, engineering, arts and mathematics (STEAM) content provider based in Finland providing early childhood and primary school educators in 28 countries around the world with research-backed content for teaching a play-based science curriculum. Through partnership with Sanoma Media Finland, the largest Finnish learning and media company, Kide Science has also sold more than 25,000 story–activity books based on its learning model and currently reaches approximately 300,000 Finnish children through its Kide Science television show.

In 2013, Dr Jenni Vartiainen began researching science education among young children in Finland (Vartiainen, 2016; Vartiainen & Kumpulainen, 2020). The empirical part of her work focused on developing a new model to implement play-based science education. In earlier studies, data was collected from science clubs, while later studies concentrated on scrutinizing implementation of the model in schools. Dr Vartiainen founded Kide Science in 2017 in response to demand for the science clubs she created. The distribution of the Kide Science pedagogy today occurs through a comprehensive, technology-enabled STEAM learning programme delivered through kindergartens and primary schools around the world. Demand for Kide Science grew significantly during the COVID-19 pandemic and now reaches more than 800 schools and learning environments. Some of these learning locations are purely online schools that existed pre-pandemic, while some emerged and are still operating because of the pandemic. This scale translates to more than 2,000 paying teacher-customers and approximately 60,000 children globally.

PEDAGOGICAL BACKGROUND OF KIDE SCIENCE

The Kide Science pedagogy approaches science education from the inquiry-based learning perspective (Minner et al., 2010). It is based on socio-cultural learning theory (Vygotsky, 1978). Inquiry-based learning refers to science education that includes consideration of the process and the nature of science (Abd-El-Khalick et al., 2004). It seeks to provide children with skills to produce, evaluate and apply knowledge rather than merely demonstrate what is already known. For young children, the inquiry is divided into three stages to scaffold the complex inquiry process: 1) Orientation, 2) Investigation and 3) Conclusion. The emphasis is on science process skills that emerge throughout these phases. Science process skills are transferable skills needed in all fields of science and across other academic subject areas. Examples of these exercises include making observations, measuring, classifying and drawing conclusions. According to Vygotsky, play is a leading activity for a child and can generate a zone of proximal development. For Vygotsky (1978), pivotal in play is creating imaginary situations. Kide Science follows a pedagogical model of scientific play (*Vartiainen & Kumpulainen*, 2020) that centres on imaginary science situations where inquiry can emerge. Imaginary situations are triggered and maintained with stories and props as science accessories. Kide Science pedagogy can be summarized as a method that blends 'hands-on, heads-on, and hearts-on' approaches. In addition to learning science process and critical thinking skills, children's emotions and sense of meaningfulness are also taken into account.

Kide Science provides an online platform named Supra for teachers to implement the programme in classrooms or to enact Kide Science via distance learning. Supra includes professional development in play-based STEAM education and a vast library of lesson plans designed around Kide Science pedagogical principles. For children, Kide Science appears as stories and hands-on inquiry activities using typical classroom (or household) supplies. The average Kide Science classroom lesson requires between 2 and 7 supplies, including items such as: plates, masking tape, water, pipettes, sugar and a flashlight. For the adapted remote learning model, this supply list remained simple for families to procure. Some schools and daycare centres provided physical learning kits to support children in learning at home.

The robust teacher training for facilitation of Kide Science content made the addition of remote teacher training during the early days of the COVID-19 pandemic seamless. The content team quickly adjusted the focus of training , to virtual environments, while maintaining fidelity to the fundamental pedagogical approach described above and ensuring minimal impact on the student experience. This transformation process was guided by the question of how to maintain young children's engagement when the social dimension of science education in classrooms is reduced to interaction with a teacher behind a screen. An example of a Kide Science lesson named 'The Thirsty Robot' (see Table 1) shows this transformation, comparing a regular classroom activity with the distance learning version of the same lesson. Online lessons generally follow the same structure as onsite lessons. The most notable differences between regular and distance learning lessons are in the preparation, entering the science adventure and the communication practices with children. The actual experimentation phase is exactly the same in both modes. The outcome of Kide Science's distance learning model was observed, and the characteristics of distance learning reflected the engagement theory that will be described below.

Table 1. *Characteristics in onsite vs distance implementations of 'The Thirsty Robot' lesson*

The Thirsty Robot lesson SUPPLIES	
Regular onsite classroom activity	**Distance learning activity**
- Scientists' accessories for children and a teacher (lab coats, goggles etc.) - Robot Hoseli prop (Usually Robot Hoseli shaped lamp) - Printed story - Transparent cups - Teaspoons - Ice tray, many lids or small plates - Water - Skimmed milk - Cola - Orange juice - Vinegar - Cooking oil - Lemon juice	- Transparent cups or jars - Spoons - Several plates or reaction plate - Cooking oil - Optional liquids - Skimmed milk - Soda - Water - Orange juice - Vinegar - Lemon juice - Other liquids you have If possible, children can prepare their own scientist accessories to use during the online lesson

The Thirsty Robot lesson PREPARATIONS BEFORE THE LESSON	
Regular onsite classroom activity	**Distance learning activity**
Teacher gathers supplies so that children work in small groups (max. four children). Each group gets a set that contains all equipment. Teacher prepares the experiment stations, setting out the supplies that children will use, and pours the liquids into transparent cups before the lesson starts so that children don't know which one is which.	***Choosing online platform:*** Platform should allow all families to join and should support a 45-minute lesson. ***Clear communication with parents:*** Teachers send parents the participation link, list of supplies and other considerations such as covering the table for messy substances. Teachers should send photos of the experiment setup. Parents are reminded of online platform usage tips. ***Preparing the scene:*** Teachers plan the research station so that children can see the teacher and the experiment supplies. Everything needed should be nearby, so the teacher doesn't have to leave the station. ***Preparing the research station at home:*** Parents collect the supplies and set them near the children. Parents fill up one jar/cup per substance in advance so that children won't know which one is which. The original packages are kept close by during the lesson so that children can match the substances to these.

The Thirsty Robot lesson ORIENTATION: ENTERING THE SCIENCE ADVENTURE	
Regular onsite classroom activity	**Distance learning activity**
Teacher gathers children in a circle on the floor. Everyone puts on their scientist accessories and participants take roles as little scientists. Teacher reminds children about the mysterious Supraland and Robot Hoseli. Teacher introduces the Hoseli prop and finds a letter that Hoseli has delivered.	Teacher welcomes children and reminds them how to use the online platform. Teacher also reminds parents about their role as research assistants. Teacher reminds children about the mysterious Supraland. Everyone puts on their scientist accessories if applicable. Teacher uses a picture of Robot Hoseli or a Hoseli prop, then introduces a letter that Hoseli has delivered.

The Thirsty Robot lesson **ORIENTATION: SETTING THE AIM BY READING A STORY**	
Regular onsite classroom activity	**Distance learning activity**

Teacher reads a letter from Supraland aloud (excerpt of letter below):

Dear scientist friend,

My name is Kelvin. You'll never guess what me and my friends, Esther and Pi, found in the garden!

It was some kind of little creature, with a blinking light on top of his head. What is it? Could this be a REAL robot? The little robot seemed lost and confused and was making little beeping sounds: 'Blip blip... Hello, my name is Hoseli... blip... what is this place? Blip blip... Hoseli is very

The Thirsty Robot lesson **INVESTIGATION: EXPERIMENTING**	
Regular onsite classroom activity	**Distance learning activity**

Experiment: Hoseli's favourite drink

Phase 1: Liquids from kitchen

'Let's try to find out what the substances are!'

1. Ask the scientists to choose one substance and observe it closely using different senses. What colours do you see? If you try to move the substance around in the cup, how does it move? What does it smell like?
2. Repeat until you have observed each substance.
3. Next, ask the scientists to interpret what the different substances might be. Name the substances together.
4. Classify the substances and put them next to the correct picture

Phase 2: Hoseli's drink

'Remember the confused and thirsty robot? The only thing he remembers is that he should drink something that doesn't mix with anything else. Let's try to find out together what that is!'

1. Ask the scientists to choose one substance.
2. Measure two spoonfuls of the substance on a plate.
3. Pick another substance and measure it on the plate, on top of the first substance.
4. Observe: What happens to the substances? Make an interpretation: Do the substances mix?
5. You can then let the scientists continue the experiment freely. Repeat the process so that everyone has used each substance at least once.
6. Conclude together: Which substance didn't mix with any of the others?
7. How could you help Hoseli? Which substance will quench Hoseli's thirst?

The Thirsty Robot lesson COMMUNICATION DURING THE EXPERIMENTATION	
Regular onsite classroom activity	**Distance learning activity**
Teacher observes children's experimenting and frequently asks questions that help children develop science process skills and solve the problem. Encouraging and praising feedback is often given. Teacher aims to create communication between children. If needed, teachers model asking for help from each other. Children use multiple modes to communicate their ideas: words, gestures, pictures and videos. Teacher draws attention back to the story to keep children engaged and to help them remember the activity's aim.	As communication through the screen is less dynamic than in person, the teacher communicates more intensively than they would in a regular setting. Still, the teacher doesn't have to pretend excitement and finds a way to communicate in a concentrated and inspirational way. Gestures and facial expressions are important to creating connection with children. To give the children confidence to communicate their ideas, the teacher listens carefully to what children have to say and makes clear that their comments and thoughts are valuable. There are moments when children must keep their microphones on, making it possible for teachers to hear children's ideas and hence scaffold children's working. Every child should feel that they are participating and heard. Teacher asks simple questions directed to the whole group. Children can answer by showing their artefacts or using gestures. Every child should be given the chance to describe their observations individually.

The Thirsty Robot lesson CONCLUSION: REPORTING BACK
Teacher attracts the children's attention and they prepare to report to Kelvin by writing him a letter or drawing a picture: - Which substance will quench Hoseli's thirst? - How can Hoseli identify this substance? - What could Hoseli do to avoid this problem in the future? After the report, science accessories are taken off and the teacher and children step out of the science adventure.

SUPPORTING ENGAGEMENT IN DISTANCE LEARNING

The pandemic forced schools and kindergartens to implement distance learning widely. Online learning presents challenges in engaging learners. Particularly affected is emotional engagement, which gets little attention when online learning solutions are designed (Plass & Kaplan, 2016). The Kide Science transformation from science education taking place in physical facilities to online science education was based in engagement theory (Fredrics et al., 2004). There are three overlapping dimensions in engagement: 1) Cognitive, 2) Behavioral and 3) Emotional. By cognitive engagement, we mean that a child is willing to put cognitive effort into learning and resist distractions. Behavioral engagement refers to the engagement through which a child is willing to do activities and show perseverance. Emotional engagement means that a child shows interest in learning: they are having positive emotions and experience tasks as meaningful.

To understand children's engagement, a qualitative case study of Kide Science (Yin, 2012) was conducted. The observational data were collected from 12 children and video-recorded data from six children to better understand how Kide Science supports children's engagement in distance learning. The data were analysed using theory-driven content analysis and the results support each dimension of engagement. Children using Kide Science are 3 – years old and therefore parents or other assisting adults play an important role in organizing the materials. To support engagement, it is important that the equipment is ready and children's attention is not affected by searching for equipment during the lesson.

Children's behavioral engagement was high when children were able to interact with the material environment. From a pedagogical point of view, this means that there should be only a short interval with the teacher talking and a lot of hands-on working. Parents are needed to guide and scaffold hands-on work if children's fine motor skills are still developing. However, the data revealed that children didn't need much help from parents because the level of the tasks was suitable for children to act independently, according to their age group. To make sure children are able to maintain behavioral engagement, teachers need to give verbal instructions, use visual aids, and model actions for children. For the parents at home, they are reminded to observe and intervene only when needed, for example, if a child's fine motor skills are still developing and a child cannot fill cups or use a pen.

Overall, children's behavioural engagement was undistracted throughout the 45-minute story and play-based lesson. The children's willingness to undertake activities indicated interest and curiosity about the lesson's tasks. The results revealed that children's cognitive engagement was high and they worked intensively to solve the problem. A deep level of cognitive engagement was evident when children drew connections between new concepts and phenomena and their previous knowledge and experiences. The story-based approach supports cognitive engagement as the story sets the aims for inquiry. Children feel that solving a problem arising from a story is meaningful. By using a story-based approach in distance learning, it is possible to increase children's willingness to understand the phenomenon, and hence to support children's cognitive engagement.

The child's emotional engagement was also strengthened with the story-based approach. Emotional engagement was evident in the joyful atmosphere when laughter and exclamations of amazement were observed. However, it was evident that distance learning did make frequent high-emotional engagement challenging. The interaction between children is thin and therefore the joy of shared learning and 'finding out together' is difficult to support. Notwithstanding, data showed that emotional engagement can be supported by a teacher if they maintain an intensive interaction with all children.

In conclusion, Kide Science pedagogy is effective for engaging children in STEAM education in physical learning environments and in distance learning. Prior to the school shutdowns induced by the pandemic, Kide Science was a supplementary science programme, or was identified as the core science curriculum in daycare centres, primarily in early years (age 3–6) learning. As schools begin to re-open, Kide Science users around the world continue in their usage of the remote learning content, indicating a desire to retain the Kide Science distance model.

Behavioural engagement is high when children are allowed to do most of the hands-on work in a lesson on their own, supported by an engaged remote teacher. Inactive listening time should be minimal. To engage behaviourally, children need clear instruction that is mediated through multiple modes of communication. Cognitive engagement can be effectively supported by utilizing stories. Children want to help story characters and their motivation to stay cognitively engaged is strong. Stories also support emotional engagement. When implementing online STEAM education, careful attention should be paid to supporting emotional engagement. The teacher should take into account that every child feels the need to be heard. Successful moments should be praised and celebrated with a child. Multimodal features of online-based environments, such as emojis and virtual reactions, can be used to strengthen emotional engagement in a virtual setting.

ALIGNMENT WITH THE FUTURES OF EDUCATION VISION

Kide Science pedagogy is especially aligned with the learning of twenty-first century skills among young children. Some institutions stress economic growth as a motivation to implement twenty-first century skills, while others underscore citizens' ability to manage everyday life. Despite the diversity of aims for implementing these skills, almost all frameworks identify similar core skills: collaboration, communication, ICT literacy, social and cultural competencies, creativity, critical thinking and problem-solving (Voogt & Roblin, 2010). Kide Science allows children to practice these skills and pays particular attention to problem-solving and critical thinking, weaving the theoretical principles of learning into socio-cultural approaches of collaboration, communication, and social and cultural competencies in all their lesson activities, training and content.

With regard to twenty-first century skill development in children, it is essential to consider teachers' professional development. UNESCO states that teachers' professional development should steer them to implement pedagogies and tools that underscore the depth of understanding in learning (Voogt & Roblin, 2010). Kide Science's professional development programme supports teachers' adoption of pedagogical approaches that emphasize children's thinking skills, cooperative learning and problem-solving skills.

Kide Science teacher training is delivered through an online platform that includes training modules and step-by-step instruction for each lesson. Teachers are provided with multimodal instructions (text, video, pictures) to ensure effective teaching. The online platform allows training whenever and wherever it is most suitable for teachers. The training is integrated into the lesson plans: teachers learn by doing STEAM with children. This braided approach ensures teachers are highly engaged and immediately see the meaningfulness of the training in action. The platform allows teachers to train in bite-size playlists and, hence, it is not distracting for busy teachers. In addition, the use of a web-based platform increases teacher training equality: teachers don't need to travel to expensive in-person workshops; they can use the platform with any internet browser regardless of their device or user interface. Basic Kide Science teacher training takes approximately 20 hours and is currently offered in Finnish, English and Mandarin Chinese. Furthermore, there is the possibility of continuing teacher development by using the extensive Kide Science lesson plan library. With a Kide Science licence, teachers can obtain support from the Kide Science team and an extensive global teacher-peer network.

CONSIDERATIONS FOR SCALE

The Kide Science programme currently reaches a broad spectrum of educators It has the potential to scale across an even broader range of geographies and educational environments. As an education technology innovation, it holds pedagogy as its core technology, yet the actual technology platform has been pivotal in facilitating distribution prior to the COVID-19 pandemic.

Post COVID-19, as government and educational leaders rebuild and recover, Kide Science provides a case study for science/STEAM education continuance for younger children. With additional training and professional development content, Kide Science was able to respond to school shutdown, and quickly enable remote learning to mitigate learning loss in the critical subjects of science and twenty-first century skills.

Kide Science has continued to build additional distribution channels for its pedagogy. The highly transformative, yet flexible, nature of the programme makes it resistant to many issues that humanity and global education systems will inevitably face in the future. Kide Science already has meaningful evidence that its pedagogy translates via the channels of television shows, children's books, classroom activities, distance learning activities, hobby centre activities and home activities with parents.

As an example of scaling the programme to homes, Kide Science confirmed a partnership with technology company TCL Alcatel during the pandemic to provide a free family version of the Kide Science programme, pre-installed in more than five million of the new affordable tablets for children that will be sold/distributed by the end of 2021.

Kide Science has embraced a vision for global scale since its inception. From this viewpoint, the founding team believes that the COVID-19 pandemic only accelerated the mass demand for their programme and content, as well as the significant increase in adoption of remote learning for both children and adults.

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Sarah K. Lee (Ed.M) is a former education startup founder with 17+ years of experience launching and scaling innovative education programs/school networks, coaching founding teams of edtech startups globally, and investing in future-of-learning/future-of-work companies. Her areas of investment interest are: Future-of-Work, Future-of-Learning, EdTech, K-12 EdTech, Higher Education Innovation/Alternatives, SeniorTech/Later Life Learning, SilverTech, Early Childhood Education, and Modernized Montessori. Ms. Lee was a Fulbright Teaching Fellow (Taiwan, 2005). She obtained her B.A. in Economics from Mills College, her Ed.M. in International Education Policy from Harvard Graduate School of Education, and is currently a doctoral candidate at The Johns Hopkins University Department of Education focusing her research on the neuroscience underpinnings of hybrid intelligence learning environments.

Jenni Vartiainen is a researcher and holds a university lecturer position at the University of Helsinki. Jenni is an expert in science, mathematics, and inquiry-based learning, especially in early childhood education. Her passion is to understand how play affects children's learning by conducting research on early childhood STEAM education. Jenni is a co-founder of Kide Science.