EDUCARE 2022: 2

doi: 10.24834/educare.2022.5.8

Didaktik modelling illustrated by sustainability teaching arrangements in preschool

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This paper presents the research behind the formulation of a new didaktik model on waste and material resources in preschool. The research was part of an extensive collaborative R&D programme, involving close to 300 preschool teachers/managers and researchers, to build systematic knowledge on what may characterize teaching in preschool based on scientific grounds and proven experience. The guiding question in this specific study was what it can look like to teach sustainability issues in preschool. The teaching examined in the study was informed by the concept of didaktik as well as by pragmatic theory. Using the methodological approach of abductive analysis, a new didaktik model was designed. This process of generating a new didaktik model is part of didaktik modelling, a focus of the paper.

Keywords: didactic modelling, didaktik models, preschool teaching, sustainability issues, waste management

1. Introduction

In recent years there has been a growing interest in exploring what characterizes teaching in preschool (e.g., Hedefalk, Caiman, Ottander & Almqvist, 2021; Melker, Mellgren & Pramling Samuelsson, 2018; Pramling et al., 2019, Thulin & Jonsson, 2018; Vallberg Roth, 2020). One content area of focus is science teaching (e.g., Broström, 2015; Andersson & Gullberg, 2014; Fridberg, Jonsson, Redfors & Thulin, 2019; Gomes & Fleer, 2020; Sundberg, Areljung & Ottander, 2019). In the latest version of the Swedish curriculum for preschool (SKOLFS 2018:50), sustainable development was added as a curriculum goal.

The study described in this paper was part of a broad R&D programme during the years 2018-2021. It was a collaborative initiative involving eight Swedish municipalities and the independent Institute for Innovation, Research and Development in School and Preschool (Ifous), as well as Malmö University. Close to three hundred preschool teachers/managers collaborated with a research group consisting of six researchers from Malmö University.

The question that guided the 24 teaching arrangements empirically studied and presented in this paper was: "What can characterize teaching in preschool from the standpoint of pragmatic and didaktik informed teaching arrangements with a focus on values?". The analysis resulted in didaktik modelling along with examples of what it means using the teaching of sustainability issues in preschool. A new didaktik model of waste management and material resources resulted from the modelling. It should be noted, however, that the formulation of this new model is only one of several possible outcomes of didaktik modelling in preschool on sustainability issues. Furthermore, didaktik models are never fully finalized. They always need to be interpreted and mangled, in practice as well as theoretically.

This paper starts by describing didaktik itself as a concept, followed by didaktik models and didaktik modelling (section 2). Thereafter it briefly describes pragmatic theory (section 3). It is followed by a short state-of-the-art description of Early Childhood Sustainability-Oriented Education (section 4), a field to which the work presented in this paper aims to contribute. Thereafter follow a methods section (section 5), results sections (6-8) and discussion/concluding remarks (section 9).

2. Didaktik theories, models and modelling

The concept of didaktik was coined in Germany during the early 17th century based on a linguistic connection to the Greek word for teaching, *didaskein* (e.g., Gundem, 2000). At the end of the 18th century the concept spread to countries that had close connections with German-speaking cultures, mainly the Scandinavian countries (Denmark, Norway, and Sweden) and Russia. Today, the humanistic didaktik tradition is still fairly strong, especially in central and northern Europe, where it refers to both the art of teaching and the professional scholarship of teaching (e.g., Gundem, 2000; Arnold, 2012; Meyer, Meyer & Ren, 2017; Krogh, Qvortrup & Graf, 2021). Although this tradition did not take hold in English-speaking countries, where the term "didactic" often suggests a conventional method of delivering content knowledge through lecturing (e.g., Hamilton, 1999; Gundem, 2010), the term is at the same time increasingly being used in the international education literature with a similar meaning to that given by "didaktik" in continental Europe (e.g., Hudson & Meyer, 2011; Zierer & Seel, 2012; Osbeck, Ingerman & Claesson, 2018; Ligozat & Almqvist, 2018). However, in this paper the Scandinavian-German spelling ("didaktik") is used instead of "didactics".

In the humanistic didaktik tradition there is a strong connection between the concepts of didaktik and *Bildung* (e.g., Westbury, Hopmann & Riquarts, 2000). According to Duit (2015, p. 325), didaktik "stands for a multifaceted view of planning and instruction; it is based on the German concept of Bildung." Bildung refers to, among other things, the knowledge- and values-formation of learning subjects (children as well as adults, including preschool teachers) in interaction with their surrounding society and world (e.g., Horlacher, 2016; Sjöström, Frerichs, Zuin & Eilks, 2017). To specify the meaning of Bildung today, we have to base it on the fact that we live in a globalised risk society with many global and ecological challenges (e.g., Straume, 2015; Taylor, 2017; Sjöström, 2018; Roselius & Meyer, 2018). Bildung can "be understood as a process in which an individual deals self-actively with the world and thereby develops a multi-dimensioned ability to self-determination under the claim of morality" (Rucker 2020, p. 51). "As an educational concept, Bildung incorporates culture, aesthetics, self-cultivation, political awareness and engagement" (Hogstad 2021, p. 591). Fellenz (2016) emphasizes the human subject in a world when he describes Bildung as "autonomous self-formation and reflective and responsible action in (and interaction with) society" (p. 273). Similarly, Rømer (2021) connects it to the term "worldification". It is about the interplay

between the self and the world, to both create and leave something of lasting substance. According to Biesta (2012, p. 817), "the role of the individual in the process of Bildung, […] has to be understood as a reflexive process", that is, a process in which the individual establishes both a relationship and a critical stance towards the existing culture and society. Bildung processes are important for all, including preschool children and teachers (see e.g., Broström, 2015).

Practice based on Bildung and practical wisdom is often called *praxis*. Sörlin (2019, p. 26) writes: "I do not believe that values are different from knowledge. What we know shapes our thoughts and also what we think. And what we think shapes what we know or think we know" (author's translation). Kemp (2005, p. 143) emphasizes that there is no "ready-made formula for what good action is, but that it must be learned through praxis […] To learn the good life requires not only enlightenment but also a living educator" (author's translation). Hopmann (2007, p. 117) has stated: "Didaktik and Bildung require normativeness […] they challenge the teacher to be aware of the unavoidable normativeness in every dealing with whatever subject matter." This is important not least when preschool teachers chose content and teach sustainability issues in preschool. However, it does not mean that the teacher should be prescriptive in, for example, the only correct ways of thinking and behaviour, but rather open to different informed views. Recently, Ryen and Jøsok (2021) argued that perspectives from Bildung-centered didaktik can contribute to European citizenship education beyond competence.

Didaktik can also be seen as the science for teachers (e.g., Seel, 1999; Ingerman & Wickman, 2015; Wickman, Hamza & Lundegård, 2020). This science should be based on critical-democratic values and theories and research approaches from the humanities and social sciences – mainly from different educational sciences – in addition to knowledge bases in and about different knowledge areas (subjects), such as chemistry, earth system sciences or human ecology. Furthermore, it is also a design science and as in other design sciences modelling is central (Sjöström & Tyson, 2022).

Didaktik models are a central part of didaktik (Lunde & Sjöström, 2021) and involve theoretical tools that teachers can use in planning, implementing and/or analysing teaching (Wickman, Hamza & Lundegård, 2018; 2020). Thus, they are an important part of teachers' praxis theory. Didaktik models may look different, but they have in common that they support teachers when reflecting on

and/or practicing teaching based on the three main didaktik questions: why, what, and how to teach specific content for a specific group of learning subjects, indoors or outdoors (e.g., Sjöström, 2019a; Sjöström, Eilks & Talanquer, 2020; Lunde & Sjöström, 2021; Vallberg Roth et al., 2019). Didaktik models are useful in planning and evaluation of teaching as well as in action. They constitute the basis for teachers' professional judgment and reflection. Didaktik models can be understood as a bridge between theoretical perspectives and teaching practice (see Figure 1). They often have both a theoretical-philosophical grounding and an empirical-analytical one. Often used synonyms for didaktik models are tools, instruments, frameworks, compasses and thought figures.

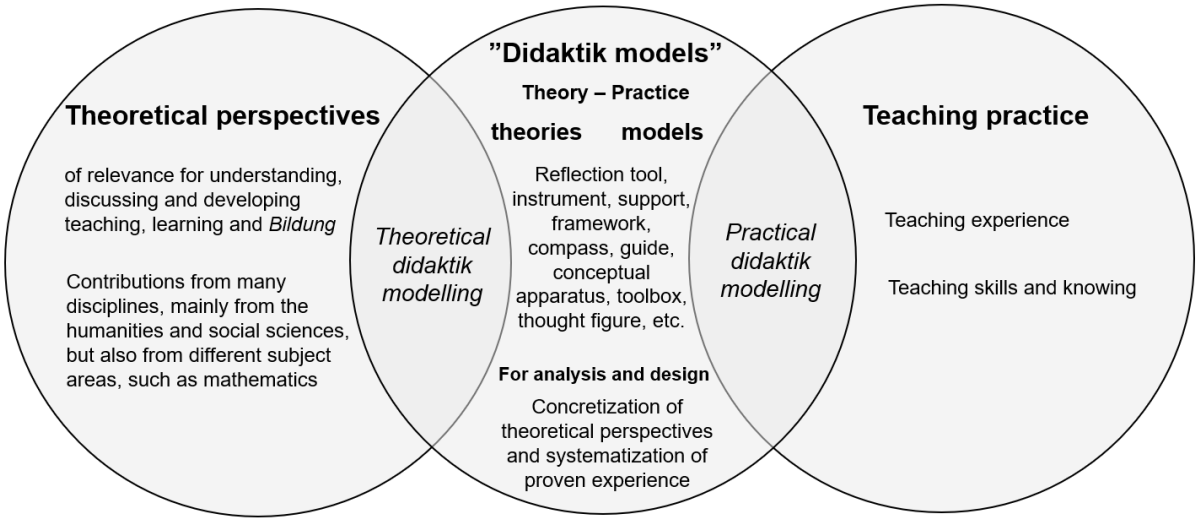

Figure 1. Didaktik models (in a broad sense, including both "didaktik theories" and practice-oriented didaktik models) as a bridge between theoretical perspectives and teaching practice. They support teachers in their didaktik choices and reflection in relation to didaktik questions. The author of this paper got the initial idea to the three-circle model in April 2021. A Swedish version of the model was first published in Sjöström & Tyson (2022, p. 275) and another English version of the model has been presented at some conferences, e.g. Sjöström & Vallberg Roth (2021).

Examples of "didaktik theories", which also can be seen as didaktik models (in a broad sense), are pragmatic theory (e.g., Dewey, 1916/1966), variation theory (e.g., Marton, 2015), and a play-responsive teaching approach (Pramling et al., 2019). Teachers' challenges are part of a dilemmatic

space (Fransson & Grannäs, 2013) in which the teachers' dilemmas are ever present. Teachers' daily work often produces dilemma situations; teachers have to make wise choices based on theories, models and proven experience. Didaktik theories and models can give support for such choices.

Other examples of didaktik models are didaktik triangles (e.g., Gundem, 2000), Klafki's areas of questions (Klafki, 1995), the Berliner model (Gundem, 2000), didaktik relationship models (Gundem, 2000), Herbart's didaktik tact (Løvlie, 2015; Vallberg Roth & Holmberg, 2019), organizing purposes (Hamza, Palm, Palmqvist, Piqueras & Wickman, 2018), curriculum emphases (Roberts, 1982), companion meanings (Lundqvist, Almqvist, & Östman, 2009) and didaktik dilemmas (Rydberg, 2018). These can also be regarded as didaktik theories (in a broad sense). With other words "didaktik theories" and "didaktik models" are almost synonymous, but didaktik theories are more to the left in the middle circle in Figure 1 and didaktik models (in a practically oriented sense) more to the right. However, in the rest of this paper "didaktik models" will be used as an umbrella term including both didaktik theories and didaktik models.

Didaktik models have the potential to change practice, but practice will also affect the models. Such an interaction between theory and practice is one important characteristic of didaktik modelling (e.g., Ingerman & Wickman, 2015; Sjöström, 2019a). Didaktik models can be traced back to Klafki's didaktik analyses in the late 1950s with five areas of questions (e.g., Klafki, 1995; Sjöström & Eilks, 2020; Yavuzkaya et al., 2022). Ingerman and Wickman (2015) describe didaktik models as ways of introducing teachers to a more general form of didaktik analysis.

Didaktik modelling stands for both the development and systematic use of didaktik models in teaching practice. In other words, the term means working systematically with research and/or praxis-based didaktik models in practice (e.g., Wickman, Hamza & Lundegård, 2018; 2020; Sjöström, 2019a; Vallberg Roth et al., 2019). Didaktik modelling does not only have to be connected to (formal) research-related activities; it can also be about teachers using didaktik models to systematically design and analyse their teaching (Sjöström, 2019a). Didaktik modelling refers to didaktik knowledge being developed systematically by teachers sometimes in collaboration with researchers (e.g., Ingerman & Wickman, 2015; Hamza et al., 2018), creating opportunities for

teachers' systematic development of their teaching. As illustrated in Figure 1, one can distinguish between theoretical and practical didaktik modelling, although they often are intertwined.

Didaktik models are created and developed in systematic didaktik modelling processes, for example, as part of research. It entails documenting and creating systematic conceptual frameworks based on the teachers' proven experience in interaction with existing and developed theories and theoretical perspectives. Figure 2 shows a modelling cycle with four phases (Lunde & Sjöström, 2021), which is based on the three phases of extraction, mangling and exemplification described by Wickman et al. (2018). In addition, a fourth phase can be added: modification. The modelling cycle is based on inspiration from a model in an article by Chiu and Lin (2019). Extracting a new didaktik model is one of the parts of (research-based) didaktik modelling. Mangling entails didaktik models being tested and adapted in new situations. Exemplification allows the meaning of developed didaktik models to be concretized (Lunde & Sjöström, 2021). The modelling process can continue through several cycles in which didaktik theory and model development interact with empirical testing and confirmation.

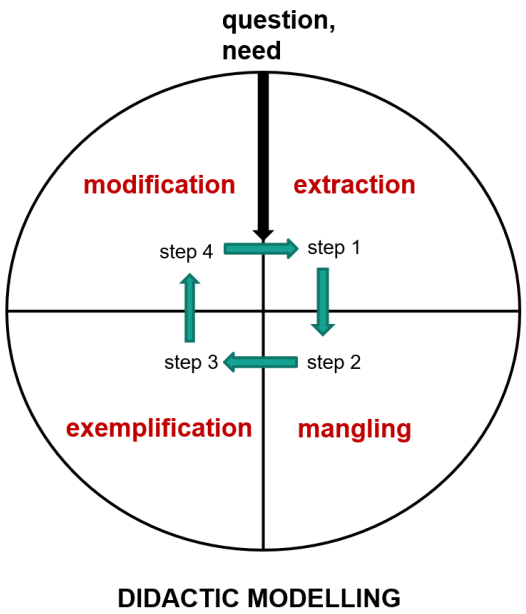

Figure 2. Didaktik modelling cycle with four steps (translated from Lunde & Sjöström, 2021).

In this paper the modelling process behind a new didaktik model is described. The model was formulated based on extraction from an empirical material. However, the entire R&D collaboration programme's approach to testing different theory-informed teaching approaches (in this paper didaktically and pragmatically informed teaching approaches) can also be said to be an example of didaktik modelling (Vallberg Roth et al., 2021). In these cases, a theoretical basis already exists and the associated didaktik models (in a broad sense) are tested, modified, adapted and concretized, that is, they undergo mangling and exemplification (see Figure 2). The multidimensional understanding of didaktik modelling in this paper is based on a humanistic, Bildung-oriented didaktik tradition (e.g. Hopmann, 2007).

3. Pragmatic theory

In this teaching case, one of the theoretical bases was pragmatic theory. It can also be regarded as a didaktik model (in a broad sense). From a pragmatic perspective, knowledge manifests itself in and through action (e.g., Vallberg Roth, 2020), for example, by consciously trying to reduce food waste in order to contribute to sustainable development. Pragmatic perspectives focus on reflective learning, experiencing and creation of meaning (e.g., Burman, 2014; Dewey, 1916/1966; Hedefalk, 2014; Öhman, 2014). Reflective learning can also be expressed in terms of learning by reflective experience (Burman, 2014). Three characteristics of a pragmatically informed teaching approach are meaning making, values and visibilizing alternatives. Typical concepts are gap, stand fast, guideline and teaching principles (Hedefalk, 2014).

Hedefalk (2014) has discussed three teaching traditions in a preschool context: fact-based, normative, and pluralistic. It is the pluralistic tradition that is theoretically most connected to pragmatic theory (e.g., Öhman, 2014). The answers to the didaktik questions will be different based on different teaching traditions. Previous studies have shown that in preschool practice, the normative tradition is most common, while the fact-based one also occurs. The pluralistic tradition, on the other hand, is rarer (e.g., Ärlemalm-Hagsér & Sundberg, 2016; Hedefalk, 2018). Lundegård and Caiman (2019) have discussed different ways of working to strengthen pluralism and democratic participation in, among other places, preschools.

In a table in Hedefalk's doctoral thesis (2014, p. 37) one can read the following about the pluralistic teaching principle: "Facts are not enough, values must be added"; "the teacher stages situations where the child practices critically reflecting on different ways of acting and thinking"; the purpose is to "be an active, critical citizen" (author's translation). This last principle, to be an active and critical citizen, has many similarities to Bildung (e.g., Mogensen & Schnack, 2010).

In this paper the teaching was modelled based on both pragmatic theory and didaktik questions, namely what questions (content), how questions (teaching actions), who questions (actor/actors), where questions (space/place), when questions (time) and why questions (goals). The three main didaktik questions – *why, what*, and *how* – are primary.

4. Early Childhood Sustainability-Oriented Education

Sustainable development in preschool can be understood from at least three different perspectives: (1) nature and environment in focus; (2) democracy and human rights in focus; and (3) a holistic perspective in which "sustainable development permeates all situations and activities in preschool" (Ärlemalm-Hagsér, 2021a, p. 26; author's translation; see also Broström & Frøkjær, 2021). The holistic perspective can be about a future-oriented and thematic interdisciplinary content, including environmental sustainability, democratic working methods and active problem solving and critical thinking with the aim of increasing the participants' action competence (Ärlemalm-Hagsér, 2021b). For further information on action competence, see Sass et al., 2020, for example.

Recently, Caiman and Halvars (2020) wrote a review of previous research on environmental sustainability in preschool (see also: Sjögren, 2020). They write: "Children are offered opportunities where they can link their previous experiences to a continued sensory and physical exploration and where play and creativity are given space and seen as important aspects in learning for sustainable development" (p. 176; author's translation). They place sustainability issues in the Anthropocene, the age of mankind, and integrate ideas such as the planetary boundaries, ecological literacy, different political sustainability views and Agenda 2030. (Further information on Environmental Humanities can be found in Hutchings et al., 2014 and O´Gorman et al., 2019, for example). The Anthropocene concerns man's global impact on climate and ecosystems (e.g., Sjögren, 2020). Several different years have been proposed for the start of the Anthropocene, depending on focus,

but 1945 is a strong candidate (Sörlin, 2017). From that time on, the volume and number of man-made objects and materials, including plastics, have increased greatly in the world, as has the level of carbon dioxide in the atmosphere. The changes have therefore also been called "The Great Acceleration". After the end of World War II, the era began when the ecologically destructive lifestyle accelerated with "the car, the steak and the home", which Sörlin (2017, p. 207; author's translation) highlighted as three typical phenomena of the Western lifestyle of the Anthropocene.

Around 2009 research on sustainable development in the preschool began. Discussions related to the Anthropocene started six years later (Sjögren, 2020). Sweden was and remains very active from an international perspective. The fairly extensive research since that time (see, for example, Borg & Gericke, 2021; Caiman, Hedefalk & Ottander, 2022; Pramling Samulesson & Park, 2017; Sundberg, Areljung & Ottander, 2019; Svedäng, Halvars, Elfström & Unga, 2018; Thulin, 2011; Ärlemalm-Hagsér, 2021b; Ärlemalm-Hagsér & Hedefalk, 2018) can according to Caiman and Halvars (2020) be organized under the following four headings:

- Teaching and learning in preschool – from a sustainability perspective
- Agency and action competence
- Exploration, play and creativity
- The preschool teacher's didaktik – why, what, and how

Previous research has shown that waste sorting is the primary activity that preschool teachers associate with environmental and sustainability education in preschool (e.g., Ärlemalm-Hagsér & Sundberg, 2016). In line with this a study on what characterizes teaching in preschool on sustainable development showed that the most typical word was "sorting", sometimes alone, sometimes in "waste sorting" or "source sorting" (Sjöström, 2019b). Other things associated with sustainability issues in preschool are recycling, food waste and composting (Sjöström, 2019b).

According to a Danish research study on environmental education in preschool, waste sorting and composting are most often presented in practice as "non-political projects", where the focus is on doing or action ("sorting pedagogy") or on scientific facts and not at all framed by major political and global issues (Jordt Jørgensen & Nielsen, 2019) such as the climate challenges, sustainable food

supply or the plastic waste in the world's oceans. The intentions and consequences of such teaching point in several different directions. It is thus not global sustainability values that come to the fore, but rather factual knowledge or sorting per se. As an alternative, Jordt Jørgensen argues for what she calls "waste pedagogy" (e.g., Jordt Jørgensen & Nielsen, 2019; Jordt Jørgensen, Madsen & Læssøe, 2018), which from a theoretical point of view is mainly rooted in poststructuralism.

5. Method

In the R&D programme of which this study is a part, the collaborating preschools were engaged in didaktik modelling based on different didaktik theories/models during different semesters (Vallberg Roth et al., 2021). In the spring of 2020 the teaching arrangements were, as described above, informed by pragmatic theory as well as didaktik. The question that guided the teaching arrangements was "What can characterize teaching from the standpoint of pragmatic and didaktically informed teaching arrangements with a focus on values?" (Sjöström, 2021). The United Nation's global goals for sustainable development were a matter of public attention at the time. During an introductory meeting in March 2020 with close to all the three hundred participants in the R&D programme (participating online due to the pandemic), theoretical input was given in the form of lectures and discussions. As a result, the participating preschools tried out pragmatic and didaktically informed teaching arrangements based on the guiding question. Each implementation of a teaching arrangement was preceded by co-planning (planning together in a group) and followed by co-evaluation (Sjöström, 2021).

By June 2020, documentation had been submitted from 41 of 45 participating preschool units (91%). Each of the 41 participating preschools had made and documented one teaching arrangement each. The documentation included 61 video files (a total of approximately five hours) and 92 photos. The total submitted material was 243 documents/files consisting of approximately 50,000 words.

The analysis of the empirical material can be described as abductive analysis (Peirce, 1903/1990; Tavory & Timmermans, 2014), alternating between theory-loaded empiricism and empirically loaded theory. We looked for qualitative patterns. More concretely, the analysis involved identifying traces in the material in relation to the research aim. The analysis can be described in terms of the following interpretive paths (see, for example, Rapley, 2011; Tavory & Timmermans, 2014): close reading/watching; identifying distinctive traces; and problematizing distinctive traces in relation to earlier research and concepts. Cohesive analysis was performed in light of didaktik models, resulting in a conceptualising focus. In practice, empirically based and theory-based interpretive paths were typically intertwined. Quotations were selected for their clear exemplification of the traces in the material (Vallberg Roth et al., 2021).

The research portion of the programme was reviewed and approved by the Regional Ethical Review Committee in Lund (10 January 2018). The collaborative research complies with research ethics principles in accordance with humanistic-social scientific research (Swedish Research Council, 2017).

6. Overall results

This section presents the overall background to the new didaktik model on waste and material resources in preschool. More specific results are presented in the following two sections (sections 7 and 8). This section starts with a few examples related to the three teaching traditions already mentioned, namely fact-based, normative, and pluralistic (Hedefalk, 2014), and represented in the empirical material as follows:

- Fact-based: Film about rubbish in nature.
- Normative: How are we in nature? What happens to the animals if we throw away glass, for example, in nature?
- Pluralistic: The children should be allowed to come up with suggestions / alternatives to where we throw the rubbish. Recycling is contrasted with throwing rubbish out.

Thematically, the 41 teaching arrangements can be divided into three groups, as described in the three subsections that follow. First there is a focus on nature and environmentally sustainable development (26 arrangements). Then there is a focus on health (6 arrangements), followed by a focus on social sustainability (9 arrangements).

6.1 Focus on nature and environmentally sustainable development

About 60 percent of the units (26) chose to focus on environmentally sustainable development or nature, mainly rubbish occurring in nature or the local environment and waste sorting (in total one third of the units were about waste sorting and/or rubbish in nature). There was also coverage of reuse, reduced use of paper and water, life-cycle perspective, reduced food waste, composting, cultivating, thinking about animals, insects, and photosynthesis. Two units had an outline of the life cycle of paper and experiments with different types of paper. One included a study visit to a garbage truck and another an app about cultivation. Twenty-four (24) of the 26 units dealt in some way with waste issues in a broad sense (see additional information in section 7). Of the remaining two units, one focused on nature and the other cultivation.

6.2 Focus on health

Fifteen percent of the units (six) chose to focus on health, mainly hand hygiene in connection with COVID-19, but diet and nutrients was also included in one and motor skills and body image in another. One of the four arrangement that focused on hand hygiene covered washing hands the "right" way.

6.3 Focus on social sustainability

About 20 percent (nine) of the units chose to focus on social sustainability, including topics such as around being friends, rules of the game, thinking about each other, co-determination, and similar.

7. Extracting a new didaktik model on waste for preschool teachers' sustainability teaching

This section discusses the 24 arrangements that dealt with waste issues in a broad sense. One specific teaching arrangement could have more than one track dealing with waste management (in a broad sense). A total of fifty-two tracks were identified, and they could be divided into eight content track types. These included sorting, recycling and composting, and dealing with waste management in a broad sense (see Table 1). The average was 2.2 waste tracks per unit. Ten of the units had only one track in their arrangement, eleven had 2 to 3 tracks and two had 4 to 5 tracks. In one exceptional case, six tracks were identified, namely picking up litter, sorting, reusing, recycling, composting and reducing food waste.

Table 1: Content track types dealing with waste management (in a broad sense) in the implemented teaching arrangements.

a) Sorting: 8 tracks (15%)
b) Reusing: 13 tracks (25%)
c) Recycling: 6 tracks (12%)
d) Composting: 3 tracks (6%)
e) Reducing food waste: 3 tracks (6%)
f) Reducing consumption: 4 tracks (8%)
g) Rubbish experiments: 5 tracks (10%)
h) Picking up litter in nature: 10 tracks (19%)

The categorization and results presented in Table 1 formed the basis for the creation of the star-shaped model that is illustrated in Figure 3. It has eight tips, one for each content track type that has to do with waste. Note, however, that "reducing consumption" is called "saving paper" in the figure. At each tip, the percentage is stated relative to the total of 52 waste tracks. Based on the empirical material, the basic features of a new didaktik model on waste have been extracted. As described above, extracting a new didaktik model is one of the parts of what is called didaktik modelling (see Figure 2). The extracted model has the potential to work as a reflection tool – in line with how didaktik models are generally described in Figure 1 – for preschool teachers when

planning teaching related to waste. It will be empirically grounded and developed further in the rest of the paper.

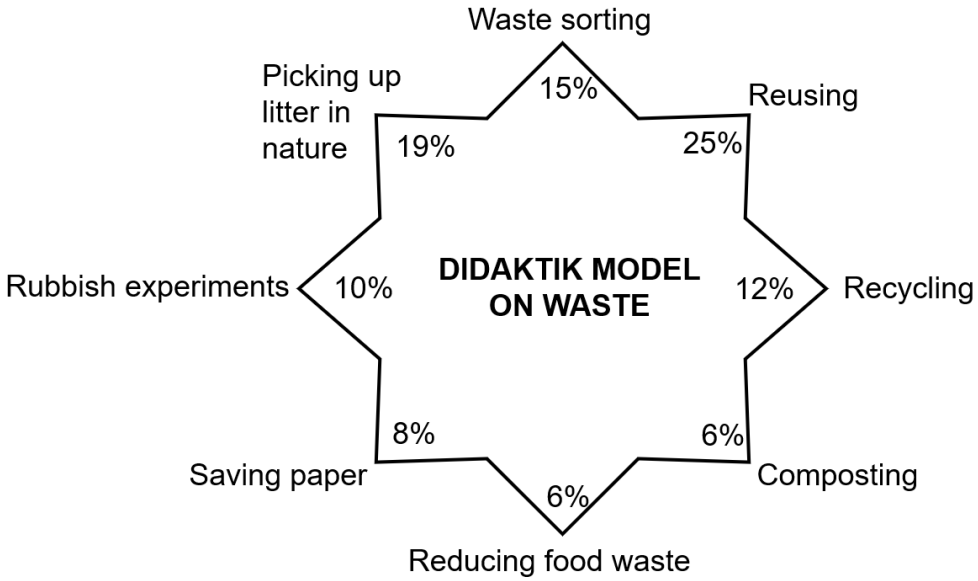

Figure 3. Empirically based eight-tipped didaktik model on waste. Percentages are relative to the total of 52 waste tracks in the 24 included teaching arrangements.

Each of the eight tips in the star model will be discussed below, based on examples from the empirical material. For further details (in Swedish), see: Sjöström, 2021.

7.1 Waste sorting

Some approaches situated source sorting as part of something larger, others had sorting itself as the focus, without any clear connection to the overall purposes of source sorting, and yet others had sorting linked to more general life-cycle perspectives. In some cases, waste collection was combined not only with source sorting and recycling, but also with reduced food waste and composting. In one case, garbage collection was combined with sorting and study visits to a garbage truck. One child shared the following reflection after the study visit: "The rubbish ends up in the huge oven, then it goes into the element, so it gets hot" (from film transcript). In some cases, sorting was linked partly to garbage collection and partly to "create with art", but the life-cycle perspective was

then largely lacking. It is difficult for children to understand the connection to a more comprehensive sustainability perspective if they are only told not to throw rubbish in nature.

In a co-evaluation report, the following was written: "A sorting station was set up inside the preschool so that the children themselves could sort paper, plastic and cardboard". Another report included this statement: "We discovered that at first it was not so easy to sort at source; we noticed that the children did not know the difference between paper, cardboard and metal, for example. So, we switched more to teaching about what kind of materials we found. Some of the children quickly learned what cardboard, metal, plastic, etc. were." This is an example of factual knowledge coming to the fore ahead of global challenges.

7.2 Reusing

There are examples of approaches in which reuse thinking is linked to more general questions about resource use, and there are examples in which the focus is rather on doing or action in the form of "junk art", building with milk cartons, or using milk cartons to grow plants. In a co-plan the following was written: "We had collected rubbish which the children then had to reuse and create new things with. Imagination flowed: an egg carton and some plastic corks became a car, and a brown paper bag, plastic pipes and plastic corks became a nice tree." In this approach, the focus was on creativity instead of on sustainability issues in general.

In one case, old wooden toy boxes were reused for growing boxes. In another, it was the children themselves who, through a vote, came to the conclusion that they wanted to work with reuse. In some cases, it was the children themselves who came up with the suggestion that you can grow plants in milk cartons instead of throwing them away. One question the children raised was: "Why do we grow in milk cartons and not as usual?". That question was the start of the focus on recycling and sorting. The leading question that came to characterize the entire work was: "Why do we sort and recycle?". In another approach, reuse was linked to a story about the life cycle of a milk carton. The reuse of discarded drawing paper provided another example. When a younger child responded to the question of why we should not throw away useful things during a gathering, he said: "The world is getting warmer." Even among the very youngest, there seems to be early knowledge of the connection between resource use and global warming.

In a planning document the following was written: "Why is it not good that rubbish is found in nature? What happens to the rubbish that is thrown in the bins? Can you use the rubbish / reuse it? […] We will share the children's knowledge, thoughts and ideas. Look for facts in books […] and the media. Meet the 'garbage truck driver' and get the opportunity to ask questions and get answers. We will work practically and reuse materials."

7.3 Recycling

There were several examples of arrangements in which the children were shown a product life cycle. Most often it was about the life cycle of paper, but in one case it was about the life cycle of the milk carton. Most often the children got to see a movie. In some cases, the children also made paper themselves, thus gaining practical knowledge about how paper fibres can be recycled. In one case, recycling was linked to the issue of trying to reduce paper consumption. In another case, the production of new paper was linked to experiments with different types of paper. In both these last-mentioned cases, some difficulties arose in creating connections between different parts that were understandable to the children.

A co-evaluation report contained the following responses from the children to what they had done at a recycling station, expressed in their own words (translated to English):
"We threw away some paper and cardboard."
"We also threw cardboard and metal."
"And we threw plastic."

7.4 Composting

There are a few examples of arrangements in which compost became part of the activity. These involved natural cycles of biomaterial decomposing into soil. In some cases, the children had the opportunity to investigate what happens to apple peel in a worm compost. In another case, the brown (paper) bag for food waste (common in Sweden) was linked to composting.

7.5 Reducing food waste

There were some examples of reduced food waste being the focus. In two cases, measuring the amount (weight) of food waste per day was an important part of the activity. For example, milk cartons were marked with different days of the week. In one case, a connection was made to the size of the brown bag. In another, the question of food waste was linked to the children not really knowing what food they liked, with the suggestion to try different flavours so that they would know what to take a lot and a little of, respectively.

In a co-evaluation report the following was written: "The food waste weeks became like a competition in which each department competed to throw away the least food. The amount of food that was thrown away was reported every day on a web page […] The food waste that was discarded was thrown in the 'green bucket' and then, together with the children, thrown in the food waste [i.e., the brown bag]."

7.6 Saving paper

In some cases, the focus was on saving, mainly paper, which entailed reducing paper consumption in different ways. In several cases, reduction was linked to the life cycle of paper. In other cases, it was more tangibly linked to the possibility of reusing sheets of paper that had been only partly used for drawing.

In a co-evaluation report the following was written: "The children have talked with each other about the use of paper and reminded each other and the staff how much paper is reasonable to use. The older children have created signs for our laundry room and studio to remind us that we must save on our paper resources. Colouring books have been created for each child instead of loose papers."

7.7 Rubbish experiments

In four cases, there were experiments that aimed to investigate the decomposition of different materials in nature. For example, with the help of a decomposition board, various examples of rubbish were nailed to a wooden plank that was then buried, to be examined later after a certain

time had elapsed. In one case, apple peel was compared to a piece of plastic and in another different materials were buried in well-marked places. The children learned about the connection between choices in everyday life and environmental impact. Decomposition was illustrated in one case with the help of a cartoon series, and a related memory game was also created.

In addition to more general garbage experiments, there was also an example of an experiment focusing on the decomposition of different types of paper, with emphasis on the statement "everything we throw in nature remains". However, paper may be considered a less well-chosen example to illustrate this fact, since paper, regardless of variety, degrades relatively quickly in nature. The experiment was linked with paper recycling, with the following statement appearing in the co-evaluation report: "The children […] experienced that old paper can be new and reused. They discovered that paper is broken down by the earth and they experienced the different lengths of time it took." The following statements by the children also appeared in the report:

> "The milk carton is hard, it takes a looooong time"
> "The napkin is gone, where is it?"
> "The toilet paper has broken and is small"
> "The magazine is still there but not so big"
> "The paper box is soft"

7.8 Picking up litter in nature

In several cases, the focus was on cleaning up rubbish in the local environment or nature. The cleaning activity was in some cases part of more expansive thinking on sustainability, while the garbage collection itself was the focus in others. In several cases, the activity was part of a garbage collection week or walk. Sometimes littering was linked to sorting and recycling. In other cases, there was no connection to more general sustainability issues. The activity rather involved, for example, sweeping up broken glass so that animals, people, and bicycles would not be harmed, or collecting fruit residues from the road to avoid animals that are interested in the waste being hit. These last-mentioned ideas and actions are not wrong in and of themselves, but the opportunity was missed to link waste issues to global societal challenges. In one instance, the following excerpt from a co-planning report revealed a similar missed opportunity: "Why should we not throw

rubbish in nature? Where do we throw it instead?" In another instance, the search for rubbish was linked, among other things, to a study visit to a garbage truck, allowing the litter search to be viewed from a larger sustainability perspective.

The following was written in a co-plan: "During both outdoor periods in the preschool yards and in excursions to nearby areas, the children find and collect different kinds of rubbish daily. The children express […] a worry / anger […:] 'Do they not know that it is dangerous?', 'The animals can die!', etc." With respect to a more planned litter hunt, the following was written: "Before the trip, the children turned into natural heroes and went away with bags from Keep Sweden Tidy Foundation and an intention to save the animals from litter." In another case, quite a lot of time was spent collecting rubbish: "All the children must pick up rubbish in their immediate environment throughout the week. Materials (gloves and bags) have been ordered for all departments". In one case, the children themselves took the initiative to make their own rubbish bins from recycled materials, with associated signs. The "trash cans" were placed in places where the children thought they were needed.

8. A further developed version of the didaktik model

The further developed didaktik model presented in Figure 4 has the percentages removed and three layers added, one each for the three main didaktik questions of *How, What* and *Why*. In addition, a few terms related to the different waste activities have been added ("life-cycle perspective"; "explore"; "act"; "reduce"). The purpose of this version of the model is to support preschool teachers when co-planning, implementing, and co-evaluating teaching about waste and material resource management in preschool.

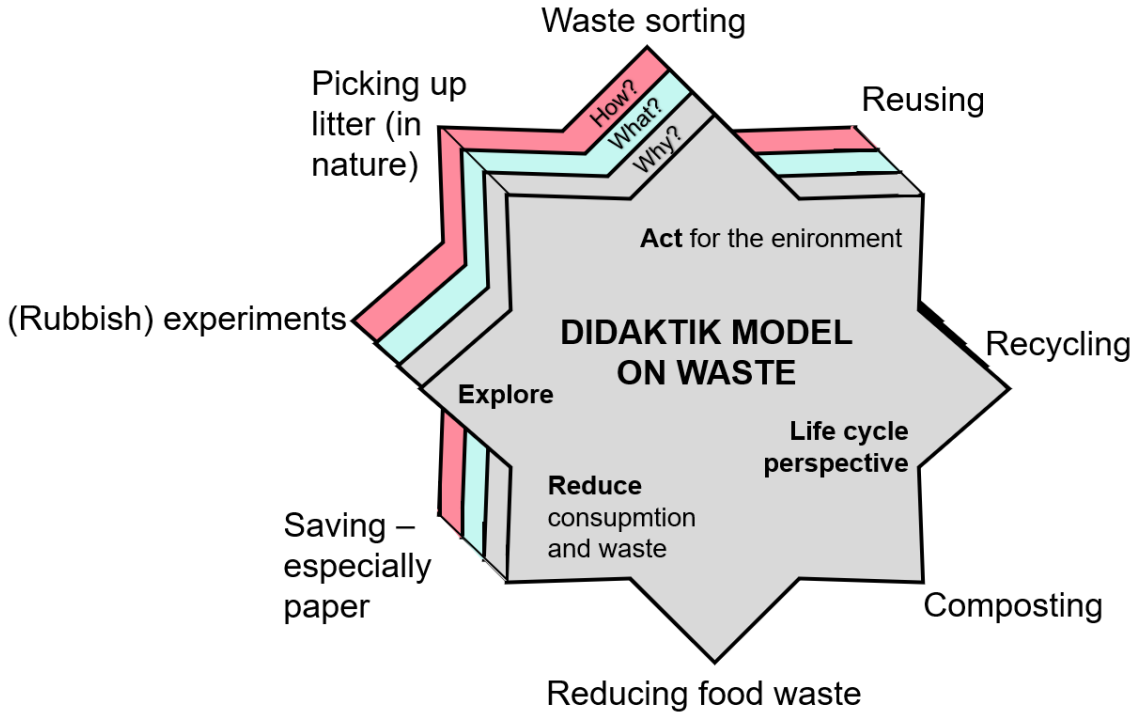

Figure 4. Didaktik model on waste including the three main didaktik questions Why?, What? and How?.

9. Facts, values and actions in interplay: some concluding remarks

The question that guided the 41 teaching arrangements was: "What can characterize teaching from the standpoint of pragmatic and didaktically informed teaching arrangements with a focus on values?" Twenty-four (24) of the 41 units focused on waste management in a broad sense. In total 52 tracks were identified in the 24 teaching arrangements, giving on average a little more than two tracks per waste-oriented unit. The tracks could be categorized into eight different content track types, including sorting, recycling, and composting, among others. As expected, (e.g., Ärlemalm-Hagsér & Sundberg, 2016; Sjöström, 2019b), "waste sorting" were among the eight identified "waste management activities". Both sorting and composting were mainly presented as "non-political projects", where the focus was on doing or action or on scientific facts. The arrangements were not framed by major political and global issues. This result is in line with a previous Danish research study (Jordt Jørgensen & Nielsen, 2019). However, at the same time, many of the teaching arrangements explicitly aimed at increasing the children's action competence.

Based on eight identified waste activities, a new empirically based didaktik model on waste material resources in preschool was extracted/formulated/created. This model may, like other didaktik models, support preschool teachers in answering the didaktik questions, in particular, the *what* and *how* questions. It can also be used as a framing to get a "whole preschool perspective" on environmental issues as part of broader global issues. This is needed, because very few of the analysed teaching arrangements included several (four or more) of the eight waste activities described with tips in the model. However, like all models, this new one is limited in its scope. It is broad in relation to "waste management" but needs to be complemented with broader sustainability perspectives as well as with more specific models.

All eight tips in the new didaktik model are based on both knowledge and values, that is, knowledge and values are in one way or another intertwined. There is a risk, however, that one aspect could become dominant, such as the teaching becoming too normative (correct actions approach), the focus being entirely on facts (e.g., the names of different materials), or the doing or action (e.g., sorting or creating) predominating. When the pluralistic principle was evident in the arrangement (only few examples), elements of reflection and critical action were also built in. Such arrangements contained facts, values, and actions in interplay. They clearly related to all the three main didaktik questions.

Examples of arrangements containing facts, values, and actions in interplay – at least to some extent – entailed the children themselves creating signs or "garbage cans", or actively trying to reduce food waste, save paper or clean up rubbish. Typically, these activities were placed in a somewhat broader sustainability context and were related to a life-cycle perspective. On the whole, many different and creative ideas were tested in practice, which made the development of the new didaktik model possible. However, it should also be acknowledged that relatively few of the teaching arrangements that were analysed were "exemplary examples" of pragmatically informed arrangements in which there was an interplay between facts, values, and actions, with the teaching arrangement supporting the children's thinking and actions. This is in line with previous studies also showing that the pluralistic tradition seems to be rare in sustainability teaching in Swedish preschool (e.g., Ärlemalm-Hagsér & Sundberg, 2016; Hedefalk, 2018).

The didaktik why-question is the one most strongly connected to an Anthropocene awareness followed by sustainability thinking and actions. It can also be connected to Bildung. As stated above Bildung processes are important for all, including preschool teachers and children. Such processes can – at least to some extent – begin already in early childhood and are very much supported if the preschool teacher has an awareness of and interest in them. Furthermore, such processes are connected to 'practical wisdom' and are promoted by values-informed didaktik choices and decisions. In other words, there is a connection between didaktik, Bildung and responsible action. However, in the empirical material there are only few traces of this. Therefore, there is need for additional (meta)didaktik models supporting eco-reflexive Bildung-praxis (e.g. Sjöström & Tyson, 2022), in preschool and elsewhere.

This paper concludes with some thoughts on possible follow-up studies. Perhaps the most obvious is to carry out further steps in didaktik modelling based on the new didaktik model on waste. Following elements shown in Figure 2, the model (Figures 3 and 4) as a whole and its different parts need to be mangled and it needs to be exemplified in different preschool contexts, such as with children of different ages and in outdoor environments with different characteristics. Further modelling can also be tried in other activities related to preschool, such as in preschool class or at leisure centres. More studies are also needed on how to better succeed in managing and arranging pragmatically informed teaching in which facts, values and actions are in interplay, as part of eco-reflexive Bildung-praxis in the Anthropocene.

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