Teaching in preschools: Multivocal didaktik modelling

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Since teaching in Swedish preschool was regulated in the Education Act 2010, preschool teachers have appeared to struggle with the concept of "teaching" in their day-to-day practices. This paper is based on a collaborative R&D programme involving preschool teachers and researchers aimed to build knowledge of what can characterize teaching in preschool. The research was carried out in 40–44 preschools/preschool departments in eight municipalities in Sweden between 2018 and 2020. The method was based on a praxiographic approach where preschool teachers tried out different theory-informed teaching

arrangements, including didaktik, variation-theory, post-structural gateway and pragmatic perspective. The material for the article consisted of 350 co-plans, 305 co-evaluations and 35 hours of video. Analysis was based on a *didaktik* premise and can be methodologically described in terms of abductive analysis. Theory-informed teaching arrangements have been tried out and shown to support teachers in conducting teaching in the complex reality that is based on scientific grounds and proven experience. In summary, the analysis is merged in a communicable entity through the concept of "multivocal didaktik modelling".

Keywords: Collaborative research, didactics, didaktik model, multivocal didaktik modelling, preschool teaching.

1. Introduction, literature background and identified research gap

Preschool teaching in Sweden has been regulated by the Education Act since 2010 (SFS 2010:800). The School Inspectorate (2018) has noted major variations regarding how preschools approach the pedagogical mission. Moreover, there has been uncertainty regarding what the concept of teaching means in the preschool context (see e.g., Doverborg, Pramling, & Pramling Samuelsson, 2013; Hammer, 2012; Hedefalk, 2014; Pramling & Wallerstedt, 2019; Rosenqvist, 2000; Sæbbe & Pramling Samuelsson, 2017; Skolinspektionen, 2018; Sheridan & Williams, 2018; Vallberg Roth, 2020). Regulation of teaching was strengthened in the revised preschool curriculum that came into force on 1 July 2019 (SKOLFS 2018:50). In addition, education and teaching must rest on scientific grounds and proven experience. This entails major challenges for those active in the preschool (Sheridan & Williams, 2018).

Even though teaching has been a part of the curricular history of preschool (e.g., Vallberg Roth, 2006), the idea of teaching has been viewed as problematic (e.g., Vallberg Roth, 2020). In this context, school administrators and individuals active in the preschool asked questions about teaching in collaboration with the independent Institute for Innovation Research and Development in School and Preschool (Ifous). Ifous contacted Malmö University in 2015 and an initial R&D programme, "Teaching in the preschool" (Undif), began in 2016 (Ifous 2019:1). The impact of, interest in, and need for teaching studies in the preschool grew and a second R&D programme, "Multivocal teaching in preschool" (Fundif), began in 2018 and ended in 2021. The article presents the overall findings from the research portion of the Fundif research and

development programme. Previous articles and publications have presented the research portion of Undif (e.g., Holmberg & Vallberg Roth, 2018; Palla & Vallberg Roth, 2018, 2020; Vallberg Roth, 2020; Vallberg Roth, Holmberg, Löf, & Stensson, 2019; Tallberg Broman & Vallberg Roth, 2018). The present peer reviewed article is based on a scientific report that was reviewed by Professor Stig Broström at Aarhus University in Denmark (Vallberg Roth, Aasa, Ekberg, Holmberg, Sjöström, & Stensson, 2021).

A fundamental assumption is that "no theory can actually encompass the teaching situation as a whole" (Arfwedson, 1998, p. 131). We do not employ a "one size fits all" approach and various theory-informed teaching arrangements therefore have been tried out (see section 2.4). The article presents examples of various teaching arrangements that preschool teachers tried out in practice. The content included mathematics and programming, movement, music, natural science including chemistry, technology including digital technology, and fundamental values such as sustainability issues. Different theories focused on content and learning were combined with didaktik in the various teaching arrangements.

Didaktik can be seen as the knowledge base for teachers reasoning and decisions regarding teaching in a broad sense. Typical are questions about why, what and how to teach a specific content[1]. The teaching arrangements can be viewed as encompassing combined didaktik models that include different learning and content foci. The examples in the article present teaching as multivocal (cf. Dysthe, 1993); it involves several voices, including those of the preschool teacher, children, government (mainly with reference to the preschool curriculum, which can be interpreted as a government voice) and research. Everything is tried out through the collective concept "multivocal didaktik modelling." Didaktik modelling aims to identify, try out and further develop didaktik models as a collaborative effort (Sjöström, Eilks & Talanquer, 2020; Vallberg Roth, 2020; Vallberg Roth et al., 2019; Vallberg Roth et al., 2021; Wickman, Hamza & Lundegård, 2020).

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[1] We use the German word didaktik (with use of the k letter), which is common in continental Europe and the Nordic countries, and not the Anglo-Saxon word didactics.

In recent years, research on learning and teaching in preschool has increased in Scandinavia (Furenes, Reikerås, Moser, & Munthe, 2021). Despite this, there are still a deficit of comprehensive and long-term studies that investigate teaching conducted in collaboration between preschool teachers, leaders, and researchers, and with a focus on trying out not just *one* but *multiple* theory-informed teaching arrangements in preschools. In the collaborative research at hand, opportunities to shift the focus from learning to teaching were created by introducing didaktik into all teaching arrangements. At the same time, we also tried out co-assessment and feedback in the preschool teaching arrangements, which has not been the case in earlier research on preschool teaching in Scandinavian countries (Vallberg Roth et al., 2021).

1.1 Aim and research questions

The aim of the research portion of the Fundif R&D programme is to describe and develop knowledge about what can characterize teaching in preschool, through a collaborative effort involving preschool teachers, leaders, and researchers. Furthermore, the research portion of the programme, i.e., the collaborative research, specifically aims to try out the concept "multivocal didaktik modelling". Overall, the collaborative research is guided by the following questions:

- What can characterize teaching in texts and documented co-actions by participants, based on theory-informed teaching arrangements?
- What traces of didaktik models can be inferred from texts and documented co-actions by participants?

The collaborative research is being conducted based on scientific grounds and proven experience at 40 to 44 preschools/departments in each teaching arrangement (see Table 1). The preschools/departments were located in eight municipalities in Sweden and the research was conducted between 2018 and 2021. Participants include preschool teachers and leaders, such as principals, assistant principals, and administrators. The article focuses on preschool teachers' texts and documented co-actions. Participant texts refer to co-plans and co-evaluations from teaching. Co-planning, co-action and co-assessment entail planning, action, and valuation, which include at least two participants. The term "co-action" (cf. Gjems, 2011; Lenz Taguchi, 2012; Uljens, 1997)

refs to actions between children and teachers, or between children, teachers, and materials. Action refers to something that is being carried out – being active. The research portion of the programme is described below. Other articles of this themed issue then provide more detailed examples from sub studies concerning the theory-informed teaching arrangements that were tried out in the programme.

2. Theoretical resources

Based on the aim and research questions, the collaborative research is based on didaktik as a practical theoretical resource (Vallberg Roth et al., 2021). In addition, the main concept "didaktik models", including didaktik questions, didaktik levels and theory-informed teaching arrangements, and the overall concept "multivocal didaktik modelling" are also described. Many different didaktik directions have developed (e.g., Bengtsson, 1997; Kroksmark, 2007; Selander, 2017; Uljens, 1997) and we do not purport to provide a complete picture of didaktik. In the collaborative research we refer to critical-reflective didaktik.

2.1 Critical reflective didaktik

The collaborative research is guided by critical didaktik (cf. Biesta, 2011, 2017; Broström, 2012; Klafki, 1997). We try out critical-reflective didaktik (cf. Uljens, 1997). Didaktik can then be linked with Bildung as "a process in which the child is 'shaped' through education for the encounter with an unknown future" (Brante, 2016, p. 57). Moreover, critical-reflective didaktik can be linked with objectives to be strived for in the preschool, which have a predetermined trajectory without predetermined endpoints (see SKOLFS 2018:50).

In Sweden, the preschool objectives to be strived for do not include "shall" objectives stipulating knowledge requirements at the individual level. Critical-reflective didaktik can be based on reflection regarding alternatives to what is taken for granted in relation to an uncertain future. Specifically, we have replaced the modal verb "shall" (see e.g., Uljens, 1997; Selander, 2010) with "can" in the research and analysis questions (Vallberg Roth, 2020). We link "can" to critical-reflective didaktik. "Can" opens the possibility for alternatives to the choices that are made, and we do not purport to establish once and for all "what must be taught" or "what characterizes teaching". Instead, we focus on "what *can* be taught" and "what *can* characterize teaching".

2.2 Didaktik models

"Didaktik models" can be used both as support in teaching and as interpreting instruments for research purposes (e.g., Comenius, 1632/1989; Jank & Meyer, 2006; Uljens, 1997). Practice and theory meet in didaktik models (Ingerman & Wickman, 2015; Sjöström, Eilks & Talanquer, 2020; Sjöström & Tyson, 2022; Wickman, Hamza & Lundegård, 2020). Didaktik models can be viewed as a possibility to convert didaktik theories into practice and vice versa. Examples of fundamental didaktik models are didaktik questions and the didaktik triangle, which encompasses teacher, child and content in different combinations (see e.g., Comenius, 1632/1989; Friesen & Osguthorpe, 2018; Rosenqvist, 2000; Uljens, 1997). In Undif and Fundif, we have included several didaktik questions, such as what, how, who, where, when, and why. For reasons of space in this article, we choose to focus on the two questions of *what* and *how* (Uljens, 1997). Didaktik levels are another example of didaktik models.

2.3 Didaktik levels as a didaktik model – theoretical and practical aspects of didaktik

Didaktik is an academic field that can be associated with multiple scientific foundations. The practical side of didaktik relates to practical know-how "that builds on proven experience" (Brante, 2016, p. 57). Didaktik in Brante's article (ibid.) is oriented more towards a theoretical rather than a metatheoretical level. However, there are also examples of articles concerning didaktik with a metatheoretical orientation. For example, Kroksmark (2007) positions didaktik on a phenomenographic foundation and Bengtsson (1997) writes in terms of "metadidaktik" based on a phenomenological foundation. Selander (2017) relates didaktik to a realistic foundation.

In the collaborative research we refer to Kansanen's (1993) didaktik model with three levels, which focus on "Action level", "Thinking level I" (Object theories) and "Thinking level II" (Metatheory). The action level focuses on concrete actions in relation to planning ("preaction"), teaching ("interaction") and evaluation ("postaction"). In the collaborative research the *action level* may relate to traces of co-planning, teaching and co-evaluation, that could be linked to policy documents, such as the national preschool curriculum (see Tables 1 and 2). *Theoretical level* may refer to traces in which participants base their teaching practices on scientific grounds and relate them to theoretical gateways and concepts. In the collaborative research this occurs where participants try

out teaching arrangements informed by didaktik, variation-theory, post-structural input and pragmatic perspectives (see section 2.4 and Table 2). *Metatheoretical level* may pertain to traces of participants immersing and positioning themselves in the theoretical gateways on a metatheoretical level that concerns ontology and epistemology. This article focuses on the action level and the theoretical level.

2.4 Theory-informed teaching arrangements as overall didaktik models

"Theory-informed arrangement" refers to the testing of various teaching arrangements that were "informed" by different theories (cf. Vallberg Roth et al., 2019; Vallberg Roth et al., 2021). In this research, the theory-informed arrangements were related to theories that participants addressed in descriptions of what might characterize teaching when the collaborative research started in August 2018 (Vallberg Roth et al., 2019).

To shift the focus from learning to teaching, the collaborative research tried out theory-informed teaching arrangements that consistently combined didaktik with theories, such as variation theory and intentional learning, with reference to Marton (2015), Ljung-Djärf and Holmqvist Olander (2013) and Björklund (2013). Moreover, a link was made between didaktik and a post-structural gateway and rhizomatic learning, with reference to Broström (2012), Deleuze and Guattari (1987), Holmberg and Zimmerman-Nilsson (2014), Lenz Taguchi (2012) and Palmer (2010). In addition, pragmatic perspectives focusing on reflective learning, experiencing and creation of meaning were tried out, with reference to Burman (2014), Dewey (1916/1966), Hedefalk (2014) and Öhman (2014). For example, Öhman wrote in terms of "pragmatic learning theory" (2014, p. 39). Reflective learning can also be formulated in terms of "learning by reflective experience" (Burman, 2014, p. 36). These theory-informed teaching arrangements were tried out as overall didaktik models, that included didaktik questions and didaktik levels, which all in all were integrated in the concept of "multivocal didaktik modelling".

2.5 Multivocal didaktik modelling

The term "multivocal" refers to multiple voices in different parts, which can be translated into multiple perspectives and a variety of approaches and interpretations in the collaborative research. The Norwegian linguist Dysthe (1993) launched "the multivocal classroom" concept, largely

inspired by the Russian philosopher and literary theorist Bakhtin and his colleagues. Sociolinguistic and sociocultural premises were prominent. Multivocal teaching can be inspired by Dysthe's figure of thought, even as a more expansive approach intended to encompass several scientific grounds is tried out (cf. Liberg, 2003). The expansive approach aims to contain many scientific grounds (see position paper).

Didaktik models can be systematically developed through "didaktik modelling" (Ingerman & Wickman, 2015). Didaktik modelling refers to how teachers, based on theory-informed arrangements or models for teaching, develop contextual relationships between co-planning, teaching and co-evaluation (cf. Ingerman & Wickman, 2015). The focus is on identifying, trying out and refining didaktik models. Didaktik modelling may entail development of didaktik knowledge in a collaborative effort involving teachers and researchers (Ingerman & Wickman, 2015). The process entails efforts to shape and reshape teaching based on children and groups in unique situations, on objectives and types of knowledge, and on the experiences and organizational circumstances of the participants.

All theoretical gateways and theory-informed arrangements have the potential to change practices, though practices and proven experience can also challenge the models and arrangements. Ingerman and Wickman (2015) refer to this interplay between theory and practice as "didactic modelling". This collaborative reserach explores and makes explicit the processes involved in didaktik modelling (see the results section). Didaktik, with its included assessment, is a cohesive knowledge base. The assessment is teaching-oriented and includes feedback with reference to Hattie and Timperly (2007),[2] as well as to Osberg and Biesta (2010). In this article co-assessment then is seen in the following sense: "judgements should not be seen as something that is done from the 'outside' – teachers judging students; parents judging children – but should rather be seen as a collaborative process, as something that all who are engaged in the activity should take part in and should do so continuously" (Osberg & Biesta, 2010, p. 603). This article focuses on feedback and judgements in teaching as part of co-actions in the didaktik how question.

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[2] See for example, "Where am I going (goals) – feed up [What is the goal?)]; How am I going – feed back [Where am I in relation to the goal?]; Where to next – feed forward" [How do I get to the goal?] (Hattie & Timperly, 2007, p. 87)

In summary, multivocal didaktik modelling can be tried out as a tool for critical reflection, which may include the perspectives (versions) of various actors, diverse scientific grounds, and proven experience (cf. Vallberg Roth, et al, 2019; Vallberg Roth et al., 2021). Multivocality and variation in the different alternatives for teaching can also be interpreted as being more beneficial for democracy and sustainability than exclusively unanimous choices (Vallberg Roth et al., 2021).

3. Research methodology

From the standpoint of aims and research questions, the collaborative research is methodically influenced by praxiography (Bueger, 2011, 2014). Praxiography refers to studies and analysis of registered practitioners (Vallberg Roth et al, 2019; Vallberg Roth et al, 2021). Our methodological design, which is expressed in terms of praxiographic interaction, involves a relatively large-scale interactive method that focuses on processing of quality data. The interactive method relates to interaction with participants through the collaborative research, ranging from initiation and dialogue concerning research questions, across selection of design for theory-informed teaching arrangements, to generation of data and discussion of analysis and results.

3.1 Praxiographic process

The praxiographic research process can be described as the process of "converting implicit knowledge to explicit. This process entails a high degree of interpretation" (Bueger, 2011, p. 6, our translation). The overall focus of "praxiography is to reconstruct meaning" (Bueger, 2011, p. 4). In the collaborative research, this approach relates to our design of abductive-oriented analysis (see section 3.5). Making explicit and reconstructing meaning can be linked to the focus of abductive analysis on drawing attention to something that extends beyond the known. This may be something that can only be suspected and that can pave the way for reconstructing and further developing knowledge (Peirce, 1903/1990). It can further lead to "experimental answers in the form of hypotheses" (Qvarsell, 1994, p. 9) and in testing and further development of models. Overall, we make explicit and try out "multivocal didaktik modelling". The method that praxiographers use to turn implicit knowledge into explicit is to try, based on observations, speeches, and actions, to identify "moments where participants themselves tend to articulate implicit meaning" (Bueger, 2011, p. 6).

In the collaborative research the researchers have analysed texts, questionnaires, observations/videos and documents that participants in the programme generated in their practice. The participants have generated empirical material without researchers being directly present in the practical experiences. This methodological design, in which the participants generate data and choose what they want to show the researchers, has proven to be feasible even in cases of reduced physical presence, such as during the COVID-19 pandemic in 2020.

3.2 The selection and input to theory-informed teaching arrangements

The selection of preschools and participants was made by the school authorities. In total, between 40 and 44 preschools/departments generated materials in each teaching arrangement (see Table 1 and Vallberg Roth et al., 2021).

Knowledge was developed in a collaborative effort involving preschool teachers, leaders and researchers. Each participating municipality/responsible school authority participated through one or more development teams that included preschool teachers and principals. They ran and tried out teaching arrangements in the preschool. In addition, the responsible school authority appointed one or more local process leaders to support the participants. Their primary task was to lead and run the developmental processes locally within the municipality. Process leaders were generally development managers/strategists or had similar roles in their municipality.

For the purposes of the study presented in this article, collaboration meant in part that participants initiated questions about teaching, and in part that they generated material. Furthermore, collaboration also entailed analysis in which the material and the teaching arrangements were repeatedly discussed with the process leaders (three times each term, total of 18 occasions), as well as communication with other participants during national two-days seminars once each term (total of five occasions). At the seminars, "co-exploratory" sessions were also held in which participants discussed initial analyses. The research group held meetings about once a month to work with teaching arrangements and analysis.

Input to the theory-informed teaching arrangements took place once each term when the arrangements were introduced. The number of participants then was about 300, including about 200 preschool teachers (see Vallberg Roth et al., 2021). Municipal administrators appointed the participants in the seminars and in the co-research. Input referred to lectures by researchers associated with each theory-informed teaching arrangement, as well as to seminars with theory-informed discussions. Workshops were held during which participating preschool teachers and leaders generated intermunicipal and municipal co-plans that were followed up through intermunicipal co-evaluations after the arrangements were carried out (see Vallberg Roth et al., 2021). All participants also had access to reference material describing the theory-informed arrangements with links to relevant references (Vallberg Roth, 2018).

Based on this input, the participants then tried out the theory-informed teaching arrangements in the municipalities without the presence of researchers in the preschools. In the spring of 2020, we were concerned that the outbreak of the COVID-19 pandemic would change conditions and have an impact on the implementation of the R&D programme. However, the methodological design using the praxiographic interactive method proved to be feasible even when we switched to digital communication in the programme (see Table 1). During the spring term 2021, the participants in the municipalities themselves chose which theory-informed teaching arrangement were to be tried out, where one possibility was play-responsive teaching (Pramling et al., 2019).[3]

3.3 Material overview

Table 1 presents an overview of data in the form of various types of documentation generated in the various teaching arrangements of the research portion. Number of documents (doc.) and approximate number of video hours (approx. hrs), as well as number of words in written documents (approx. words) are also presented in the table.

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[3] *Limitations on material:* For reasons related to limited space, this article only presents results from material generated pertaining to the four theory-informed teaching arrangements at preschools/departments between 2018 and 2020. The article does not include inter-municipal co-plans and co-evaluations, or material from the municipalities' own selected theory-informed teaching arrangements from 2020.

Table 1. Material overview for collaborative research between 2018 and 2020.

Arrangement	Co-planning	Video/doc. Implementation	Co-evaluation	Total
1 Didaktik informed arrangement Autumn term 2018 Cycle 1 Cycle 2 44 dept./preschools*	Co-planning C1** 40 doc. C2*** 42 doc.	Videos C1 53 doc. C2 57 doc. Approx. 12.5 hrs	Co-evaluation C1 34 doc. C2 36 doc.	**262** doc. Approx. **12.5** hrs. Approx. **45000** words
2 Variation-theory informed arrangement Spring term 2019 Cycle 1 Cycle 2 43 dept./preschools*	Co-planning C1 43 doc. C2 38 doc. Pre-assessment at individual level: C1 42 doc. C2 39 doc.	Videos C1 62 doc. C2 61 doc. Approx. 12.5 hrs	Co-evaluation C1 40 doc. C2 40 doc. Post-assessment at individual level: C1 38 doc. C2 35 doc.	**438** doc. Approx. **12.5** hrs. Approx. **92000** words
3 Post-structurally informed arrangement Autumn term 2019 40 dept./preschools*	Co-planning/prelim. work 60 doc.	Video: 80 doc. approx. 5.5 hrs Photos/documentation: 73 doc.	Co-evaluation finishing work 38 doc.	**251** doc. Approx. **5.5** hrs. Approx. **70000** words
4 Pragmatically informed arrangement** Spring term 2020	Co-planning 46 doc.	Video: 61 doc. approx. 5 hrs Photos/documentation: 92 doc.	Co-evaluation 44 doc.	240 doc. Approx. 5 hrs.

41 depts./preschools*				Approx. **50000** words
Total	**350 doc.**	**375** video doc. Photo/doc.: **165** Approx. **35** video hrs	**305 doc.**	**1,194** doc. Approx. **35** hrs. Approx. **360000** words

*dept./preschool refers to department/preschool.

**C1 refers to Cycle 1. A cycle includes co-plan, video/doc, and co-evaluation.

***C2 refers to Cycle 2.

**** Material generated during the COVID-19 pandemic spring term 2020 and autumn term 2020.

The documentation generated in the teaching arrangements included co-plans, pre- and post-assessments, and video and photo documentation, as well as co-evaluations. Recorded material was transcribed by the researchers. The transcription makes no claims that all sounds and actions were transcribed. Rather, this represents a partial transcription (cf. Duranti, 1997). Italics represent verbal communication. Non-verbal communication includes noise creation/song, facial expressions, and body movements (see examples in the presentation of results).

3.4 Analysis procedure

This section addresses triangulation and abductive-oriented analysis (see also Vallberg Roth et al., 2021). Triangulation can serve as support to generate and capture variation and to strengthen analysis and credibility, since the same phenomenon can be investigated using various types of data, theoretical perspectives, and researchers/actors in the research process (cf. Larsson, 2009; Tracy, 2010).

Triangulation of data may mean that researchers use multiple forms, points in time and situations to generate data. In the collaborative research, source data consist of word data and audio-visual data that are generated in different groups and by different participants at different points in time. Theoretical triangulation may mean that several different theoretical perspectives are used to shed light on the same phenomenon, such as teaching, which is the case in our collaborative research. Methodological triangulation may mean that different methods and approaches are used to shed

light on the same phenomenon. We use different methods such as co-plans, co-evaluations and videotaped teaching sessions. Regarding qualitative and quantitative approaches, we mainly process and analyse quality data (see section 3.5).

In summary, triangulation can help to capture the complexity of the teaching reality. The goal is not to provide a valid singular truth, but to consider the possibility of a more complex and in-depth understanding of what may characterize teaching in the preschool (cf. Tracy, 2010).

3.5 Abductively oriented analysis

The researchers' analysis of the material in this study can be described in terms of abductive analysis, alternating between theory and empirics (cf. Peirce, 1903/1990; Tavory & Timmermans, 2014), "where both are gradually reinterpreted in light of each other" (Alvesson & Sköldberg, 2008, p. 57). The focus may be on drawing attention to something that goes beyond the known, something that can only be suspected and that can open the door to further developed knowledge. Abductive moments can be interpreted as:

> reality is not simply "what is here-and-now" /…/ but also includes what potentially can be achieved
> – and which in the moment merely reflects a vague possibility" (Peirce, 1903/1990, p. 31).

3.6 Analytical questions and traces

Didaktik questions serve as both practical tools and as a basis for analytical questions in the study (Vallberg Roth, 2020). The article focuses on the didaktik questions "what" (content) and "how" (teaching actions). The analysis shows characteristic traces that are related to the aim and questions of the collaborative research, revealing the variety in the material. The same applies for selection of examples, quotes and excerpts from transcriptions which, in relation to aims and questions, focus on clarifying the variation and characteristic traces in the material in the least cumbersome yet simultaneously clear and illustrative manner (cf. Derry et al., 2010).

In the analysis we use the term "trace" instead of, for example, "category". Trace is a term which from an analytical standpoint may be consistent with various grounds and perspectives, and

various ways of relating to and processing source data (see Vallberg Roth & Holmberg, 2019; Vallberg Roth, 2020). The term "category" may misdirect thoughts to something more rigid with sharply defined limits. Category may create the semblance of something that is more or less complete to search for and capture and in which the material is arranged based on concrete and static classifications (cf. Lenz Taguchi, 2012; Palmer, 2010). Traces can be associated with both fixed and temporary determinations and constructions that can be related to various scientific grounds and be capable of capturing the variation in the material (Vallberg Roth et al., 2019; Vallberg Roth et al., 2021).

As mentioned previously, abductive moments in the analysis can involve suddenly seeing an alternative; discovering a previously undiscovered possibility (Peirce, 1903/1990). In the collaborative research we try out concepts in relation to traces in the material (see Table 2) that are revealed as possibilities by the analysis (cf. Vallberg Roth et al., 2021).

3.7 Ethical considerations of research

The collaborative research was reviewed and approved by the Regional Ethical Review Committee in Lund, Sweden (10 January 2018) The collaborative research complies with research ethics principles in accordance with humanistic-social scientific research (Swedish Research Council, 2017). A total of 10 404 individuals gave their consent to participate in the research portion of the programme, including 8 219 guardians/children and 2 185 preschool teachers, daycare centre employees, principals, assistant principals and administrators.

4. Results

This part presents the summarized results of the theory-informed teaching arrangements from the standpoint of the didaktik questions what and how, with an emphasis on co-action and feedback in the how question. The results section ends in an analytical overview (Table 2), where examples of characteristic traces are arranged based on the didaktik questions for didaktik, variation theoretical, post-structurally and pragmatically informed teaching arrangements respectively.

4.1 Didaktik informed teaching arrangements

Didaktik informed teaching arrangements were introduced in the autumn term of 2018. The guiding question is: "What can characterize teaching from the standpoint of didaktik informed teaching arrangements with a focus on music and movement?"

4.1.1 The "what" question: In relation to the subject music, the content appears to be part science (e.g., concepts such as tempo and pulse), part craftsmanship (for e.g., playing instruments), and part art (e.g., creativity and sensory experiences from music). The various dimensions of music are also made apparent. Here we have an acoustic dimension (e.g., the sound from guitar strings), emotional dimension (e.g., emotions related to music), kinetic physical dimension (e.g., movements of dance) and structural dimension (e.g., dynamic, tempo and pulse). In particular, the structural dimension emerges as the focus (from the co-plans) of the content – more specifically, tempo, meter, and pulse, but also dynamic and rhythm. In relation to movement, gross motor function and balance are prominent, but there is also content that focuses on body perception, fine motor function, health, and well-being (from the co-plans).

4.1.2 The "how" question: One prominent trend in relation to the "how" question involves activities such as singing, listening, playing and movement in obstacle courses (from the video transcripts). Teaching is carried out mainly as relatively teacher-led co-action, which is characterized by a situation in which the preschool teacher is primarily the main actor in leading joint action and directing attention. It can be expressed as "clear leadership" (from the co-evaluation). Below is an example of teacher-led co-action from the video transcript:

> As the video begins, we come upon a warm-up exercise with dramatic elements. The preschool teacher stretches her arms over her head and four children stand in a semicircle in front of her and stretch their arms over their heads.
> Preschool teacher: *Can you stretch your arms? Ohhh almost up to the ceiling!*
> The children laugh and reflect the pattern of movement.
> The preschool teacher stretches one arm up a little higher and waves with her hand and says with a playful voice: *This is Plipp.* Then the teacher stretches up her other arm at the same time that she lets the first arm slide down a bit and says: *This is Plopp. And they are stretching up.* The

preschool teacher stretches to the ceiling with alternating arms. The children laugh, reflect and perform the same pattern of movement as the preschool teacher and wave back. (from the video transcript)

Another example is a preschool teacher who plays guitar and gives instructions by singing different movement assignments, and four children co-act in response to the motor challenges: Jump, spin, run, be rowdy, roll, crawl, creep, balance and sneak.

> Preschool teacher: *Ohhh up and jump now, let's see if you can jump.* Takes one child by the hand as support to help the child get up.
> The preschool teacher plays a chord on the guitar and asks: *Ready?* Starts to sing and play at the same time that the children jump in place and laugh. *And now we're going to jump, jump, jump. And now we're going to jump, jump, jump. Let's jump, you and I, jumping is good, jump every day, jump, jump, jump.* (from the video transcript)

Feedback may be both group-oriented and individual-oriented but is preferably group-oriented. An example of group-oriented feedback is "You're doing great" (from the video transcript). Feedback is a tool that can be used to create attention in teaching as a process. In research, various forms of feedback are described in terms of "feed up", "feed back" and "feed forward" (see note 2). There are traces in the material that derive from these forms of feedback. An example of feed up may be:

> Preschool teacher: *We're going to work on music and tempo. What do you think tempo might be? /…/*
> (from the video transcript)
> Preschool teacher: *Now we've worked with tempo – sometimes fast, fast, fast, and sometimes slow.* (from the video transcript)
> On subsequent occasions, one child demonstrated to remind everyone as an introduction.
> (from the co-evaluation)

Feed back can be exemplified as follows:

> Preschool teacher: *Fantastic, well done!*
> Preschool teacher: *You do such a great job! /…/* The children clap their hands and exclaim:
> *Yesss.*
> Child 1: *You can do it!*
> Child 2: *I can do it!*
> (from the video transcript)

As exemplified above, feedback can also be communicated through body language; examples include thumbs up, nodding and applauding. Children can also provide feedback as shown in the example above. Feed forward can emerge as expressed by feedback where preschool teachers provide something new that can stimulate the children to broaden perspectives and ability. Another example of feed forward can be exemplified by a preschool teacher who tries to inspire, demonstrate and challenge children to find their balance: "Try to find your balance /.../ Try to put one foot in front of the other, so that you don't have your feet next to each other" (from the video transcript).

Based on the abductive analysis, traces also emerge from the material that cannot be classified under any established assessment concepts. We then test combining the assessment-theory-based concept "feedback" (shortened to "feed") with traces of "rap", which leads to feedback as represented by "feed – rap/rhyme," or "rap feedback." In addition, "feedback" is combined with traces of movements (shortened to "moves") in terms of "feed – moves". Here is an example of feed – moves: "'Let's begin by balancing.' The preschool teacher stretches out her arms horizontally from the body while balancing on the bench" (from the video transcript). Another example of feed – moves is "it was easier for the children to understand what to do when they watched the teacher and followed her movements, than to understand what she said" (from the co-evaluation). An example of feed – rap/rhyme emerges in relation to an instructive feedback (feed up):

> Stand in the windbreak and hold each other,

> then wander to the ravine.
>
> Use a rope to get up the hill,
>
> listen at the top to see if you hear someone chirp.
>
> Now turn into an airplane and fly, down to the windbreak where you will then sneak in. Come
>
> in and sit down and be completely quiet;
>
> I hope you'll like the treasure.
>
> (from the co-evaluation)

So, in addition to the established assessment concepts "feed up", "feed back" and "feed forward", the material also emerges from the concepts of "feed – rap/rhyme" and "feed – moves". Multivocality can be interpreted as emerging in the didaktik informed teaching arrangements (see also Table 2), all of which can be tried out in the concept "multivocal didaktik modelling".

4.2 Variation theory and didaktik informed teaching arrangements

Variation theory and didaktik informed teaching arrangements were introduced in the spring term of 2019. The guiding question is: "What can characterize teaching from the standpoint of variation theory- and didaktik informed teaching arrangements with a focus on mathematics, programming and chemistry?"

4.2.1 The "what" question: The "what" question primarily addresses the choice of learning object with a focus on mathematics/programming and natural science/chemistry, but also includes elements of language and storytelling. Learning objects that focus on mathematics/programming are mainly aimed at order and direction, but also on number, positional words, and sorting by size and colour (from co-plans). The science-oriented content is mainly aimed at chemistry with a focus on solutions/solubility and phase transformations, but also includes elements of seeds and prerequisites for growth, carbon dioxide, soap bubbles/surface tension and "volcano experiments" (from co-plans). One example is "Variation theory is used during this teaching session to clarify contrasts between different types of sugar and how they dissolve in water" (co-planning).

A "learning object" refers to the defined content and knowledge that the learner can develop. From the standpoint of variation theory, learning can be viewed as the ability to distinguish

between various aspects of a learning object. The idea is to distinguish more and more aspects of a phenomenon. Variation is a necessary condition in order for the learner to perceive an aspect of the learning object. In the material, preschool teachers use different approaches to vary content as "contrasts", such as yellow in contrast with blue, large in contrast with small, first in contrast with last and right in contrast with left. The meaning of contrast can be formulated as follows: "Contrasts are needed in teaching, in order for children to learn", "Teach about learning objects in contrast with something else; for example, in order to learn about the colour red you have to show yellow to understand what is red. As a result, we talk about a variation" (from the co-evaluation).

A second approach to varying content is through "generalization", such as positional words "in front of" and "behind" in different contexts and representation styles. "We believe that the opportunity to test in different contexts provides support for children to generalize their learning" (from the co-planning). Generalization may mean that the learning object is generalized and transformed in other situations. In such cases the same object may present with varied representations and contexts. One example is experiments in teaching about the learning object "the phases of water", where the context varies and the experiments with water are carried out first inside and then outdoors (from the co-planning).

A third way to vary content is through "fusion": "Find variation, contrasts and fusion" (from the co-evaluation). Fusion means that several aspects vary simultaneously; for example, size and colour vary simultaneously in the material: "I continue by having them sorted, based on both colour and size" (from the co-planning).

4.2.2 The "how" question: Teaching is completed mainly as teacher-led co-action: "Teaching sessions one and two took place under strong guidance from the teacher", "Daring to be leaders" (from the co-evaluation). But there are also examples of "teacher-led and child-led co-action" in which the preschool teacher leads first and later switches roles, and then children start to lead, ask questions and provide feedback to the teacher's answers. In one video example, the children suggest that it is the preschool teacher's turn to be the robot in the robot game and then the

children lead and tell the teacher what she should do and in what order she should carry out different steps when washing her hands (see below). In this example the children also play the role of providing feedback.

Feedback is expressed explicitly in the material: "As a teacher, I provide feedback from the previous session and clearly explain the instructions, using verbal clarity to hold the child at the learning object if necessary" (from the co-evaluation). In summary, feedback may be both group-oriented and individual-oriented, but through pre- and post-assessment it is predominantly individual-oriented in this arrangement: "The variation-theory-based perspective focuses more on the individual than on the group", "Through the assessments, we can develop our teaching so that it suits all children" (from the co-evaluation).

Examples of "feed up" are preschool teachers who say: "Today we're going to do an experiment and you three are invited"/…/ "Now we've conducted a little experiment", or "Today I thought we could work with algorithms and doing things in a certain order" (from the video transcript). Examples of "feedback": Preschool teacher: "That's right, great!" "You are right about that. (from the video transcript). "The children provide feedback to one another" (from the co-evaluation) Child: "Terrific!" (from the video transcript). Examples of "feed forward" are co-action regarding patterns and order:

> Preschool teacher: *What colour comes next? What does this part start with?*
> Child: *Red.*
> Preschool teacher: *And what does this part end with?*
> Child: *Blue.*
> Preschool teacher: *So, what comes after blue?*
> (from the video transcript)

Moreover, we test combining the variation-theory-based concept "critical aspect" with the assessment theory-based concept "feedback". This combination leads to feedback focused on critical aspects, which can be formulated in terms of "feed – critical aspects". Critical aspect refers to the aspect of a learning object that the child may discern but has not yet embraced. Here are examples of statements about critical aspect: "There must be a variation, something to use as a

contrast. There must be a simultaneity. We use a learning object as a starting point to find the critical aspects" (from the co-planning). "The critical aspect makes it clearer for us to understand where we need to focus" (from the co-planning), "That we find the critical aspects together with the children", and "The teaching is set up based on the critical aspects" (from the co-planning).

One example of feedback regarding critical aspects, feed – critical aspects, can be seen in the implementation of teaching in relation to the learning object "order" for programming. The co-planning shows that "The critical aspect may be that the concepts are difficult" – for instance "order" in contrast to "bug"/disorder. During teaching, children and teachers co-act with laminated material consisting of five images of what happens when we wash our hands. The images present are: 1) turn on the tap, 2) take soap, 3) wash hands, 4) turn off the tap, and 5) dry hands using paper.

The video begins with two children and a teacher sitting at a table and discussing the order of steps when we wash our hands. The preschool teacher asks the children to place the images in order on a piece of paper, which the teacher calls "an algorithm diagram" (from the video transcript). The teacher scatters the images on the table and the children put them in order, which they then go to test in the bathroom. They chose the order: 1) wash hands, 2) take soap, 3) turn off the tap, 4) dry hands using paper and 5) turn on the tap. Testing was carried out as a robot game. One child instructs the other child, who is a robot, based on the order they arranged at the table. It turns out that some bugs snuck in (wrong order) when "the robot" follows the predetermined order. When both children had had the opportunity to be the robot in the game, the children suggest that the teacher should be the robot: "It's your turn." Then the teaching shifts from teacher-led to child-led co-action. Now the children lead and instruct the preschool teacher about what she should do and give feedback to the teacher. When the children have given instructions for all of the steps and the preschool teacher has finally dried her hands she asks: "Am I done?" The children gladly answer: "Yes." The preschool teacher then asks: "Did I do it in the right order?" The children provide feedback: "Yes."

In another teaching arrangement, feedback is aimed at the critical aspect to be discovered – the word "bug" and its meaning in relation to the contrast order/disorder. Response from one child: "it becomes one of those robot things", indicating the critical aspect:

> Preschool teacher: *Have you seen?* The teacher points to the images of the instructions for washing hands. *Now we have done it in order. And when you don't do it in order, what happens then?*
>
> One of the children begins to jump in place and says: *"It becomes one of those 'robot things'."*
>
> The preschool teachers nods and says: Then it becomes a bug.
>
> The child continues to jump in place and says: *Yes, bug.*
>
> Preschool teacher: *That means that it is something that is crazy.*
>
> Child: *Yes, crazy with that sort of thing.* Points to the images of the instructions.
>
> Preschool teacher: *Because imagine if you had taken the soap last.*
>
> Child: *Yes.*
>
> Preschool teacher: *Then it wouldn't be in the right order.*
>
> Child: *No.*
>
> Preschool teacher: *Then it would be crazy. Because you can't walk around with soap on your hands.*
>
> The child stops jumping and looks at the images.
>
> Preschool teacher: *That's why you have to do it in the right order.*
>
> (from the video transcript)

So, in addition to the established assessment concepts "feed up", "feed back" and "feed forward", the material also emerges from the concepts of "feed – critical aspects". Multivocality can be interpreted as emerging in the variation theory and didaktik informed teaching arrangements (see also Table 2), all of which can be tried out in the concept "multivocal didaktik modelling".

4.3 Post-structurally and didaktically informed teaching arrangements

Post-structurally and didaktically informed teaching arrangements were introduced in the autumn term of 2019. The guiding question is "What can characterize teaching from the standpoint of post-structural and didaktically informed teaching arrangements?"

4.3.1 The "what" question: In the "what" question, transdisciplinary and intertwined content emerge with elements of nature/natural sciences/mathematics/technology/music/image/language/ movement and values.

Transdisciplinary content is constructed as intertwined content areas. Instead of first working with one content area and then the other, they are done simultaneously. Examples in which the concept "transdisciplinary" is mentioned are as follows: "The result was transdisciplinary learning and it turned into a 'Create-a-tech'", "Transdisciplinary – different subjects are integrated with each other" (from the co-evaluations). More examples of intertwined content from the material: "Music/math/technology", "Cyclical dance/nature art", "Construction/Great Wall of China/language", "Length/pattern/creativity", "Worm/technology/pattern/fairy tale/song", "Good friend" (from the co-planning) and:

> The project can land on different traces we think it may be possible to explore:
> Technology – various materials and techniques, digitalization
> Music –nursery rhymes, pulse, song
> Mathematics – number, format
> Language – vocabulary, comprehension
> Movement – body perception, muscles for moving, dance
> Natural science – bacteria, muscles, the virus
> Integrity – stop my body, rights and obligations
> (from the co-planning)

Moreover, the post-structurally informed arrangement is described using terms such as "here and now" and "there is no right or wrong" (from the co-evaluations). However, traces also emerge indicating that the transdisciplinary content is challenging: "Forced, it sometimes feels unnatural to cross several subjects" (from the co-evaluation). Rather, traces in the material show signs of transdisciplinary moments and interdisciplinary content where a variety of content foci alternate in the foreground, as follows:

> Milestone 1. They will have to follow ready-made templates and their own drawings, based on which they will then build (technology).
> Milestone 2. We will talk about the colours of the magnets and the names of the shapes to gain greater understanding of how they can be used together. For example, four little magnets become a large square (mathematics). (from the co-planning)

There are also traces in the material that certain content areas become more means than goals, such as music, images and drama (see also Vallberg Roth et al., 2021).

4.3.2 The "how" question: In the "how" question, a project- and theme-oriented working method emerges with a variety of co-actions, though relatively child-guided co-actions are more frequent than in previous versions. Characteristic of child-guided co-action is that children figure prominently as main actors, where the teacher mainly follows the children. This occurs under indirect guidance from the preschool teacher, who has arranged the environment. One example is: "We follow the children and explore with them. This isn't linear teaching, as it starts with building houses and towers in the building room until we end up in the painting room where we create people."

> These are not planned teaching situations; rather, we let the children explore the milk cartons and allow them to freely create. /…/ the children explored and tested various techniques to be able to build a tower out of the milk cartons. They did not find a technique of their own at the start for the structure to be stable. The teacher suggested tape and the children agreed to try this idea. We then saw in the video that while two of the children helped to tape the structure, one child continued to explore and find a technique that worked to be able to build a tower" (from the co-evaluation)

In child-guided co-action, the preschool teacher cannot be seen in the video, or is only at the edge of the video. This can be expressed as: "The children's interests are given priority and they gain greater influence over their day in that the teachers follow the children" and "We teachers lead 'from behind'" (from the co-evaluations).

Regarding feedback, there are also traces of established assessment concepts such as:

> Feed up: *Today we will take a very close look at the worm.*
> Feed back: *Then I will give you feedback by showing thumbs up.*
> Feed forward: *Can you place the red block on a red colour?*
> (from photo/documentation)

In addition, traces of peer assessment emerge:

> We watch the video: critique and feedback – the story of Austin's butterfly – Ron Berger/…/on repeated occasions draw the same plant, fruit, vegetable, first alone and then with the help of constructive criticism from a friend /.../ During the process the teachers asked whether the children remembered why we drew the same picture several times. Then one child responded: "It's just because you have to develop"; another child said: "You improve".
>
> (from photo/documentation)

The previous arrangement has focused on teaching *about* content in the world. In the post-structurally informed arrangement, traces of teaching *with* the world also emerge. The material is then expressed as having agency:

> Material has a strong – almost controlling agency.
> Intra-action – interplay between teacher and material, material and child.
> Developing learning environments, looking at the sociomaterial relationships. Consider how we control using with the environments and materials we present.
> (from the co-evaluations)

Within this context, characteristic traces are captured in the evolved concepts "co-led action" and "feed with", which emphasize that feedback and response also occur from the material aspects of the ongoing events of the teaching. In co-led action, the actors may appear as alternating between main actors and co-actors, who can co-lead the action by igniting conversation, questions and responses. One example is co-led actions involving children, worms, a USB microscope, a large screen and preschool teachers, in which the enlarged worm on the screen triggers conversations about zebras, balls, chili sauce, that something is painted, and baby worms. In this context, a child's bracelet can also prompt the child to read his or her name. Here is another example in which the actors alternately lead the action:

> Teacher: *Should we get the iPad and look at the Great Wall of China together?* The children thought it was a good idea. We look together and read some facts about it. Then the children want to continue building.
> (from photo/documentation)

Moreover, teaching may occur through relatively "coincidental" feedback in a series of non-predetermined responses to co-led actions involving children, preschool teachers and tablets. An example of "feed with" occurs involving children, teacher and tablet using an app that translates languages:

> Child: *How do you say "Hi" in Chinese?*
> Teacher: *We can find out on the iPad; there is an app where you can translate from Swedish to Chinese.* We look together, try different words and sentences and laugh a lot when we can't repeat what the voice says. Nevertheless, we learn small phrases like: "Ni hao" – Hello and "She she", which means thank you."
> (from photo/documentation)

So, in addition to the established assessment concepts "feed up", "feedback", "feed forward" and peer assessment, the material also emerges from the concept of "feed with" as a potential co-actor and can provide feedback and guide the directions of events. Multivocality can be interpreted as emerging in the post-structurally and didaktically informed teaching arrangements (see also Table 2), all of which can be tried out in the concept "multivocal didaktik modelling".

4.4 Pragmatically and didaktically informed teaching arrangements

Pragmatically and didaktically informed teaching arrangements were introduced in the spring term of 2020. The guiding question is "What can characterize teaching from the standpoint of pragmatically and didaktically informed teaching arrangements with a focus on values?"

4.4.1 The "what" question: The "what" question focuses on values, especially on democracy, influence and sustainability. "What does democracy mean?", "This causes us to practice democracy and influence", "The children will have the opportunity to gain understanding of what sustainable development involves" and "We discuss how we can waste less paper at the preschool" (from the

co-planning). It is more strongly oriented towards environmental sustainability than towards social or financial sustainability. There are also elements of source criticism and health with a focus on for nutritious food, exercise and hand washing. A multivocality emerges in which environmentally oriented and/or social and financial aspects can be included, as follows:

> **Social:** Enjoy our nature and environment. Influence and participation.
> **Financial:** Reuse and sort rubbish.
> **Environmental:** What does paper do and what happens to it in our environment? (Nothing disappears.)
> (from the co-planning)

4.4.2 The "how" question: In the "how" question, teacher-led co-action is most prominent. For example, this could be formulated with a focus on "the teacher as leader, which can be developing" (from the co-planning). Furthermore, fact-based, normative and pluralistic teaching principles could be cited. According to fact-based teaching principles, the preschool teacher will teach relevant facts concerning "What are the properties of the paper and what is it made of?" (from the co-planning). Under normative teaching principles, the concern of the preschool teacher is to teach correct behaviour, such as how to treat one another, not hurt anyone, and to listen to and respect one another. "You shouldn't throw rubbish outside because it can be harmful to animals and nature" (from the co-planning). Pluralistic teaching principles refer to spontaneous and/or arranged teaching situations in which the children, with the support of the teacher, can reflect on various ways to think and act. It "opens up for discussions and reflections on different ways of thinking, expressing opinions and acting. The children also get to practice listening to one another and considering the thoughts and opinions of others while making their own voices heard" (from the co-evaluation). Here is an example where all three teaching principles are mentioned:

> **Fact-based:** Video about rubbish in nature
> **Normative:** How do we behave in nature? What happens to the animals if we throw out, for example, glass in nature?
> **Pluralistic:** The children come with suggestions/alternatives for where we throw rubbish. Recycling is considered versus throwing rubbish out.

(from the co-planning)

Feedback in the teaching arrangement is both group-oriented and individual-oriented, and "indicators" are mainly for confirmation and re-orientation, but they are also instructive. Indicators are actions that result in the action at the moment taking a certain direction. An example of a confirming indicator is when the teacher says "that's great that you held onto each other so no one fell down!" or "that's great that you helped her up onto the chair" (from the co-evaluation), or "Well done" (from the video transcript), or "You have great suggestions, let's write them down" (from transcribed audio file). Instructional indicators occur, for example, when teachers "ask the children to cooperate so that everyone will have room on the chairs", by saying "There should be room for everyone! You have to help each other", "Now it's time to work together!" and "Make sure no one is left on the floor" (from the co-evaluation). An example of re-orienting indicators is when the preschool teacher says: "Could we do this in a different way?" (from the video transcript), "Is there any other way we can do it?", "Can we show this in some other way?", "Do you have a different idea?", "We help the children with new options and strategies" and "Next time you can do this" (from the co-evaluations).

The collaborative research combined pragmatic perspectives with didaktik and assessment theory (see Table 2). The combination makes it possible to capture traces in the material in the alternative concept of "feed – transaction", which refers to feedback for change that is expressed as action resulting from the critical ability to act. An example is children who first solve conflicts by shoving one another: "The children shove each other during conflicts" (from the co-planning). After teaching signs of transaction can be discerned. Teaching focuses on questions such as: "What can we do when someone does something that we don't like?" and where the "stop hand" is introduced as a way to set boundaries. Then signs of a transaction can be interpreted when a child says that "you can use the stop hand when someone is causing trouble." Another child says: "Shoving isn't allowed" and shows this by reaching out with a stop hand at the same time and continues by saying: "Like when I shoved Tora" (from the video transcript). "The children have begun to use the stop hand and talk about it at home" (from the co-evaluation). Another example:

> We had a group of children who acted really tough to each other and to the teachers. They
> hit, kicked and used mean words. (from the co-planning)

After teaching that "reinforced the nice things children did for each other", signs of a transaction could be noted. The teaching included "Friend posters were created in all departments. We took photos of situations that we saw, where the children did nice things for each other. We had friend meetings where the children were able to discuss the photos" (from the co-evaluation). Then during a video recording when two children and a teacher sit and chat outdoors, one child says:

> Child 1: *If some people want something and others want the same thing then they start to fight. Then people can do this instead of fighting. First this person can do something for that one, then that one can do something for this one, then this one can do something for that one, then...*
> Teacher: *So you take turns?*
> Child 1 continues: *… then that one does something with this one.*
> Teacher: *Great job explaining, Kim!*
> Child 2: *Yeah!* (from the video transcript)
> We have received comments about what the child has said at home like "*You aren't listening to me now; you don't respect me.*" (from the co-evaluation).

So in addition to the established assessment concepts "feed up", "feedback" and "feed forward", the material also emerges from the concepts of "feed – transaction". Multivocality can be interpreted as emerging in the teaching arrangement (see also Table 2), all of which can be tried out in the concept "multivocal didaktical modelling".

Table 2. Examples of characteristic traces in relation to the didaktik questions of theory-informed teaching arrangements.

Arrangement	What	How
1 Didaktik informed arrangement Autumn term 2018	Content-related dimensions **Music** as science, art, crafts **Movement** – mainly gross motor function and balance	Mainly **teacher-led** co-action Feedback – **group**-individual "Feed – rap/rhyme" "Feed – moves"
2 Variation-theory and didaktik informed arrangement Spring term 2019	Learning object **Focus on mathematics/programming** & science/**chemistry** Content as contrast generalization & fusion	Mainly **teacher-led** and **child-led** co-action Feedback – **individual**-group "Feed – critical aspects"
3 Post-structurally and didaktically informed arrangement Autumn term 2019	Elements of **trans- and interdisciplinary content** with: nature/technology/ digital/language/mathematics/movement/music/ picture/form/values	Mainly **child-guided** co-action and "**co-led** action" Project-oriented Feedback **group/individual/material** "Feed with"

4 Pragmatically and didaktically informed arrangement	Focus on **values**	Mainly **teacher-led** co-action
		Fact-based, normative & pluralistic principle
	Democracy	
		Feedback – **group/individual**
	Social,	Indicators:
	Environmental	confirming,
	Financial sustainability &	instructive
	Health	re-orienting
		"Feed – transaction"
Spring term 2020		

5. Discussion – multivocal didaktik modelling

The following section discusses the results of the analyse of the didaktik questions what and how in the four teaching arrangements. We combine the didaktik models, including didaktik questions and didaktik levels, and discuss the concept "multivocal didaktik modelling" (see Table 2).

5.1 Didaktik "what" question – multivocal modelling of content

The "what" question contains both knowledge and values. The areas of content may concern music, language, mathematics, technology, nature/science – including chemistry, images, form, movement, and values. Content can be organized and modelled in limited subject areas and learning objects that go into greater depth (cf. Marton, 2015). It can also emerge as projects/themes and transdisciplinary content, which can be tentatively modelled and constructed crosswise in intertwined content areas (cf. Holmberg & Zimmerman Nilsson, 2014; Palmer, 2010).

In the didaktik informed teaching arrangement, "content-related dimensions" emerge, such as structural dimensions in music, including dynamic and tempo, and dimensions in movement such as gross motor function and balance. The concept "content-related dimensions" (Nielsen, 2006) refers to content that is drawn out in time with associations in meaning, action and sensory

experience, that can relate to aspects of science, arts and crafts (cf. Holmberg & Vallberg Roth, 2018). In the variation theory-based arrangement, content is organized into defined and intentional "learning objects" such as order, direction, pattern, number, positional words, solutions/solubility, phase transformations and volume. Content could be modelled as contrast, generalization, and fusion in education (cf. Marton, 2015). In the post-structurally informed arrangement, content can be modelled in transdisciplinary intertwining, or more interdisciplinary content divided into projects and themes. Unexpected combinations of content can then be modelled, such as "create-tech" and "rhythmatechs", with content comprising interwoven rhythmics–mathematics–technology. Even if values are woven into all arrangements, values such as integrative knowledge content will be at the forefront in the pragmatically informed arrangement.

Overall, the contents are organized and modelled in different ways depending on which theory-informed teaching arrangement is to be tried out, which could be interpreted as in line with previous research (Vallberg Roth, 2020; Vallberg Roth et al., 2019). A knowledge contribution in relation to earlier research mentioned in the introduction is the multivocal organization, or multivocal modelling, that is created from content in the arrangements.

5.2 Didaktik "how" question – multivocal modelling of teaching actions

In this article, the "how" question focuses on teaching actions that relate to co-actions and feedback (see Table 2). Teaching actions may vary, involving teacher-led and relatively child-guided co-actions. Child-guided co-actions are recurrent and have greater influence in the post-structurally informed arrangement, whereas teacher-led co-actions are prominent in didaktik, variation theory and pragmatically informed arrangements. Specific traces of co-action such as "teacher-led and child-led co-action" emerge mainly in variation-theory-informed arrangements. And "co-led action", involving teachers, children, and the material, can be discerned with reference to the post-structurally informed arrangement. Fact-based, normative, and pluralistic teaching principles become apparent in the pragmatically informed arrangement (cf. Hedefalk, 2014; Vallberg Roth et al., 2019).

Feedback is both group-oriented and individual-oriented in all arrangements, but it is clearly group-oriented in the first arrangement and repeatedly individual-oriented in the second. "Rap" feedback

in terms of "feed – rap" and "feed – moves" is emphasized and tried out in the analyses of the didaktik informed arrangement. Feedback focused on critical aspects in terms of "feed – critical aspects" is tried out in the analyses of the variation theory-based informed arrangement. In the post-structurally informed arrangement, feedback involves groups, individuals, and material, which is tried out in the analyses in terms of "feed with." Moreover, confirming, instructive and re-orienting indicators are pronounced in the fourth, pragmatically informed arrangement. Here traces also emerge in what is tried out in terms of "feed transaction" – meaning feedback on change that is evident in action, in the form of critical ability to act (cf. Vallberg Roth et al., 2019).

Overall, a multivocal modelling of teaching actions and feedback emerges in the arrangements, which can be interpreted as in line with previous research (Vallberg Roth, 2020; Vallberg Roth et al., 2019). Traces of teaching using several different approaches are formulated as: "The different thoughts and hypotheses of all children are taken into account, all children are given the opportunity to make their voices heard", "Through the assessments, we can develop our teaching so that it suits all children", and "Modifications? We wanted the scope to teach 'direction' in different ways /…/ The three children learned the same thing in three different ways. Consequently, we see how important it is to observe in order to see how each individual learns in the best way and learn from this until the next teaching session" (from the co-evaluation). Preschool teachers can be multivocally interpreted, in co-action with the children, as making the contents living, understandable, audible, graspable, visible, and conversational. A knowledge contribution in relation to earlier research mentioned in the introduction is the multivocal modelling of teaching actions and feedback emerges in the arrangements.

Overall, multivocal didaktik modelling can correspond to the need for tools to meet the complex, multifaceted teaching reality in preschool (Vallberg Roth et al., 2021). In our time, when there is a democratic decline (Lührmann et al., 2020), multivocality and variation in the different alternatives for teaching can also be interpreted as being more beneficial for democracy and sustainability than exclusively univocal [enstämmiga] choices. It can also be interpreted as compatible with the pursuit of open life chances for each child and well-being in each now (cf. Trondman, 2011).

5.3 Methodological and analytical reflection

For the theory-informed teaching arrangements the participants in the collaborative research chose what material should be included on the intended platform. Consequently, there may have been a positive bias in the sense that participants only chose to include those co-plans, videos, and co-evaluations that they wished to share. In this sense, there may have been teaching material to which the researchers had no access and that may have deviated from the analysed material. Based on the aim and research questions, it should be emphasized in this context that the results only present a picture of what "can" characterize teaching in the preschool. The outcome is related to participation and circumstances that emerged in the research and development programme.

In summary, the concept "multivocal didaktik modelling" rests on a robust empiric basis consisting of a total of 3 700 documents, about 145 video hours and about 780 000 words from Undif and Fundif, where a total of about 15 500 individuals consented to participate (cf. Vallberg Roth et al., 2019; Vallberg Roth et al., 2021). In summary, the degree of trustworthiness and generalizability can be interpreted as high based on the triangulation and that the collaborative research was carried out in 18 municipalities, in 3 regions, including about 175 preschools/divisions in Sweden (Ibid.).

Regarding generalization, an argument can be made for the logic of *situated generalization*, according to which the results provide alternative perspectives and concepts rather than a single truth (Larsson, 2009; Tracy, 2010). In this approach the reader interprets the extent to which the results can provide guidance in similar cases, situations, and contexts outside the study. The generalization is situated in the sense that it cannot be predicted and instead occurs through recognition – that is, when the reader recognizes identified teaching traces described in the paper and uses the results, models, and concepts as tools in practice (cf. Larsson, 2009).

6. Conclusions and implications

Modelling refers to how preschool teachers, based on theory-informed arrangements (i.e., models for teaching) develop connections between co-planning, teaching and co-evaluation. Multivocal traces related to didaktik questions and didaktik levels emerge from the theory-informed teaching arrangements.

The collaborative research stands to make a highly significant contribution to knowledge development concerning teaching in Swedish preschools. Theory-informed teaching

arrangements, with integrated didaktik models, have been tried and shown to give preschool teachers support in conducting teaching that is based on scientific grounds and proven experience. The concept "multivocal didaktik modelling" can pave the way for several alternative theoretical trajectories for critical reflection and for more cohesive and finely tuned teaching in the complex teaching reality. The contribution to the development of knowledge can be described in terms of theory-informed practical development as well as practically grounded conceptual development (cf. Enthoven & de Bruijn, 2010). The aim has been achieved and the research questions have been answered, through the concept of "multivocal didaktik modelling", at the same time as further analyses and further studies can provide more nuanced answers.

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