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INVESTIGATION OF THE INTERACTIONS AMONG PRESCHOOL TEACHERS' COMPONENTS OF PEDAGOGICAL CONTENT KNOWLEDGE FOR EARLY SCIENCE TEACHING

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ABSTRACT

The purpose of this case study is to explore the pedagogical constructions of preschool teachers towards science teaching and the interactions between pedagogical content knowledge (PCK) components. PCK Mapping, which is a pictorial methodological approach, has been used to reach this purpose. The case addressed in this study is to understand the nature of the interaction between the PCK components that preschool teachers use while planning and implementing the yoghurt-making activity. In order to better understand this case, six preschool teachers from different experiences participated in the study. This design is a multiple case study as the PCK conceptualization of each participant represents a different case. The data in the study were collected through *Content Representations (CoRes)* and *Instruction Based Interviews.* All participants first planned a science teaching activity (making yoghurt) through CoRes, then answered questions about their teaching background, science teaching orientations and the activity. Afterwards, interviews were made about the pedagogical tools they used while structuring the teaching. Finally, each teacher was observed and videotaped while teaching the yoghurt-making activity. After the observations, Video-Stimulated Recall interviews were made with them. Data were analysed through in-depth analysis of explicit PCK, enumerative approach, PCK mapping and the constant comparative method. The results show that preschool teachers use children's cognitive potentials, teaching strategies, and epistemological and pedagogical orientations while planning and implementing science teaching and they frequently associate them. In addition, preschool teachers have a lack of linking curriculum materials with science teaching and other PCK components.

Keywords: preschool teachers, science teaching, pedagogical content knowledge

INTRODUCTION

The recognition and development of learning and thinking skills of individuals in early childhood (0-6 years) are one of the most important rationales for their inclusion in science learning processes (Akerson, 2019; Larimore, 2020). Although children in this age group are ready to learn, they are also ambitious and curious about learning (Broström, 2015). Due to their inherent curiosity and acting like scientists, children obtain a lot of information about the world they live in before being involved in the preschool education process, and they gradually begin to produce their own theories by means of this information (Greenfield et al., 2017). However, children need to learn all areas of science with the help of a balanced curriculum so that children's cognitive skills will have a more formal structure and they can perform more abstract reasoning (Olgan, 2015), which is possible with a qualified early science teaching (Larimore, 2020). In this context, transforming children's curiosity and desires into a scientific thought will gain a more formal structure with qualified guidance (Toyama, 2016). Therefore, it is important that preschool teachers are aware of their pedagogical competencies and especially the child's cognition.

Theoretical Framework

The Role of the Teacher in Early Childhood

One of the most important ways to increase the quality of early science teaching is to increase pedagogical settings that will encourage the professional development of preschool teachers (Heikka & Suhonen, 2019; Trundle, 2015). Science learning can be encouraged in preschool children if preschool teachers have developed a number of professional competencies (Leuchter et al., 2020). These competencies include teachers' beliefs about learning and teaching, and pedagogical content knowledge, subject knowledge, and teaching skills (Gess-Newsome, 2015). However, many preschool teachers may not have the knowledge and experience to provide this qualitatively (Kahila et al., 2020; Saçkes et al., 2011), which causes them to be less ready to teach science compared to other courses, to have a lack of confidence and to act reluctantly (Early et al., 2010; Seefeldt & Galper, 2007).

Even though preschool teachers have structured curriculum units, their inability to combine the content in the context of science teaching with appropriate pedagogical tools and curriculum materials appears to be a major problem (Li & Boon, 2021; Neuman & Danielson, 2021). On the other hand, it should also be considered that the standardization of curriculum materials for all teaching situations might reduce teachers' ability to facilitate learning (Croninger et al., 2012). In order to avoid this contradiction, preschool teachers should have not only *subject matter knowledge* within the context of science but also *pedagogical content knowledge (PCK)* including *pedagogical orientations, children's understandings, curriculum materials, strategies and assessment and evaluation components* while planning and implementing science teaching (Nilsson & Elm, 2017; Wu et al., 2020).

Pedagogical Content Knowledge

In the most general sense, PCK is the type of knowledge that allows teachers to have the knowledge and skills to transform their subject matter knowledge into forms that are comprehensible to students (Shulman 1987). Therefore, the blending of subject matter knowledge and pedagogical knowledge within the context of facilitating student learning is key to the conceptualization of PCK (Park & Oliver, 2008). PCK, which has a dynamic and comprehensive structure and a unique nature, tends to vary depending on the teacher, subject and context (Neumann et al., 2019). Magnusson et al. (1999) suggested that PCK, which has such a unique feature, consists of five components. These components are *orientations to teaching science (OTS), knowledge about students' understanding in science (KSU), knowledge of science curriculum (KSC), knowledge of instructional strategies for teaching science (KISR), and knowledge of assessment of science learning (KAS)*. Teachers should have all PCK components and integrate them while planning and implementing instruction. Park and Oliver (2008) proposed a pentagon model structure to show the potential development of any of these components. Consistent relationships between them are important for the development of PCK and the quality of teaching, and these relationships are inherently complex (Park & Chen, 2012).

In brief, an attempt to understand the interaction of PCK components may provide more concrete and traceable information about teachers' processes of developing a topic specific PCK and turning this knowledge into action. Therefore, preschool teachers need a rich repertoire through which they will properly integrate their subject matter knowledge of science with their constructivist pedagogy while planning and implementing science teaching. Davies and Howe (2003) argued that it was possible by considering all the elements of knowing and doing together. Within the scope of all of them, the unique dynamics of PCK, which constitutes the based-on teachers' teaching for any subject and their professional identity, should be discussed within the context of early science teaching.

Significance of the Study

In the available literature, the studies conducted with the participation of in-service and pre-service teachers largely focused on science learning and teaching. These studies are related to *pedagogical conceptualizations* (Akşam & Kutluca, 2021), *epistemological perspectives* (Hammer & He, 2016), *views on the child cognition* (Pramling & Samuelsson, 2018), *the integration of curriculum and its effect* (Kermani & Aldemir, 2015), *science learning opportunities* (Pierro, 2019), *and assessments* (Brenneman, 2011). It was observed that these studies were conducted based on the general or single components of PCK. However, teachers need a holistic PCK structure in order to plan their teaching well and to reflect this in their teaching completely (Abell, 2008). Nevertheless, there are very few studies in the early childhood literature investigating the combined effect of the pedagogical tools needed by preschool teachers during early science teaching (e.g., Kutluca & Nacar, 2021; Leuchter et al., 2020).

As a result, this study focused on how preschool teachers integrated PCK components while planning and implementing yoghurt-making activity. PCK Mapping (Park, 2019), a pictorial methodological approach, was used to show how the interaction between preschool teachers' PCK components changes according to professional seniority. Thus, answers to the following research questions were sought:

i) How is the interaction among preschool teachers' PCK components for yoghurt-making activity?
ii) How do professional experiences change the interaction among preschool teachers' PCK components for yoghurt-making activity?

METHODOLOGY

Research Design

The interactions between preschool teachers' pedagogical constructions for science teaching within the context of yoghurt-making activity and PCK components were investigated by case study. A case study explores a real-life contemporary limited finite system or multiple finite systems in time with the help of multiple sources of information and describes them in all their aspects. (Merriam & Tisdell, 2015). The situation discussed in this study was to understand the nature of the interaction among PCK components put into effect by preschool teachers while planning and implementing the yoghurt-making activity. Six preschool teachers with different experiences were included in the study for a better understanding of this situation. Here, the PCK conceptualization of each preschool teacher represents a different case (Kind, 2009). Therefore, this design is a multiple case study (Baxter & Jack, 2008). Within the scope of the study, more than one data source was used to discuss the current situation with a more holistic perspective and to provide triangulation (Morse, 2015). All participants first planned a yoghurt-making activity and then performed general science teaching and pedagogical conceptualizations for this activity. Finally, they made explanations by watching important moments from their own teaching recorded on a video basis.

Participants

Six preschool teachers working in Istanbul, one of the metropolitan cities of Turkey, in the fall semester of the 2020-2021 academic year participated in this study. Participants were determined based on the criteria proposed by Lee and Luft (2008) and adhering to the criteria of being experienced and inexperienced. Accordingly, attention was paid to ensure that the most inexperienced teacher had at least three years of experience in order to determine the PCK structure more properly. To justify, Martin (2006) classified teachers with up to five years of professional experience as inexperienced, and teachers with more than five years of professional experience as experienced. Similarly, Berliner (2001) suggests that teachers should have five or more years of professional experience to be considered experienced. Furthermore, it was also ensured that all other participants had different seniorities (Bryne, 2001). The information about the participants selected according to these criteria is detailed in Table 1.

Table 1
Participants Features

Teacher*	Type of School	Age	Professional Experience	Student Group (months)	Classroom Size
Sarah	Public school (suburban)	27	4 years	60-72	20
Nancy	Private school (urban)	29	7 years	48-60	11
Jessica	Public school (urban)	33	11 years	60-72	13
Karen	Public school (urban)	34	13 years	36-48	14
Maria	Private school (urban)	36	15 years	60-72	15
Bonny	Public school (suburban)	40	18 years	48-60	18

**For the study, they were given the pseudonym.*

All participants graduated from a preschool teaching program with a total of eight semesters. The participants did not attend any course on yoghurt-making activity during their undergraduate education. On the other hand, all participants indicated that they carried out this activity once in each academic year in their own classrooms.

Data Collection Tools

In this study, the pedagogical constructions of preschool teachers with different professional seniority for science teaching were explored through PCK Mapping, and an analytical description was made by comparing them with each other. Yoghurt-making activity is a rich activity that will contribute to children to teach many different science fields (physical-chemical change, solubility, nutrition, heat-temperature, etc.) together. Furthermore, it was considered that preschool teachers' pedagogical familiarity was high for this context, which was one of the popular activities of preschool education settings in Turkey. The pedagogical familiarity mentioned here includes participants' orientation and pedagogical conceptualization about teaching of yoghurt-making activities processes. Therefore, two data collection tools were used in this study. These are *Content Representations (CoRes)* (Loughran et al., 2008) and *Instruction Based Interviews (IBI)* (Suh & Park, 2017). All participants first planned a science teaching activity (yoghurt-making) through CoRes and answered the questions about their teaching background and science teaching orientations, and the activity (IBI; background interview). Then, interviews were conducted on the pedagogical tools they used while structuring the teaching (IBI; pre-observation interview). Finally, each teacher was observed and videotaped while teaching the yoghurt-making activity. After each observation, Video-Stimulated Recall (VSR) interviews were conducted with the teachers (IBI; post-observation interview). All interviews were recorded and transcribed word for word. Thus, written formats representing the pedagogical construction of each teacher were created. Because of the pandemic, data collection processes were scheduled by considering the times at which the participants were available. To do this, the researcher negotiated with the teachers, and the process was planned together.

The process from CoRe to the post-observation interview took approximately 180 minutes in total for each teacher. The researchers specialized in the studies of PCK and early science teaching were consulted to ensure internal validity and external control of all questions in data collection tools (Meijer et al., 2002). Furthermore, a pilot application was conducted with a different participant. The forms containing the answers received from this application were sent back to the experts and were finalized after the feedback was received. Data collection tools are introduced in detail below.

CoRes

The Content Representation (CoRe) methodology was used to explore the content-based conceptualizations of the participants regarding yoghurt-making activity and to describe their PCK (Loughran et al., 2008). A CoRe allows a holistic exploration of the implicit nature of the teacher's content-based pedagogical construction on any topic, based on big ideas, in order to explicit it to others (Nilsson & Loughran, 2012). An original CoRe consisting of eight questions was specially edited for this study, expert opinions were received, and it was subjected to a pilot application (McMillan & Schumacher, 2010).

Accordingly, a preschool teacher firstly determines the subject matter, big ideas or themes on this subject matter, curriculum-based learning outcomes and scientific process skills related to these learning outcomes. He/she then makes content-based conceptualizations within the framework of the following themes:

i) The scope and nature of the subject, concept and big ideas required to be learnt by children about the relevant subject matter,
ii) The way how children will integrate the related subject matter with the determined learning outcomes and scientific process skills,
iii) The reason why it's important for children to learn these ideas,
iv) Children's possible learning difficulties related to this concept and targeted learning outcomes and scientific process skills,
v) The way how these ideas fit in with the teacher's subject matter knowledge.

Instruction Based Interviews (IBI)

The question set consisting of three parts was used to reveal the pedagogical content knowledge structures of the participants based on science teaching activity. Similar studies in the literature were used while creating these questions (Park & Chen, 2012; Suh & Park, 2017). Thus, it was attempted to create a sensitive protocol that allows to reveal the pedagogical constructions of preschool teachers in all details. The characteristics of these questions are presented in Table 2.

Table 2
Characteristics of Interview Questions

	Backgrounds	Pre	Post
Q-1	Strengths of science teaching	Previous learning experiences on the topic	Pedagogical description of teaching (Teacher-child interaction)
Q-2	Weaknesses of science teaching	Considerations when planning the teaching	The reasons for the activity carried out
Q-3	General teaching objectives regarding science teaching	Concepts and themes considered to be important related to the subject	Sought-after clues as to whether learning is happening
Q-4	Specific teaching objectives regarding science teaching	Students' perceptions on the subject	Self-evaluation of the quality of teaching
Q-5	Orientation regarding pre-service and in-service training	Subject-based measurement and evaluation approaches	
Q-6	Number of activities on the topic	How the lesson plan is organized	
Q-7		Learning criteria on the subject	
Q-8		Targeted scientific language development on the subject	

Part-I (*background interview*) includes six main questions that allow to explore participants' pedagogical competencies and backgrounds on early science teaching. With the questions in Part-II (*pre-interview*), what the participants took into account while structuring the teaching and their opinions about the teaching objectives were revealed. Finally, Part-III (*post-interview*) includes four questions that allow teachers to provide pedagogical lenses of their teaching. All questions in the IBI have been presented in Appendix-1.

Data Analysis

CoRe and IBI conceptualizations were subjected to qualitative analysis processes to understand the nature of the interaction among PCK components representing the pedagogical constructions of preschool teachers for science teaching. First, the CoRe and IBI conceptualizations of each participant were made into a single format and divided into teaching episodes. These episodes represent a unit of analysis (Fraenkel et al., 2012). Thus, *in-depth analysis of explicit PCK, enumerative approach and analysis of PCK mapping* were performed to describe and compare the pedagogical constructions of the participants for science teaching through PCK maps.

The *in-depth analysis of explicit PCK* was performed to determine which PCK components interacted with each other within each teaching episode (Park, 2019). At this stage, the PCK interaction categories rubric developed by Aydın et al. (2015) was considered. For instance, the fact that the structure of teaching activities is associated with curriculum units in the unit of analysis (teaching episode) analyzed indicates the KISR-KSC interaction. Thus, it was attempted to capture dyad interactions among PCK components within each analysis unit. After an in-depth analysis, the enumerative approach was used to quantitatively describe the interactions among teachers' PCK components (Suh & Park, 2017). The function of this approach is to digitize verbal data to clearly capture the patterns emerging from coding schemes (Creswell & Miller, 2000). Thus, it was assumed that all connections had the same strength, and all identified connections were given 1 point. Then, PCK mapping analysis was performed using the pentagon model proposed by Park and Oliver (2008) as an analytical tool. Pictorial representations (PCK maps) showing the integration among PCK components of each teacher were created by reflecting the number of connections reached through the enumerative approach on PCK maps. Such a process was used by various researchers to reveal interconnected parts of PCK (e.g., Aydın et al., 2015; Nacar & Kutluca, 2020).

Finally, the constant comparative method (Glaser & Strauss, 2017) was used to determine how teachers' interactions between PCK components for early science teaching changed according to their professional experiences. The open codes were categorized, according to their similarities and differences, and the relationships across them were examined in-depth. Here, it is aimed to distinguish conceptual similarities, to develop the distinctive power of themes and to explore the patterns (Boeije, 2002). In this way, the results from the other methods were compared with and integrated into results from the enumerative approach and PCK mapping to provide methodological triangulation.

During the analysis processes, the written responses of one preschool teacher each were sent to an expert researcher and subjected to a separate evaluation process (Sarah, IBI responses). Here, the expert actively participated in all of analysis processes. First, the related researcher was met, and the framework of each analysis step was negotiated and then evaluated separately. The expert conducted data analysis independently on the based on the established analysis framework. Then, the analysis results were compared and the intercoder reliability percentage (%94) was obtained (Miles & Huberman, 1994). The formula for determining the number of consensus and disagreement and calculating the reliability is as follows:

$$\text{Compliance Percentage} = \frac{\text{Consensus}}{\text{Consensus} + \text{Disagreement}} \times 100$$

The remaining forms were analysed individually based on the defined criteria, and the results obtained by the analyses were evaluated together with the same expert to ensure external control.

FINDINGS

In this section, numbers of teaching episodes and dyad connections among components were identified for each teacher firstly were presented (Table 3). Then, the findings regarding the sub-problems were included.

Table 3
Teaching Episodes and Connections

Teacher	Episodes	Dyad connections among components
Sarah	27	97
Nancy	26	90
Jessica	29	86
Karen	29	85
Maria	31	78
Bonny	28	68
Total	167	504

According to the results presented in Table 3, the quantitative reflections of the pedagogical constructions of the preschool teachers who participated in the study from the planning stage to the end stage of the yoghurt-making activity were close to each other. For instance, Sarah, one of the inexperienced teachers, associated dyad PCK components with each other for 97 times in 27 sessions while structuring and carrying out her teaching. On the other hand, Bonny, the most experienced of the group, associated different dyad PCK components to a more limited extent in 28 teaching sessions. PCK maps were created by determining the percentage of dyad connections among PCK components in order to make a more rational interpretation. Thus, it was attempted to explain more clearly how professional experience affected the quality of the interaction among PCK components for science teaching.

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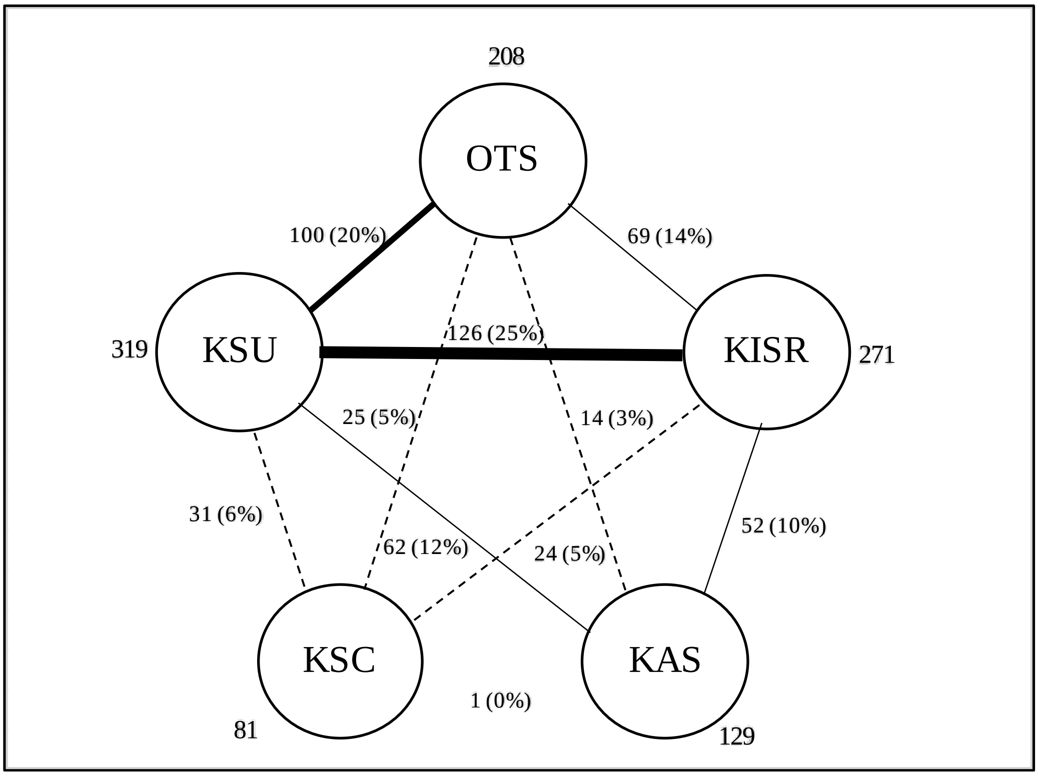
General Nature of the Interaction among PCK Components in Early Science Teaching

The first problem discussed in this study it was determine how pre-school teachers with different experiences who performed science teaching based on yoghurt-making activity integrated PCK components. In this context, all CoRe and IBI responses of six participants were combined and a single PCK map representing the group's PCK interaction for science teaching was created in order to resort to analytic generalization (Figure 1). Furthermore, the rates of interaction of preschool teachers' PCK components with other components were also presented.



OTS	208/1008 (21%)
KSU	319/1008 (32%)
KSC	81/1008 (8%)
KISR	271/1008 (27%)
KAS	129/1008 (12%)

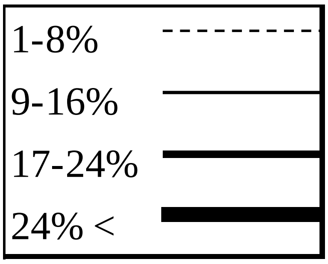


Figure 1. General Interaction among PCK Components

According to the PCK Map in Figure 1 which reflects the teacher knowledge of preschool teachers for science teaching, the strongest dyad interaction between was between KSU-KISR (25%). This result indicates that preschool teachers determined the teaching procedures and strategies they preferred while planning and implementing science teaching by taking into account the possible prior knowledge, experience and learning difficulties of children.

> ***Sarah:*** *While performing this activity, the fact that it has already been tried with children is important for the efficiency of the activity. Thus, considering children's misconceptions and using new ideas from children in the right place increase the quality of their readiness.*

> ***Nancy:*** *The fact that they bought yoghurt only from the market previously. The sweeter taste of ready-made yoghurts and their thick consistency may lead to prejudices. I also apply the question-answer technique with thought-provoking questions by taking this into consideration while performing my activity.*

For instance, Sarah indicated that children's experiences and misconceptions may affect the teaching activity. Therefore, she considered children's readiness and experiential characteristics while determining the strategy. On the other hand, Nancy considered that the differences between ready-made yoghurts and homemade yoghurts would create a dilemma for children and stated that she could overcome this situation with qualified questions by using the question-and-answer technique. The second strongest dyad connection in the PCK map was between OTS-KSU (20%).

> ***Bonny:*** *To establish a foundation for preparation to primary school. The fact that they make sense of how milk is formed, where it comes from, what yeast is and the fermentation process. I aim that they would learn beneficial bacteria, and the benefits of yoghurt to the human body, and would make sense of probiotic, calcium vitamins.*

> ***Karen:*** *An activity suitable for children's age levels, developmental characteristics and readiness will enable them to both make better sense of it and to associate it with the geography where they live, and the values.*

In sample quotations based on the OTS-KSU relationship, Bonny stated that the main purpose in science teaching was preparation for primary school, and she took into account the formation of certain prior knowledge and experiences. On the other hand, Karen considered that children's developmental characteristics and readiness levels would be effective in providing them with certain values and knowledge structures. These preschool teachers asked many questions to the children during their teaching and ensured the active participation of the children through child-centred orientations, which may indicate that they attempted to establish a bridge between learning-teaching purposes and children's cognition (Observations & Field Notes). The frequency of OTS-KISR (14%) interaction in the PCK map may confirm it. It can be considered that the OTS-KISR interaction was also relatively strong, although it was not as frequent as the aforementioned dyad connections, which indicated that preschool teachers tended to determine and implement their teaching strategies by taking into account certain goals and objectives.

> ***Nancy:*** *Experiments are important because the aim of science teaching in the preschool period is not to show and transfer the information to the child, but the child's learning effectively by doing and experiencing events related to science and nature.*

> ***Jessica:*** *I also thought that they would be more interested and permanent learning would be achieved since it was a practical activity.*

As it was stated previously, it was revealed that Nancy and Jessica had a child-centred practice mind and determined and implemented their teaching strategies in accordance with this purpose, that strengthened the dyad connections between OTS and KISR. On the other hand, it can be said that the dyad connections between KSU-KAS (12%) and KISR-KAS (10%) were relatively strong. This result shows that preschool teachers also attached importance to assessment and evaluation processes within the framework of science teaching and reflected it on children's conceptual structures and teaching strategies.

> ***Sarah:*** *I generally use the observation method and the notes I took during parents' meetings to understand whether there are misconceptions in science and nature activities. Because I think children should be able to reflect it in their daily life in order to be able to say that they have been introduced to science and nature activities.*

> ***Bonny:*** *We apply the activity we prepared in this video with the children and I ask questions. Sometimes I answer the questions I ask myself because there are also some concepts they do not know. I observe how they think and attempt to see what they have included from everyday life.*

When the teaching episodes given above were evaluated by considering the observation and field notes, it was determined that Sarah carried out science and nature activities with the help of hands-on activities and used observation and parent interviews to determine children's misconceptions and explore child cognition. On the other hand, Bonny argued that she carried out practice-oriented teaching while presenting pedagogical lenses for her own teaching, stayed connected to children's daily experiences, and used the questions both as a teaching technique and as an assessment and evaluation tool. Therefore, both teachers' explanations and observation notes showed that they integrated assessment and evaluation into the procedural structure of child cognition and teaching activities.

The weakest dyad connections in Figure 1 are between the KSC-KAS (0%) and KSC-KISR (3%) components, respectively. This result indicates that the preschool teachers who participated in the study formed a resistance point in associating curriculum materials and achievements with other PCK components and including them in teaching. Furthermore, when the observations and field notes were reconsidered, it was observed that the participants had deficiencies in integrating the curriculum with teaching strategies and assessment-evaluation approaches. Another remarkable result was that preschool teachers mentioned the KSC-KAS interaction only once during the teaching sessions.

In brief, PCK components that mostly interacted with other components were KSU (32%), KISR (27%) and OTS (21%), respectively. Furthermore, these components were involved in a strong interaction with each other. This result showed that preschool teachers used their epistemological and pedagogical orientations representing child cognition, experiences and possible misconceptions, teaching procedures and strategies, and goals and objectives while planning and implementing science teaching. PCK components with the least interaction with other components were KSC (8%) and KAS (12%), respectively. This result revealed that preschool teachers had deficiencies in associating science teaching practices with curriculum and assessment-evaluation components.

Change of the Interaction among PCK Components

The results obtained after the analyses performed to determine the change in the interaction among PCK components for early science teaching of the preschool teachers who participated in the study according to professional experience were compared specifically to each teacher by the idiosyncratic nature of PCK (Cooper et al., 2015). It has been paired comparisons were made by creating the PCK Map of each teacher. In this way, the nature and changes of interactions among PCK components were evaluated with through PCK maps of teachers.

Sarah and Nancy

The two teachers of the participant group with the least professional experience were Sarah and Nancy. While one of the participants, who had four and seven years of professional experience, was a teacher in a public school, the other was a teacher in a private school, respectively. The PCK maps created based on the teaching episodes of this participants are presented in Figure 2.

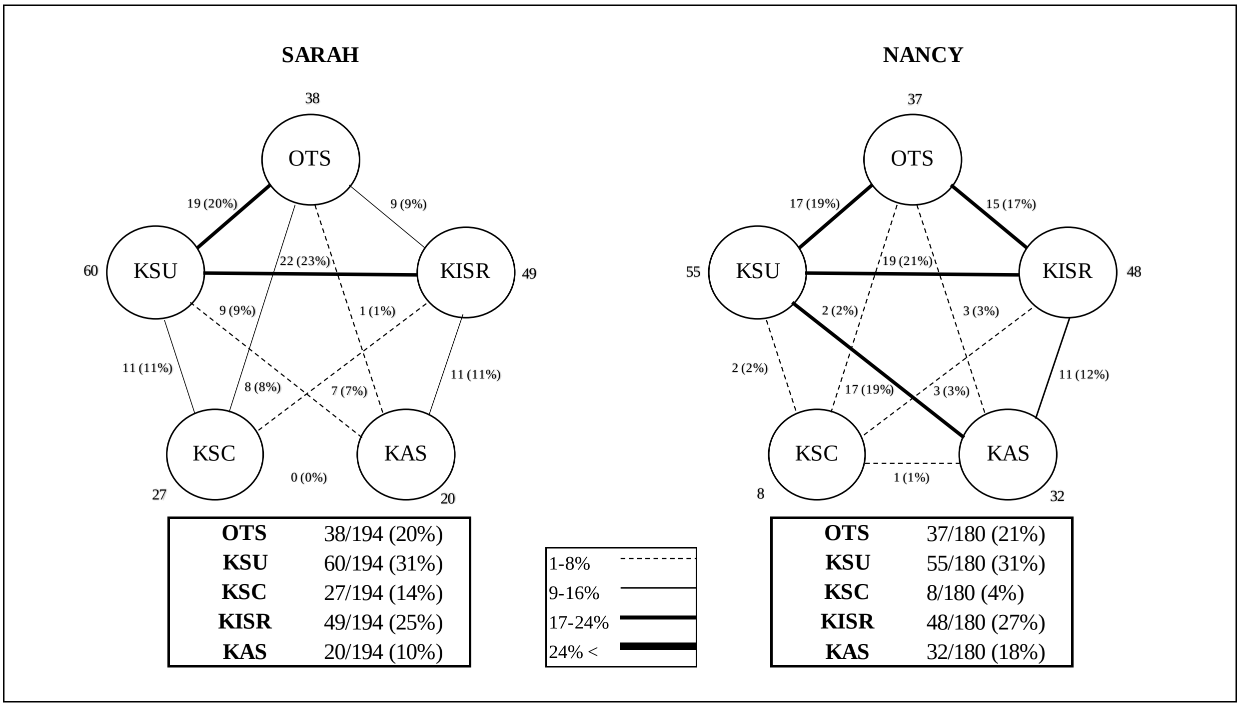


Figure 2. Sarah and Nancy's PCK Maps

When Sarah's PCK map was examined, the strongest interactions were between the KSU-KISR (23%) and OTS-KSU (20%) components, respectively. Furthermore, it can also be said that the dyad connections between KSU-KSC (11%) and KISR-KAS (11%) were relatively strong. When the individual percentages of Sarah's PCK components were examined, the components that mostly interacted with other components were KSU (31%), KISR (25%) and OTS (20%), respectively. When these results were evaluated by considering the observations and field notes, it was observed that Sarah especially centralized the child cognition and understandings and teaching strategies while planning and implementing the yoghurt-making activity. Sarah associated the KSU and KISR components both with each other and with other components throughout science teaching. Finally, it was determined that there was no connection between KSC-KAS (0%) in Sarah's PCK map.

When Nancy's PCK map in Figure 2 was evaluated, the strongest interactions were between the components of KSU-KISR (21%), KSU-OTS (19%), KSU-KAS (19%) and OTS-KISR (17%), respectively. Furthermore, it can be said that the dyad connection between KISR-KAS (12%) was relatively strong. Nancy attempted to associate all PCK components while planning and implementing science teaching, however, there were weak interactions between other components except for the aforementioned dyad connections. When the strength of the specified dyad interactions and the observation and field notes were considered together, it was revealed that Nancy centralized the child cognition and understandings and teaching strategies, like Sarah. However, unlike Sarah, Nancy both had a more balanced PCK map and tended to use assessment and evaluation processes more consciously. Furthermore, according to the observation notes, Nancy's motivation for science teaching and its quality were higher, and the opportunities she offered to involve children in teaching were more varied. On the other hand, the PCK component that Nancy interacted least with other components was KSC (4%). This result indicated that Nancy could not associate the preschool education curriculum with science teaching processes.

In conclusion, PCK components centralized by Sarah and Nancy based on the yoghurt-making activity were the same although they had different professional experiences. The elements that distinguish these two preschool teachers from each other are the integrity of the PCK Map, the consideration of the curriculum materials, and the quality of teaching.

Jessica and Karen

Jessica and Karen working as teachers in a public school had 11 and 13 years of professional experience, respectively. Within the context of science teaching, these two participants with close professional experiences were not much different in theory and practice from the other two other teachers who were less experienced than them (Sarah and Nancy). As a result of in-depth analysis, the number of teaching episodes and dyad connection were also similar (Figure 3).

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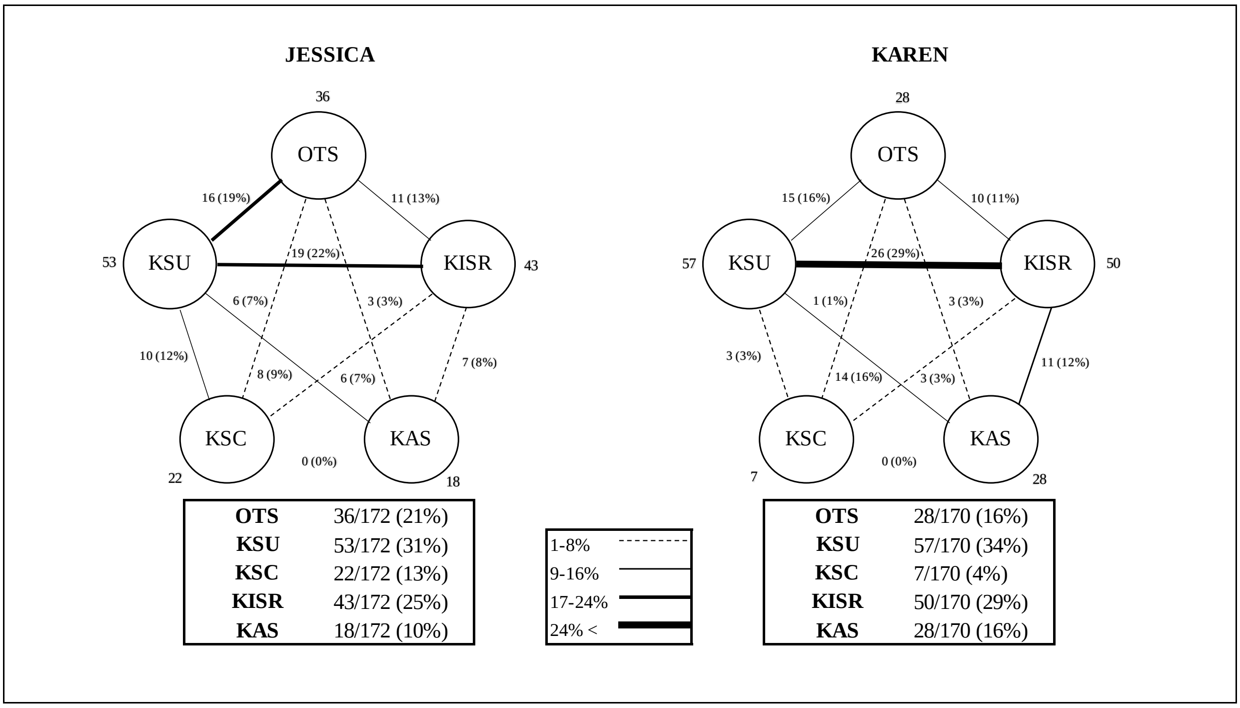

Figure 3. Jessica and Karen's PCK Maps

When Jessica's PCK map was evaluated, it was determined that she established strong connections between the KSU-KISR (22%) and OTS-KSU (19%) components. Furthermore, it can be said that the interactions between the OTS-KISR (13%) KSU-KSC (12%) and KSU-KAS (9%) components were strong. Accordingly, Jessica specifically centralized the KSU (31%) component and associated it with other components, which indicated that she mostly considered child cognition and possible misconceptions based on science teaching. Another PCK component on which Jessica focused while planning and implementing science teaching was KISR (25%). Jessica considered children's prior knowledge, experience and possible misconceptions about yoghurt-making activity and tended to determine her procedural approach accordingly. The fact that she structured her practices to ensure the active participation of children indicated that she had a child-centred pedagogical belief in terms of epistemological and pedagogical orientations, which is confirmed by her emphasis on the OTS (21%) component. Finally, although the connection between KSC (13%) and KAS (10%) components with other components was low, it can be said to have a slightly more balanced structure. However, these two components were not interconnected.

When Karen's PCK map was examined, there was a very strong connection between KSU-KISR (29%). This result indicated that she mainly integrated child cognition and instructional strategies while planning and implementing science teaching. Furthermore, Karen established the strong interactions of KSU (29%) and KISR (34%) components with other components, which revealed that Karen centralized children's understanding and teaching strategies specifically for science teaching. It can be said that the interactions between the KSU-OTS (16%), KSU-KAS (16%), KISR-KAS (12%) and OTS-KISR (11%) components were also relatively strong. While KSC (4%) was the component with the least interaction with other components, it had no connection with KSC-KAS (0%). This result showed that Karen was insufficient in making the curriculum materials specific to science teaching and associating them with other components.

In conclusion, like Sarah and Nancy, Jessica and Karen could not discuss science teaching holistically within the context of their pedagogical constructions although they were more experienced teachers. They tended to structure their science teaching by centralizing the KSU and KISR components. However, the interactions in Jessica's PCK map were more balanced.

Maria and Bonny

Maria and Bonny, who were the most experienced teachers of the participant group, associated all components with each other except for KSC-KAS (0%). Furthermore, they were insufficient in terms of KSC (6%). Therefore, it can be considered that the PCK maps of the two participants were similar in this respect (Figure 4). The strong interaction between KSU-KISR (31%) components in Maria's PCK map was remarkable. The PCK components that mostly interacted with other components were KSU (33%) and KISR (29%). This result indicated that Maria placed child cognition, understandings, possible misconceptions, and teaching procedures and strategies at the focus of yoghurt-making activity. Furthermore, it can also be said that OTS-KSU (18%), OTS-KISR (15%) and KSU-KAS (14%) interacted strongly with each other. Considering her observations and field notes, it was determined that Maria performed science teaching on the based on epistemological orientations based on values education and science literacy vision, which confirmed the effectiveness of OTS (19%) in Maria's PCK map. KSC (6%) was the component that Maria established the least interaction with other components in the PCK map, which revealed that he had difficulties in terms of the curriculum.

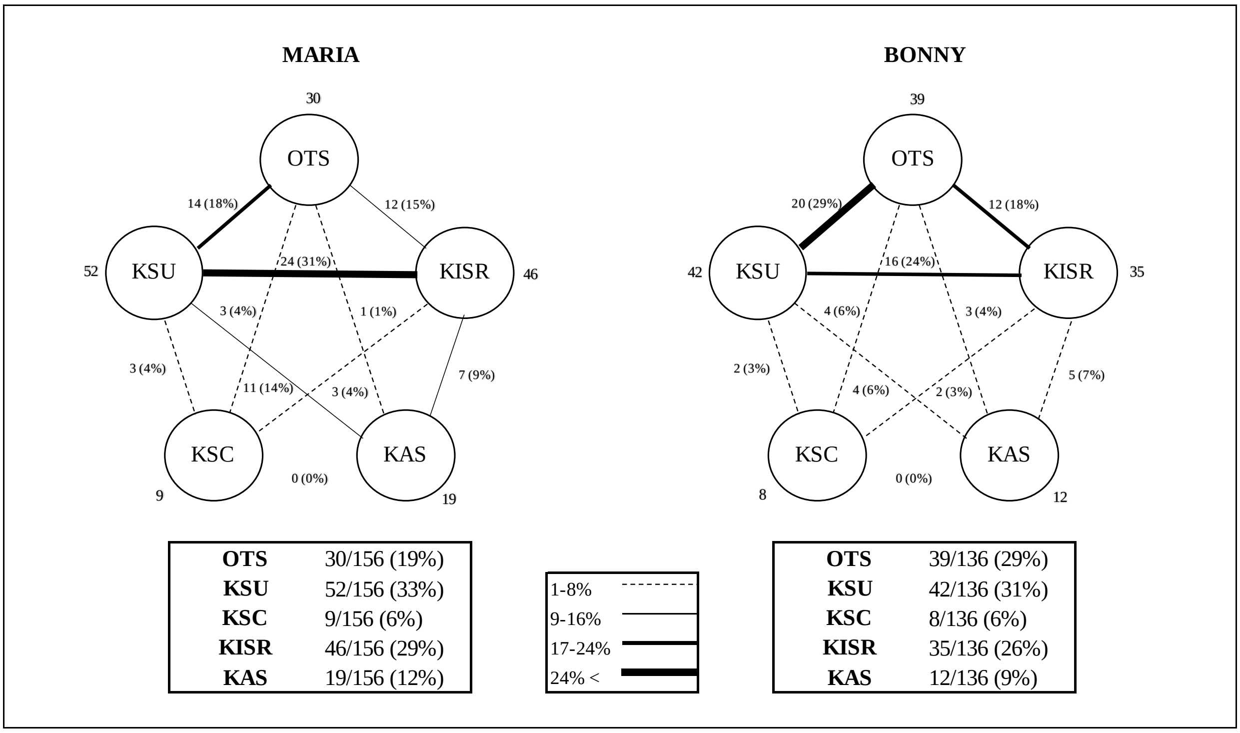

Figure 4. Maria and Bonny's PCK Maps

Finally, when Bonny's PCK map was examined, it was found that there were strong connections between the KSU-OTS (29%), KSU-KISR (24%) and OTS-KISR (18%) components. Bonny tended to integrate children's cognitive characteristics and instructional purposes while planning and implementing the yoghurt-making activity, which supports the background of the strong connection she established between KSU and OTS. On the other hand, she mostly included the question-answer technique in her teaching as an instructional activity, which demonstrates that she has a child-centred epistemology and integrated her epistemology with her teaching. Therefore, the OTS-KISR interaction itself had had a strong connection. KSU (31%), OTS (29%) and KISR (26%) were the PCK components that mostly interacted with other components. These components formed a strong triple chain among themselves. The interactions among other PCK components were very weak. Therefore, it was observed that Bonny's PCK map had a unique nature compared to other participants.

DISCUSSION AND CONCLUSION

In this study, the nature and change of the interactions among PCK components of preschool teachers with different experiences for science teaching based on the yoghurt-making activity were investigated. Two different perspectives were adopted for the changes shown through PCK Mapping, which is a pictorial methodology approach. First, a single PCK map representing the pedagogical construction of the group was created by combining the teaching episodes obtained from the analysis of the CoRe and IBI responses of all participants. Thus, the common nature of the pedagogical constructions that preschool teachers considered while planning and implementing science teaching was evaluated. Second, each teacher's PCK maps were interpreted using paired comparison. In this way, it was revealed how professional experience affected the interaction of PCK components. The conclusions reached were discussed in detail based on the existing literature.

The strongest interaction in the general PCK map reflecting the general nature of pedagogical constructions for early science teaching and the interactions among PCK components was between the KSU-KISR components. This result indicated that preschool teachers established a strong bridge between child cognition, understanding and possible misconceptions and instructional strategies while planning and implementing science teaching (Klahr & Ohman, 2014). Gustavsson and Pramling (2014) stated that children used their natural curiosity to make sense of any phenomenon. Accordingly, preschool teachers should consider this developmental potential while planning and implementing science teaching and determine their instructional strategies within this framework (Olgan, 2015). On the other hand, the participant group established a strong connection between the OTS-KSU components. Accordingly, it was revealed that preschool teachers attached importance to goals and objectives on the based on science teaching and mostly tended to associate it with children's understanding (Fleer, 2009). Furthermore, relatively strong connections were found between the OTS-KISR components. The participants tended to integrate science activities with interactive questions and science literacy goals. Thulin (2011) argued that answering the questions asked by children during science education with opposite questions was an orientation suitable for constructivist epistemology. It can be said that the participant group acted in accordance with this rationale.

In brief, preschool teachers used *children's cognitive potentials, teaching strategies* and *epistemological and pedagogical orientations* while planning and implementing science teaching, and they frequently associated them (Hammer & He, 2016; Pierro, 2019; Pramling

& Samuelsson, 2018). This result is consistent with the instructional objectives suggested by Andersson and Gullberg (2014). Therefore, it is important to pay attention to the conceptual understanding of children, to ask qualified questions, to encourage their active participation and to focus on scientific process skills in a qualified science teaching (Andersson & Gullberg, 2014). According to another result, preschool teachers had difficulty in integrating curriculum materials into science teaching. Furthermore, they could not properly integrate the curriculum component with other components, which emerged independently from experience. Davis et al. (2014) suggested that a curriculum with a clearly defined pedagogy could be helpful in teaching, however, teachers should also integrate other pedagogical tools into the curriculum to achieve it. Therefore, it was an important deficiency that preschool teachers in this study could not combine the content within the context of science teaching with appropriate pedagogical tools and curriculum materials (Neuman & Danielson, 2021).

It was determined that preschool teachers also had difficulties in terms of assessment and evaluation while planning and implementing yoghurt-making activity. This result confirms the results achieved in many studies in the literature (e.g. Brenneman, 2011; Kaderavek et al., 2015). However, regardless of their experiences, the participants mainly associated the assessment and evaluation component with student understanding or teaching strategies. With regard to this result, Loughran et al. (2004) argued that teachers focused on either their procedural approach or student understanding when talking about their teaching, regardless of their professional experience.

In conclusion, when both general and individual PCK maps were evaluated together, it was confirmed once again that PCK was a teacher-specific knowledge (Neumann et al., 2019; Park & Suh, 2015). In this study, the interaction among PCK components differed from teacher to teacher.

Implications

In this study, the pedagogical constructions of preschool teachers who planned and implemented a yoghurt-making activity for science teaching were evaluated through PCK maps. The results showed that preschool teachers focused on *children's understanding, goals and objectives, and instructional strategies* specific to science teaching. However, it differed from teacher to teacher. Therefore, there is a need for studies investigating how each of the mentioned PCK components contributes to early science teaching. On the other hand, teachers were insufficient to associate the curriculum and assessment and evaluation tools with science teaching and other PCK components. It may be recommended to encourage preschool teachers to participate in in-service training programs in order to overcome this deficiency. Furthermore, this research area is both new and has a great potential for early science teaching. Therefore, conducting similar studies in different subject contexts will contribute to the literature.

REFERENCES

Abell, S. K. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea?. *International Journal of Science Education*, *30*(10), 1405-1416. https://doi.org/10.1080/09500690802187041

Akerson, V. L. (2019). Teaching and learning science in early childhood care and education. In Brown, C. P., McMullen, M. B., & File, N. (Eds.), *The Wiley handbook of early childhood care and education* (pp. 355-375). John Wiley & Sons.

Akşam, E. & Kutluca, A. Y. (2021). Exploring the theoretical and practical nature of preschool teachers' science teaching practices. *Journal of Uludag University Faculty of Education, 34*(1), 386-435. https://doi.org/10.19171/uefad.867333

Andersson, K., & Gullberg, A. (2014). What is science in preschool and what do teachers have to know to empower children?. *Cultural studies of science education*, *9*(2), 275-296. https://doi.org/10.1007/s11422-012-9439-6

Aydin, S., Demirdogen, B., Akin, F. N., Uzuntiryaki-Kondakci, E., & Tarkin, A. (2015). The nature and development of interaction among components of pedagogical content knowledge in practicum. *Teaching and teacher education*, *46*, 37-50. https://doi.org/10.1016/j.tate.2014.10.008

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), 544-559.

Berliner, D. C. (2001). Learning about and learning from expert teachers. *International Journal of Educational Research*, *35*(5), 463-482. https://doi.org/10.1016/S0883-0355(02)00004-6

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and quantity*, *36*(4), 391-409. https://doi.org/10.1023/A:1020909529486

Brenneman, K. (2011). Assessment for Preschool Science Learning and Learning Environments. *Early Childhood Research & Practice*, *13*(1), 11-21.

Broström, S. (2015). Science in early childhood education. *Journal of education and human development*, *4*(2), 107-124. http://dx.doi.org/10.15640/jehd.v4n2_1a12

Bryne, M. (2001). Data analysis strategies for qualitative research. (Research Corner). *AORN journal*, *74*(6), 904-906.

Cooper, R., Loughran, J., & Berry, A. (2015). Science teachers' PCK. *Berry, A., Friedrichsen, P. & Loughran, J., Re-examining Pedagogical Content Knowledge in Science Education*, 60-74.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice*, *39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Croninger, R. G., Valli, L., & Chambliss, M. J. (2012). Researching quality in teaching: Enduring and emerging challenges. *Teachers College Record*, *114*(4), 1-15.

Davies, D., & Howe, A. (2003). *Teaching Science and Design & Technology in the Early Years*. David Fulton.

Davis, E., Palincsar, A. S., Arias, A. M., Bismack, A. S., Marulis, L., & Iwashyna, S. (2014). Designing educative curriculum materials: A theoretically and empirically driven process. *Harvard Educational Review*, *84*(1), 24-52. https://doi.org/10.17763/haer.84.1.g48488u230616264

Early, D. M., Iruka, I. U., Ritchie, S., Barbarin, O. A., Winn, D. M. C., Crawford, G. M., ... & Pianta, R. C. (2010). How do pre-kindergarteners spend their time? Gender, ethnicity, and income as predictors of experiences in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, *25*(2), 177-193. https://doi.org/10.1016/j.ecresq.2009.10.003

Fleer, M. (2009). Supporting scientific conceptual consciousness or learning in 'a roundabout way'in play-based contexts. *International Journal of Science Education*, *31*(8), 1069-1089. https://doi.org/10.1080/09500690801953161

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). Internal validity. *How to design and evaluate research in education*. McGraw-Hill.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK. *Re-examining pedagogical content knowledge in science education*, *41*(7), 28-42.

Glaser, B. G., & Strauss, A. L. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

Greenfield, D. B., Alexander, A., & Frechette, E. (2017). Unleashing the power of science in early childhood: A foundation for high-quality interactions and learning. *Zero to Three*, *37*(5), 13-21.

Gustavsson, L., & Pramling, N. (2014). The educational nature of different ways teachers communicate with children about natural phenomena. *International Journal of Early Years Education*, *22*(1), 59-72. https://doi.org/10.1080/09669760.2013.809656

Hammer, A. S. E., & He, M. (2016). Preschool teachers' approaches to science: a comparison of a Chinese and a Norwegian kindergarten. *European Early Childhood Education Research Journal*, *24*(3), 450-464. https://doi.org/10.1080/1350293X.2014.970850

Heikka, J., & Suhonen, K. (2019). Distributed pedagogical leadership functions in early childhood education settings in Finland. *Southeast Asia Early Childhood Journal*, *8*(2), 43-56. https://doi.org/10.37134/saecj.vol8.no2.4.2019

Kaderavek, J. N., North, T., Rotshtein, R., Dao, H., Liber, N., Milewski, G., ... & Czerniak, C. M. (2015). SCIIENCE: The creation and pilot implementation of an NGSS-based instrument to evaluate early childhood science teaching. *Studies in Educational Evaluation*, *45*, 27-36. https://doi.org/10.1016/j.stueduc.2015.03.003

Kahila, S. K., Heikka, J., & Sajaniemi, N. (2020). Teacher leadership in the context of early childhood education: Concepts, characteristics and enactment. *Southeast Asia Early Childhood Journal*, *9*(1), 28-43.

Kermani, H., & Aldemir, J. (2015). Preparing children for success: integrating science, math, and technology in early childhood classroom. *Early Child Development and Care*, *185*(9), 1504-1527. https://doi.org/10.1080/03004430.2015.1007371

Kind, V. (2009). Pedagogical content knowledge in science education: perspectives and potential for progress. *Studies in science education*, *45*(2), 169-204. https://doi.org/10.1080/03057260903142285

Klahr, S., & Ohman, J. (2014). Doing, knowing, caring and feeling: Exploring relations between nature-oriented teaching and preschool children's learning. *International Journal of Early Years Education*, *22*(1), 37–58. https://doi.org/10.1080/09669760.2013.809655

Kutluca, A. Y. & Nacar, S. (2021). Exploring preschool teachers' pedagogical content knowledge: The effect of professional experience. *Journal of Science Learning, 4*(2), 160-172.

Larimore, R. A. (2020). Preschool science education: A vision for the future. *Early Childhood Education Journal*, *48*, 703–714. https://doi.org/10.1007/s10643-020-01033-9

Lee, E., & Luft, J. A. (2008). Experienced secondary science teachers' representation of pedagogical content knowledge. *International Journal of Science Education, 30*(10), 1343-1363. https://doi.org/10.1080/09500690802187058

Leuchter, M., Saalbach, H., Studhalter, U., & Tettenborn, A. (2020). Teaching for conceptual change in preschool science: relations among teachers' professional beliefs, knowledge, and instructional practice. *International Journal of Science Education*, *42*(12), 1941-1967. https://doi.org/10.1080/09500693.2020.1805137

Li, F., & Boon, N. S. (2021). A case study of professional growth of cross-disciplinary preschool education master students. *Southeast Asia Early Childhood Journal*, *10*, 25-39. https://doi.org/10.37134/saecj.vol10.sp.3.2021

Loughran, J., Mulhall, P., & Berry, A. (2004). In search of pedagogical content knowledge in science: Developing ways of articulating and documenting professional practice. *Journal of Research in Science Teaching, 41*(4), 370-391. https://doi.org/10.1002/tea.20007

Loughran, J., Mulhall, P., & Berry, A. (2008). Exploring pedagogical content knowledge in science teacher education. *International Journal of Science Education*, *30*(10), 1301-1320. https://doi.org/10.1080/09500690802187009

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In *Examining pedagogical content knowledge* (pp. 95-132). Springer, Dordrecht.

Martin, S. P. (2006). Trends in marital dissolution by women's education in the United States. *Demographic research, 15*, 537-560. https://doi.org/10.4054/DemRes.2006.15.20

McMillan, J. H., & Schumacher, S. (2010). Research in Education: Evidence-Based Inquiry, MyEducationLab Series. *Pearson*.

Meijer, P. C., Verloop, N., & Beijaard, D. (2002). Multi-method triangulation in a qualitative study on teachers' practical knowledge: An attempt to increase internal validity. *Quality and quantity*, *36*(2), 145-167. https://doi.org/10.1023/A:1014984232147

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. SAGE.

Morse, J. M. (2015). Critical analysis of strategies for determining rigor in qualitative inquiry. *Qualitative Health Research*, *25*(9), 1212-1222. https://doi.org/10.1177/1049732315588501

Nacar, S., & Kutluca, A. Y. (2020). Exploration of the pedagogical content knowledge of a preschool teacher on science teaching. *Mersin University Journal of the Faculty of Education, 16*(3), 529-545. https://doi.org/10.17860/mersinefd.727664

Neuman, S. B., & Danielson, K. (2021). Enacting content-rich curriculum in early childhood: The role of teacher knowledge and pedagogy. *Early Education and Development, 32*(3), 443-458. https://doi.org/10.1080/10409289.2020.1753463

Neumann, K., Kind, V., & Harms, U. (2019). Probing the amalgam: the relationship between science teachers' content, pedagogical and pedagogical content knowledge. *International Journal of Science Education, 41*(7), 847-861. https://doi.org/10.1080/09500693.2018.1497217

Nilsson, P., & Elm, A. (2017). Capturing and developing early childhood teachers' science pedagogical content knowledge through CoRes. *Journal of Science Teacher Education*, *28*(5), 406-424. https://doi.org/10.1080/1046560X.2017.1347980

Nilsson, P., & Loughran, J. (2012). Exploring the development of pre-service science elementary teachers' pedagogical content knowledge. *Journal of Science Teacher Education*, *23*(7), 699-721. https://doi.org/10.1007/s10972-011-9239-y

Olgan, R. (2015). Influences on Turkish early childhood teachers' science teaching practices and the science content covered in the early years. *Early Child Development and Care*, *185*(6), 926-942. https://doi.org/10.1080/03004430.2014.967689

Park, S. (2019). Reconciliation between the refined consensus model of PCK and extant PCK models for advancing PCK research in science. In *Repositioning pedagogical content knowledge in teachers' knowledge for teaching science* (pp. 117-128). Springer, Singapore.

Park, S., & Chen, Y. C. (2012). Mapping out the integration of the components of pedagogical content knowledge (PCK): Examples from high school biology classrooms. *Journal of research in science teaching*, *49*(7), 922-941. https://doi.org/10.1002/tea.21022

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in science Education*, *38*(3), 261-284. https://doi.org/10.1007/s11165-007-9049-6

Park, S., & Suh, J. (2015). From portraying toward assessing PCK. *Re-examining pedagogical content knowledge in science education*, 104-119.

Pierro, R. C. (2019). *What leads to effective science-teaching practices in preschool classrooms? An examination of teachers' person, context, and time influences on science teaching* [Unpublished doctoral dissertation]. The University of North Carolina.

Pramling, N., & Samuelsson, I. P. (2018). Pedagogies in early childhood education. In *International Handbook of Early Childhood Education* (pp. 1311-1322). Springer, Dordrecht.

Saçkes, M., Trundle, K. C., Bell, R. L., & O'Connell, A. A. (2011). The influence of early science experience in kindergarten on children's immediate and later science achievement: Evidence from the early childhood longitudinal study. *Journal of Research in Science Teaching*, *48*(2), 217-235. https://doi.org/10.1002/tea.20395

Seefeldt, C., Galper, A., & Jones, I. (2007). *Active experiences for active children: Science*. Pearson/Merill Prentice Hall.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review*, *57*(1), 1-23. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Suh, J. K., & Park, S. (2017). Exploring the relationship between pedagogical content knowledge (PCK) and sustainability of an innovative science teaching approach. *Teaching and Teacher Education*, *64*, 246-259. https://doi.org/10.1016/j.tate.2017.01.021

Thulin, S., & Helldén, G. (2011). Opening doors for learning ecology in preschool. In *Educational encounters: Nordic studies in early childhood didactics* (pp. 65-84). Springer, Dordrecht.

Toyama, N. (2016). Preschool teachers' explanations for hygiene habits and young children's biological awareness of contamination. *Early Education and Development*, *27*(1), 38-53. https://doi.org/10.1080/10409289.2015.1036347

Trundle, K. C. (2015). The inclusion of science in early childhood classrooms. In *Research in early childhood science education* (pp. 1-6). Springer, Dordrecht.

Wu, D., Liao, T., Yang, W., & Li, H. (2020). Exploring the relationships between scientific epistemic beliefs, science teaching beliefs and science-specific PCK among pre-service kindergarten teachers in China. *Early Education and Development*, *32*(1), 82-97. https://doi.org/10.1080/10409289.2020.1771971

Appendix-1. Instruction Based Interviews (IBI)

Background Interview Questions

1. What are the strengths of your teaching?
2. Which areas in your teaching do you think are relatively weak?
3. What is your goal for early childhood science teaching?
4. What was your purpose in teaching this activity?
5. What do you think about the lessons you have taken for this teaching activity?
6. How many times have you taught this teaching activity before?

Pre-interview Questions

1. Could you briefly explain the lessons you took to carry out this teaching activity?
2. What did you consider when planning this teaching?
3. What are the most important concepts (ideas) that children should understand while the learning of this subject? Why is that? Please justify your answer.
4. What misconceptions or alternative opinions do you think children have about this topic?
    a. Were there any misconceptions/difficulties you spotted during your previous lectures on this teaching activity? *If yes, how did you respond to the misunderstanding/challenges? Did this work? Why do you think it works?*
    b. How did you realize that the children had misconceptions/challenges? *What assessment and evaluation approaches have you used to understand these challenges? Why is that?*
5. How do you determine if children understand this topic?
6. Have you made any changes in the lesson plan or within this lesson different from the lessons you have done before? *If so, what were these? Why is that?*
7. What criteria would you consider as proof of what they have learned as the children speak during the activity?
8. What kind of scientific language do you expect children to develop during the activities?

Post-interview Questions

1. Please briefly describe what you and children did in this video.
2. The goal of this practice is:
    a. What are children expected to do in this practice?
    b. Why did you think this practice was important for advancing children's learning?
3. What were you looking for as proof that the children understood the concepts in this practice? *Did the children you identified during this practice have any misconceptions/challenges?*
4. If you were to change it, how would you like to change this practice?