Investigative Activities as a Basis for Integrating Pre-primary Craft, Technology and Science Education

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The aim of this study is to explore the integration of pre-primary craft, technology, and science education. Inquiry-based approaches and hands-on activities are common modes of teaching within these learning areas in pre-primary education. Referring to the way young children act in a learning context, the term 'investigative activities' has been used to describe the combination of inquiry-based and hands-on activities, such as designing and crafting. However, few studies have focused on the possibilities of integrating different joint objectives in pre-primary education. This paper presents an initial set of investigative activities that create the integrative basis for pre-primary craft, technology, and science education, and further, opens up the activities with a pedagogical example. With these activities, the three learning areas form an integrative, holistic learning project, supporting children to understand their natural and man-made environments and become active creators within these environments.

Keywords: investigative activity, craft, design and technology education, science education, pre-primary

Introduction

The main educational goal in Finnish pre-primary education is to develop children's transversal competencies using versatile working methods and learning environments. Transversal competencies, the Finnish interpretation of 21st century skills (Binkley et al., 2012), refers to the set of knowledge and competences needed in society today and in the future. In pre-primary education these competences are approached in integrative ways, combining children's interests and five learning modules with joint objectives: diverse forms of expression, rich world of the language, me and our community, exploring and interacting with my environment and I grow and develop (FNBE, 2016). This study focuses on two of these objectives, diverse forms of expression, and exploring and interacting with my environment, and especially the contents and implementation of craft, technology, and science education, as well as their combinations.

The Finnish National Core Curriculum for pre-primary education (FNBE, 2016) emphasizes the promotion of children's interest in science and technology, creative designing and making, problem solving, examining and experimenting with structures and materials, and reflection on the processes and products. These activities also form the core of inquiry-based learning, which is the joint basis for young children's craft, technology, and science education. By engaging in inquiry, i.e., in the processes of observing, questioning, predicting, and evaluating, young children learn to construct knowledge, particularly when guided and encouraged by adults (Hollingsworth & Vandermaas-Peeler, 2017). In inquiry-based activities, children are encouraged to figure out and build various constructions or solutions to their own, self-found technological problems using versatile materials, and to verbally describe their decisions (FNBE, 2016; Turja, Endepohls-Ulpe & Chatoney, 2009).

When learning activities are connected to experiences, children have possibilities to wonder, explore, and experiment, as well as to ponder and recognize interesting phenomena. This is at the core of the way young children learn because they have a natural ability to ask and explore (Vartiainen & Aksela, 2013). Learning to observe and form questions are the most necessary skills in inquiry-based learning

Techne Series A: 28(2), 2021 173–180

(Johnston, 2009). According to earlier studies (Aerila & Rönkkö, 2015; Efland, 2002; Rönkkö & Aerila, 2015; 2018) this kind of integrated learning process can be an effective and a creative way of working in pre-primary education. Furthermore, it aims to offer children a complete, comprehensive, and inspiring learning experience that supports their growth and welfare and offers a versatile foundation for the development of their knowledge and skills (Rönkkö & Aerila, 2018).

Young children's craft, technology, and science education form an entity, which offers different ways to implement learning modules, including inquiry-based and hands-on elements. The term *investigative activity* depicts young children's functional way to act in a context of inquiry-based approach, where several objectives of early years' education are integrated in child-centred way (Rönkkö, Yliverronen & Kangas, 2021). Synergies between inquiry-based and hands-on activities in early years' science education have been highlighted in several studies (Lindeman, Jabot & Berkley, 2014; Park et al., 2016). Both approaches can be employed as tools for knowledge creation and learning, and both offer motivational support for promoting a positive attitude to science and creative ways of working (Stylianidou et al., 2018). Indeed, according to Roden (2015), it is almost impossible to separate some aspects of science, technology and craft education.

In the present study, the aim is to examine the confluences in pre-primary students' craft, technology, and science education, as well as the similarities in the implementation of these learning areas. For this, the following research question is addressed: *What kind of elements create the integrative basis for investigative activities in early years' craft, technology, and science education?* In the following, we first present a short theoretical overview of the three learning areas in pre-primary education. The overview is not a systematic review, but aims to open up pre-primary science, technology, and craft education, focusing on the most significant and critical aspects of the current knowledge in these fields. Then, we provide a summary, with a pedagogical example of a pre-primary students' 'Power Creature' project, of the investigative activities that form the basis for integrating young students' craft, technology, and science education. In the end, we make some concluding remarks.

Diverse approaches to investigative activities

Science education

Awakening an interest in science and experimentation are one of the main goals of young children's science education. This mode is often most successful when science is approached via familiar and practical starting points, and young students learn to notice scientific connections in their real life (Roden, 2015). Early years' science education has a practical essence involving observations, experiences and explanations connected to children's ability to develop their logical thinking and reasoning skills as well as their collaborative and cooperative working skills (Osborne, 2010; Roden, 2015). The developing competence of naming phenomena and understanding and using different concepts promotes children's multiliteracy (FNBE, 2016).

The emphasis on young children's own questions and investigations is a fundamental part of their science education because questions and observation create the basis for science learning already from their first playful explorations (Bulunuz, 2013). Children's interest towards science is evoked using playful elements where they are guided towards holistic investigation processes with observations and realizations, finally evaluating their approach. A playful learning environment allows children to play with materials, open starting points leading to a variety of solutions and support children's creativity (Archer, 2015; Pramling Samuelsson & Asplund Carlsson, 2008). They learn to compare, classify, and organize the information they have acquired through observations or measurements, which are the key elements for scientific working (FNBE, 2016; Roden, 2015). Children are encouraged to draw conclusions, come up with solutions to problems, and implement playful experiments.

The first steps towards children's early years' science education are usually implemented with natural science content. Children's own environments offer versatile materials for their learning, and hands-on activities combined with science provide creative elements for young learners to get familiar with scientific inquires (Johnston, 2009; Roden, 2015; Vartiainen & Aksela, 2013). This education creates a foundation for a sustainable way of living by familiarizing children with nature preservation, reuse, and recycling (FNBE, 41). If children have been provided with the possibility to learn natural sciences in an informal way at pre-primary age, it is expected that they will be interested in activities involving natural sciences in the future.

Technology education

Like science education, technology education is part of the joint objective *exploring and interacting with my environment* in the Finnish national core curriculum for pre-primary education (FNBE, 2016). Within the objective, children's development as thinkers and learners is supported by utilizing their own observations, experiences, and knowledge of natural and man-made environments. Technology education, in particular, aims to support children in exploring and understanding everyday technology, and in pondering how it can be used to solve daily life problems (FNBE, 2016; Sundqvist & Nilsson, 2018; Turja et al., 2009). One of the main goals is to encourage children to observe technologies and technological solutions surrounding them, and to evoke their interest in technology in practical, hands-on ways. Children take part in tasks, using age-appropriate materials, tools, and techniques, to creatively resolve their own technological matters. The main principles in young children's technology education are child-centered ways to act, use of imagination, and constructive play (Turja et al., 2009).

In the curriculum, technology education is seen as a wide-ranging and practical form of early childhood educational content, with many common goals with other learning areas. The idea of integrating technology education with other fields is not new, and the STEM (science, technology, engineering, mathematics) framework is an especially well-known integrative approach to technology education (Sanders, 2008). Within the STEM approach, technology is seen as a vehicle for contextualizing science and mathematics curricula. During the last decade, however, the letter "A" has been added to the acronym to represent arts, design, and humanities (e.g., Bequette & Bequette, 2012), with the aim of promoting creativity and children's engagement in STEM.

The essence of the STEAM framework, as well as of pre-primary technology education, is in creative activities and seeing children as active constructors of their environment. Providing children opportunities for creative ways of working with technology from early stages of education is seen as crucial for developing the technological competence needed in future society and working life (Papavlasopoulou, Giannakos & Jaccheri, 2017). Learning through inventing, making, and constructing various structures and solutions out of various materials develops children's understanding of technology as an outcome of creative human activity (FNBE, 2016). Describing the solutions they have made also provides the children the basis for critical reflection on technological solutions in general. Furthermore, a creative and wide-ranging approach to technology education offers children varying opportunities to become interested and inspired in the possibilities of technologies.

Craft education

In pre-primary education, craft is a part of the joint objective *diverse forms of expression* (FNBE, 2016). Like technology education, craft education also underlines the creative process, however, within this objective, the holistic and expressive nature of the process is emphasized. In Finland, craft in pre-primary as well as in basic education is based on the concept of the holistic craft process. The holistic craft process comprises all the phases of the craft-making process, i.e., the maker executes the ideation, designing, making, and assessment of the final product and the whole process (Pöllänen, 2019; Rönkkö & Aerila, 2015). Besides creativity, the holistic craft process emphasizes critical thinking and problem solving, as well as self-expression and understanding of the technological and cultural world (Pöllänen, 2019). It includes reflection in action, and the embodied process consists of collaborative action with hands, eyes, and mind (Seitamaa-Hakkarainen, et al., 2016). Thus, craft education affects many significant areas of child development, including bodily perception, fine motor skills, visual perception, and concentration, as well as children's self-esteem through the joy of success and received feedback (Pöllänen, 2019; Yliverronen & Seitamaa-Hakkarainen, 2016).

Young students approach the holistic craft process gradually. They are encouraged to design and implement various craft processes by using their imagination and practicing the use of different tools, instruments, and materials (FNBE, 2016). As stated in the core curriculum, pre-primary students carry out at least one process where they design and make a craft product that they work on over a longer period under the supervision of a teacher. However, the curriculum does not provide any instructions for implementation, pedagogical models, materials, nor craft techniques (FNBE, 2016). Instead, craft-making with design is emphasized and seen as a separate skill from handicrafts, e.g., crafts where the maker only produces designs made by another, as in making craft from a kit or a ready-made design (Rönkkö & Aerila, 2015). Furthermore, a sense of thinking through material (Groth, 2016) and material knowledge (Härkki, Seitamaa-Hakkarainen & Hakkarainen, 2016) is emphasized. The importance of embodiment as a part of thought processes, the handling of tools and materials, the use of space, and interaction with others is spotlighted.

In pre-primary education, the holistic craft process could be supported with scaffolding and limitations set by the teachers regarding the materials and techniques that enable all children to design and implement designs (Aerila, Rönkkö & Grönman, 2019; Rönkkö & Aerila, 2015; Yliverronen, Marjanen & Seitamaa-Hakkarainen, 2018). While children's motor skills may be limited, they can explore the world around them through crafts. The holistic process makes it possible to study phenomena in concrete terms, for example, by making prototypes. In that sense, design and craft-making are also an essential part of the joint objective *exploring and interacting with my environment*. This enables open-ended and inquiry-based processes for the younger students also. The contribution of the learning areas may differ from one project to another. What is essential is that children get experiences of holistic processes, participation, and the ability to influence the end result.

Summary with a pedagogial example

We were interested in examining the confluences in pre-primary students' craft, technology, and science education. For this, we stated a question: *What kind of elements create the integrative basis for investigative activities in early years' craft, technology, and science education?* Based on studies of early years education, we proposed to combine pre-primary science and technology education and crafting using investigative activities on the basis on children's living environment. Figure 1 illustrates investigative activities in the intersection of craft, technology, and science education. Combining these three learning areas through investigative activities form an integrative whole, which helps children to understand their natural and man-made environments, and to become active creators within these environments.

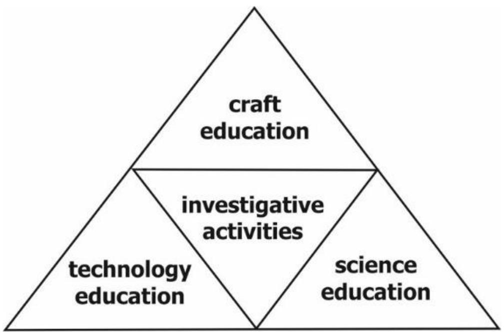

Figure 1. Investigative activities combining young children's craft, technology, and science education as diverse approaches

Investigative activities, intended for children, contain the following modes of action:

- Ideation
- Questioning, discussions, and joint reflection
- Small scale investigations
- Holistic processes with concrete products
- Playfulness
- Child-centered pedagogy
- Scaffolding

An earlier study (Rönkkö & al., 2021) explored a *Power Creature* project, an example of investigative activity in craft, technology, and science education. During this project, children designed and constructed felted toys containing soft circuits. The learning project started with **ideation**: The project was introduced by reading picture books dealing with emotional intelligence and confidence issues (i.e., self-esteem, managing fears). After the reading, children's emotional skills were exercised with **discussions** about children's own characteristics and strengths. After this phase, children were guided to make a poster according to these **reflections**.

Children were guided to become acquainted with electricity as a phenomenon and how it affects their everyday lives. The teacher asked **questions** about the theme and the children were asked to reveal their perceptions and views of electricity, which led to a child-level (meaning not too abstract) **discussion** about electricity as a phenomenon. After this, the children had **playful experimentations with circuits**, but they also implemented a circuit with real components (batteries, a battery holder, a switch, alligator clips, and a buzzer). During a **small-scale investigation**, children explored various materials (i.e., plastic and metallic cutlery, furniture, walls, floors) to observe if the material is conductive or nonconductive. After the activities, the children designed their own Power Creature with LED lights and implemented their ideas on their soft toys. During the project, crafting was implemented through versatile embodied and material experiments, which helped the children to build their knowledge related to everyday technologies, functions of circuits, and knowledge of materials.

Holistic processes, including diverse activities, provide the basis for understanding natural phenomenon. Crucial for learning are multi-stage tasks, which are relevant to the children's world, (Milne, 2013) and include sufficient design and making limitations (Aerila & Rönkkö, 2015; Kangas & Seitamaa-Hakkarainen, 2018.) Pre-primary-aged children's cognitive development is in the concrete operations phase, which means that they can solve problems in a logical fashion, but they need physical objects to reflect the whole process (Frey, 2018). Holistic, step by step, continuing processes are important models for children to learn that things do not just happen, but they are results of multiple phases, designing, and decisions.

Guided inquiry with **playful elements** is the common way to implement science education with young children. This kind of action, where the teacher creates a learning environment for asking, making investigations and other activities together that is suitable for young learners (Bulunuz, 2013; Vartiainen & Kumpulainen, 2020). Play is an integral part of children's processes, both in their own planned task boundaries (cf. play planning) and in the use of self-made craft products as play equipment. Concrete results of the holistic working period can lead to children using the finished products as play equipment (Yliverronen, 2014). According to Bulunuz (2013), children's playful science learning activities should be combined with multisensory hands-on activities like drawing, reading, music, and drama, where the activities are suitable for children's age and capacity. This kind of active participation creates meaningful circumstances for learning outcomes.

Child-centered pedagogy is based on the process of co-constructing learning experiences among children, adults, and the environment (Roden, 2015). Children are viewed as active knowledge constructors, having both choice and autonomy, and the adult's role is mainly to facilitate this by providing guidance, opportunities, and encouragement (Lerkkanen et al., 2016). Listening to children and their questions, observing them play, and understanding their spontaneous investigations and perceptions of the themes which they are pondering, offer good possibilities to create inquiry-based learning processes based on children's interests.

Teacher **scaffolding** gives support for holistic investigation processes. Scaffolding, meaning help, such as prompts and hints from a more skilled person on the critical points of working, is a crucial part of the learning process (Reiser & Tabak, 2014). Further, it seems that children can transfer their understanding of a technological phenomenon from one situation to another when they have adequate language skills and sufficient reiteration (Milne & Edwards, 2013).

Conclusions

The aim of the present study was to explore the confluence in pre-primary students' craft, technology, and science education. Children are typically interested in small-scale investigations like observing daily life technological solutions and their functionality, phenomena related to nature and technology, and making artifacts as a result of their experiences. Kindergarten adults' duty is to enable children to implement their thoughts and investigations by preparing the tasks convenient to children's age and skills and offering scaffolding on critical moments when needed (Yliverronen et. al., 2018). Inquiry-based approaches and their benefits are widely recognized in early science education (e.g., Samarabungavan et. al., 2008; Vartiainen & Kumpulainen, 2020). It is natural to integrate technology education with design and craft education because these learning areas have common objectives and procedures; children are encouraged to discover, make constructions out of various materials, and resolve and describe the technological problems they have found (Yliverronen et. al., 2018). According to Bennett and Monahan (2013), students become more motivated and engaged when they have problem-solving tasks that are personally relevant and related to their lives. Through design and hands-on activities, learners have an opportunity to identify a problem or need, solve various sub-problems, consider various options for a design, and test and implement their own ideas. The present study was our initial attempt to explore the integrative basis for pre-primary science, technology, and craft education. In the future, a more systematic literature review could be conducted to support a more thorough analysis of young students' investigative activities.

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