International Journal of Science Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tsed20

Young children's questions about science topics when situated in a natural outdoor environment: a qualitative study from kindergarten and primary school

Ingunn Skalstad & Eli Munkebye

To cite this article: Ingunn Skalstad & Eli Munkebye (2021): Young children's questions about science topics when situated in a natural outdoor environment: a qualitative study from kindergarten and primary school, International Journal of Science Education, DOI: 10.1080/09500693.2021.1895451

To link to this article: https://doi.org/10.1080/09500693.2021.1895451

Published online: 14 Mar 2021.

INTERNATIONAL JOURNAL OF SCIENCE EDUCATION
https://doi.org/10.1080/09500693.2021.1895451

Young children's questions about science topics when situated in a natural outdoor environment: a qualitative study from kindergarten and primary school

Ingunn Skalstad [a] and Eli Munkebye [b]

[a]Department of Mathematics and Science Education, University of South-Eastern Norway, Notodden, Norway; [b]Department of Teacher Education, Norwegian University of Science and Technology, Trondheim, Norway

ABSTRACT

Asking questions is an important way of acquiring information and knowledge and plays a significant role in a child's learning processes. In this study, we examine what characterises the questions asked by children to their teachers in two kindergartens (4–6-year-olds) and six primary school classes (2nd–4th grade) when situated in a natural outdoor environment. Recordings are undertaken by means of action cameras and audio recorders. We also examine the contexts in which the questions are asked. We found that whereas the preschool children's science topic questions mostly concerned subject matter (74–95%), the schoolchildren more often asked practical questions. Our findings indicate that providing the children with activities that open for the children's own explorations of a variety of nature elements seems to elicit subject matter questions in the children. We also found that children ask subject matter questions to gain factual information, as well as first-hand experiences about the object being studied, and that they ask few questions of higher cognitive levels. By providing answers to the children's basic information questions, this seems to elicit questions of higher cognitive levels. In all the question-asking settings, it is important that the teacher follows up on the children's explorations.

ARTICLE HISTORY
Received 11 March 2020
Accepted 22 February 2021

KEYWORDS
children's questions; kindergarten; primary school; science education; natural outdoor environment

Introduction

Children are naturally curious and explore and seek for information about everyday situations and about the natural world. The children's first-hand experiences provide them with information about how something feels or looks like, and to some extent, how things function or work. Fact-based knowledge like e.g. abstract concepts or some scientific phenomena, on the other hand, has to be provided by others in order to be fully understood (Bruner, 2009; Harris, 2012). Asking questions is therefore an important

CONTACT Ingunn Skalstad ingunn.skalstad@usn.no University of South-Eastern Norway, PO Box155, N-3672 Notodden, Norway

way of getting the information needed and seems to play a significant role in a child's learning processes.

The children's questions can be seen as expressions of an interest in, and wish of understanding more of a specific content or subject (Siraj-Blatchford & Macleod-Brudenell, 2003; Thulin, 2010) and can therefore, according to Thulin (2010), be important didactic starting points for building scientific knowledge in the children. At the same time, children's questions are not necessarily a result of an already existing interest, but can, according to Hartmeyer and Mygind (2016) instead *create* interest. When getting answers to their questions, the children are provided with new knowledge that in turn may raise interest.

Chin and Brown (2002) found that questions that are of a higher conceptual level (that is, questions that require reflection), seem to trigger the use of deep-thinking strategies and play an important role when it comes to engaging students' minds more actively. This involves generating discussion and a meaningful construction of knowledge.

Even if students' questions are seen as valuable resources when teaching science, studies from classrooms have shown that students ask few questions, and especially few at a higher cognitive level (Chin & Brown, 2002; Dillon, 1988; Scardamalia & Bereiter, 1992). Studies of preschool children, on the other hand, show that young children ask many questions to adults (Chouinard et al., 2007). The number of questions, including higher cognitive level questions, was even higher when the children and adults were observing live animals (Chouinard et al., 2007). It is also found that when preschool children were given both time and opportunity to examine a certain science content most of their questions addressed the content being studied (Thulin, 2010), whereas few questions were 'off-topic'.

These studies implicate that contexts where children are presented to both living and non-living objects might affect the number of questions asked by the children as well as the degree of questions of a higher cognitive level. Studies of preschool- and schoolchildren exploring in a *natural outdoor environment* show that children's findings of elements and objects like e.g. insects, plants, rocks or puddles, in the following called *nature elements,* seem to interest and engage the children (Skalstad, 2020; Waters & Maynard, 2010). Natural outdoor environment is here defined as an area outside the kindergarten or school's area that is largely unaffected by human intervention like e.g. a forest, river, or seashore-area. As children's questions may be expressions of an interest of a certain subject, one could assume that experiencing nature elements would elicit questions from the children. This assumption is in line with schoolteachers' (Mygind et al., 2019) and early childhood student-teachers' (Skarstein & Skarstein, 2020) experiences in outdoor settings. However, Fischer and Madsen (2002) observed that preschool children exploring material in or from a natural outdoor environment (e.g. insects in a tree stump, or the content of the forest floor), do not ask many questions, and that questions do not occur until a longer period of examining the material had passed. More knowledge is therefore needed about which contexts that facilitate children's question-asking about natural science topics. It is also important to examine if and how children's curiosity and question-asking can be maintained in school as well as in kindergarten. According to e.g. Engel (2011), by encouraging and guiding the children in their explorations in classroom settings, the adults can enhance curiosity and question-asking in the

children. As far as we can see, this is a field of research that has not been addressed as concerns natural outdoor environments.

With regards to this, the intention of this study is to identify what characterises the contexts where children in kindergarten and primary school ask questions to the teacher about natural science topics when situated in a natural outdoor environment. The research questions are:

(1) What characterises the children's questions about natural science topics asked to the teacher when situated in a natural outdoor environment?
(2) Which contexts facilitate children's questions about subject matter in a natural outdoor environment?

In the following, we will present previous research on children's questions, including categorisations of these. Next, we present the participants, study context and methods used for data collection and analysis. Results are then presented, and the findings are discussed.

Research on children's questions

Whereas several studies have addressed schoolchildren's question-asking in science classrooms (e.g. Aguiar et al., 2010; Chin & Brown, 2002; Dillon, 1988; Scardamalia & Bereiter, 1992), little research is conducted on preschool children's science-related questions (e.g. Hansson et al., 2014; Thulin, 2006; 2010). There is, however, some research on preschool children's questions in general (e.g. Chouinard et al., 2007; Frazier et al., 2009; Kurkul & Corriveau 2018). Some of these studies present various categorisations of the children's questions that are used as starting point for the categories that are developed and applied in our study. This research is therefore presented in the following.

Schoolchildren's science topic questions

In a study by Scardamalia and Bereiter (1992), 5th and 6th grade children's written questions about various science-related topics were divided into *basic information questions* and *wonderment questions*. Basic information questions involve questions that ask for information needed for orientation to a topic (more fact-based), whereas wonderment questions reflect e.g. curiosity, puzzlement or a knowledge-based wondering (Scardamalia & Bereiter, 1992). The results show that when a topic was less familiar to the children, their questions were mostly basic information questions, whereas when the topic was known to them, more of the questions were wonderment questions. This can be related to van Zee et al. (2001) who found that having familiarity with the subject matter facilitates children's question-asking in general.

Based on Scardamalia and Bereiter's (1992) categorisations, Chin and Brown (2002) categorised 8th grade children's questions during a small-group classroom discourse in chemistry into basic and wonderment questions. The basic information questions were further divided into *factual questions* (require only recall of information), and *procedural* questions (seek clarification about a given procedure). Chin and Brown (2002) found that 86% of the children's questions were basic information questions, while

14% were wonderment questions. Most of the children's questions (65%) were procedural. Chin and Brown (2002) also found that some children asked more wonderment questions than others, and that children that usually had a surface approach to learning were able to ask wonderment questions if they got enough time, and if they were encouraged to do so. Surface approach here means that the child is likely to memorise and reproduce facts, terms and procedures rather than focusing on understanding the meaning and relating e.g. new ideas to existing ideas (Chin & Brown, 2000). In addition, they found that questions on a higher conceptual level were occurring more frequently during problem-solving activities compared to teacher-directed activities and procedural tasks.

Preschool children's questions

When it comes to studies of younger children, Chouinard et al. (2007) have studied and analysed the extent and content of questions asked by children (age 1–5), to their parents/adults during everyday situations at home and when observing real animals and drawings and replicas of these in a zoo (age 2–4). The results show that the children ask more than 100 questions per hour per child at an average, and that most of the questions (71–78%) were seeking information (e.g. 'What's that?') while 29% of the questions were non-information-seeking (e.g.: 'Can I have an apple?'). The information-seeking questions were further divided into two categories: *Fact* and *explanation*. *Fact* includes questions that require information that does not contain a causal component. *Explanation* includes questions that require information that involves a causal relation between object and/or events. The results presented by Chouinard et al. (2007), show that children of all ages ask mainly 'fact' questions. However, the percentages of explanatory questions increase as the children get older. They also found that the children asked more questions concerning biological information when observing real animals compared to when they were observing drawings and replicas of the same animals. The findings also showed that the children more often asked for explanatory information when asking questions about biological phenomena compared to when asking non-biological questions. Also Kurkul and Corriveau (2018) and Thulin (2010) found that most of the children's questions were asking for information. Kurkul and Corriveau (2018), who studied everyday conversations between four-year-olds and their caregivers, found that most of the questions (about 85%) were information-seeking. As for Chouinard et al. (2007), they found that most of these were fact-based, and only 14% (130 of 916 questions) were causal (*explanatory* in Chouinard et al., 2007).

Whereas Chouinard et al. (2007) and Kurkul and Corriveau's (2018) have been focusing on children's questions during everyday situations with their caregivers, Thulin (2010) has studied children's questions during a science activity ('What is soil?') in a Swedish kindergarten (age 3–5 years). She found that 173 of 206 of the children's questions related to the content of the subject being studied (corresponding to 84%). That is, what things are, what the different elements' purposes are, and what the meaning of the scientific concepts are (e.g. 'This one, for example, what is this?') (Thulin, 2010). The results also indicate that the children want to take part in the content of the activity as well as in sharing their experiences (e.g. 'May I hold the worm as well?'). The remaining

questions concerned the tools used during the activity or were categorised as 'off-topic'. Thulin (2010) found an increase in the number of questions over time, which, according to the author, may indicate that children need place and time to relate to a certain domain of knowledge to be able to ask questions about the topic. As the children get more experienced, the ability to ask questions increases as well. These findings indicate that young children ask questions to get information, both in everyday situations, as well as for getting information about science topics. The findings also underline the importance of facilitating children to experience and explore nature elements when learning science in school and in kindergarten.

Responding to children's questions

In order to create good learning opportunities, it is important that the teachers respond sufficiently to the children's questions. In a study by Frazier et al. (2009), the results reveal that by providing explanations to the children's causal questions, this may prolong the conversation and promote knowledge-seeking in the child. When no explanations were given, the children more often re-asked their questions or made their own explanations (Frazier et al., 2009). This confirms some of Thulin's (2006) findings who found that when teachers responded to children's questions by a responding question like 'What do you think?', some of the children's questions remained unanswered and the situation went on in another direction. According to Thulin (2006), this may leave the child to seek his/her own explanations. However, other studies have shown that having an open dialogue with the children may provide the children with good learning opportunities and deeper understanding and knowledge of nature (Gustavsson & Pramling, 2014; Skalstad, 2020). It is therefore evident that to take full advantage of the learning opportunities in situations where children ask questions, it is important to have knowledge about children's questioning as well as the teacher's responses to these.

Method

Participants and study context

The study involves children and teachers from two different Norwegian kindergartens (abbreviated 'K-1' and 'K-2') and six different primary schools, grade 2–4 (abbreviated 'S-1', 'S-2', etc.) that were focusing on natural science topics during an outdoor session. The teachers were free to decide the aims and to plan and conduct the session. K-1 had two teachers, in which one had the leading role. The other kindergarten and schools had one teacher present.

The term *teacher* includes both kindergarten teacher and schoolteacher. In some of the kindergartens and schools, there were one or two assistants present. One researcher was present in all cases, observing the children and teachers.

The number of children, teachers, and assistants, as well as the macro-context (that is the aim, design/organisation and duration of the session, equipment, natural environment, the teacher's participation, time available and group-size), are presented in Table 1.

Table 1. Description of the macro-context of the different kindergartens and schools.

Kindergarten/ school	Description of macro-context
K-1	Aim: Explore nature (in an open forest-area). 8 children, 2 teachers.
5–6 years	Recorded time: 140 min. Activities: Free play within a confined area defined by the teachers. The teachers observe the children, and sometimes join them in conversations and in exploring nature elements. Equipment: Fact books.
K-2	Aims: Find, explore and identify leaves, insects, spiders and other small animals (in an open forest).
4–5 years	9 children, 1 teacher, 1 assistant. Recorded time: 100 min. Activities organised by the teacher: Find and explore insects, spiders and other small animals. Use a handheld microscope (Easi-Scope). Find and identify leaves. The teacher is open for input from the children and adjusts, to a large extent, the activities to the children`s suggestions and wishes. Equipment: Various loupes, insect's boxes, Easi-Scope, field identification guide for children, fact books.
S-1	Aim: Get to know fish 12 children, 1 teacher, 2 assistants.
2nd grade	Recorded time: 70 min. Activities organised by the teacher: Pull up fish traps from a lake. Dissect fish (individually). The teacher informs about the task and demonstrates how to use the equipment, and is available for questions/input from the children. Equipment: Fish trap, buckets, knives, wooden boards, laminated sheet with image of a fish and its internal organs. Life jackets.
S-2	Aim: Get to know insects, spiders and other small animals in the river. 10 children, 1 teacher.
2nd grade	Recorded time: 45 min. Activities organised by the teacher: Look for and identify insects, spiders and other small animals in a river. The children work in pairs. The teacher informs the children about the task and demonstrates how to use the equipment. She actively checks upon the children and their findings. Equipment: Scoop nets, loupes, plastic boxes, fact books.
S-3	Aims: Get experience with and motivate in relation to the theme floating/sinking. To wonder what is floating/sinking.
3rd grade	20 children, 1 teacher. Recorded time: 129 min. Activities organised by the teacher: the children chose 10 objects (e.g. leaf, cone), they investigated whether these objects floated or sunk when placed in the river. The results were written down. The children worked in groups. The teacher informed the children about the task. She actively followed up the groups. They end by summarising the children's results. Equipment: paper and pencil.
S-4	Aims: Get to know and observe different leaves. Able to recognise rowan (Sorbus aucuparia).
3rd grade	29 children, 1 teacher (and one interpreter for the deaf). Recorded time: 112 min. Activities organised by the teacher: The children are informed about the goals in the classroom, then when they arrive to the nature area. The students can choose whether to work individually or in groups. The teacher is available for questions from the children. Equipment: loupes, knives.
S-5	Aims: Get to know four species of deciduous trees, distinguish between conifers and deciduous trees, and experience changes in nature.
3rd and 4th grade	15 students and one teacher (and one assistant). Recorded time: 137 min. Activities organised by the teacher: The class has a walk along a predetermined route where it is possible to find different trees. The teacher repeats the goals several times during the day. The children work in groups and the teacher actively follows up the children. Equipment: bags, description of various trees, paper, and pencil.
S-6	Aim: Get to know nature 19 students, 1 teacher.
4th grade	Recorded time: 179 min. Activities organised by the teacher: Children work in groups to map animals and plants in a 1×1 m area in a forest. The teacher constantly follows up the groups. Equipment: string, knives, loupes, insect's boxes, field identification guide for children, field books, tweezers, paper, and pencils.

Data material and data reduction

Recordings of the conversations between children and teachers are done by means of action-camera (K-1, K-2, S-1, and S-2), and audio recorder (S-3 to S-6) mounted to the chest of the teacher(s). All conversations between children and teachers concerning science topics were transcribed, and the sequences that contained children-generated questions asked to the teachers were identified. These questions, that all dealt with science topics, were extracted and categorised. *Science topic* is defined as a topic that deals with e.g. plants, animals, rocks, weather and seasons (questions asking about date or month are not included).

When identifying a question, both the verbal expression, the tone and context were taken into consideration. Based on the question-asking tone, an expression like *And*

water striders, maybe? is defined as a question even if it does not contain a question word like e.g. 'what' or 'how'.

Inaudible questions and questions that consisted of a single word said in a questioning tone (e.g. 'No?') were not included in the data material. As the activities take place in outdoor settings, situations may occur where the children, due to e.g. wind or rain or trees/high vegetation do no hear or see the teacher's verbal or physical actions. The children may therefore ask questions to clarify the teacher's sayings or actions (e.g. 'Which one? … that?' or 'Was it this one you took?'). These questions may lead to an artificially increased number of questions and are therefore excluded from the data material. A question that was repeated by the same child in one question-sequence was counted as one (-1-) question. The number of questions and recorded time in each case were registered.

As the number of questions that constitute the total data material, that is questions about natural science topics, in each case is quite low (19–108), no statistical analysis is undertaken. The percentages are, nevertheless, sometimes given to easier illustrate our findings.

Data analysis

Categorising the children's questions

The analytical process was undertaken in several steps. Initially, all the questions concerning natural science topics were divided into *questions about subject matter* and *practical questions*. Questions about subject matter ask for knowledge about what a specific science phenomena or object is, or why/how a phenomenon occurs. Practical questions, on the other hand, concern procedures related to a specific task given by the teacher (e.g. how to make a bow and arrow), or how to solve a science-related problem or an event that occurs spontaneously (e.g. where to put an insect or find equipment). The practical questions are not analysed further.

The questions concerning subject matter were analysed partly deductively, by applying Chin and Brown's (2002) two main categories *basic information questions* and *wonderment questions*, and partly by applying a general inductive approach, as described by Thomas (2006). Descriptions of the categories and related examples are presented in Table 2. Chin and Brown's (2002) sub-category 'procedural questions' is included in the questions we have defined as 'practical questions' and is therefore not included in Table 2. The cognitive level ('lower'/'higher') of the different questions are indicated in the table.

Questions of *lower cognitive levels* are defined as questions that do not require reflection by the child (e.g. 'What's that?'), and where the answers required from the teacher are short and factual. Questions of *higher cognitive levels, which in this study constitute wonderment questions,* reflect some degree of reflection in the child (e.g. 'How do butterflies talk to each other?'), and require reflection and understanding from the teacher answering them. This is consistent with previous literature (Bloom et al., 1956; Chin & Brown, 2002; Chouinard et al., 2007). Questions that reflect knowledge-based considerations in form of e.g. claims or hypothesis formulated as a question (abbreviated C/H-questions) are categorised as questions of higher cognitive level.

Table 2. Categories of children's subject matter questions. The categories *Basic information* – and *wonderment questions* are based on categories created by Chin and Brown (2002), whereas *action-seeking questions* and *inform* are inductively developed. The authors are also inspired by Chouinard et al. (2007) and Thulin (2010).

Main category	Sub-category	Description	Cognitive level	Example
Basic information	Factual	(a) Yes/No-questions Can be answered with yes/no.	Lower	*Is it dead?*
		(b) Asking for labels Require only short answers. Usually recall of information.	Lower	*What is that?*
		(c) Asking for localisation Questions about where something is.	Lower	*Where is the caterpillar?*
Wonderment	Explanatory	Asking for explanations and causes. Often 'why' and 'how'-questions.	Higher	*Why doesn't the ant bite?*
	Claim/ hypothesis	Require some degree of reflection by the child. Show that the child is able to relate existing knowledge to an observation/a phenomenon or theoretical knowledge.	Higher	*If water had come inside, maybe it would have sunk?* *Owls … they eat squirrels, don't they?*
Action-seeking		Seek permission to do something with e.g. an object/a phenomenon.	Lower	*Can I have a look?*
Inform		Intend to inform/tell about a nature science topic/phenomenon.	Lower	*Do you know that … ?*

Analysing the contexts

In order to identify factors that facilitate question-asking in the children, we have analysed the macro-contexts according to the aim of the session, the design/organisation of the activities, equipment, the teacher's participation, time available, natural environment and group-size. The different macro-contexts are described in Table 1. In addition, we have analysed the situations in which the questions occurred and analysed the teachers' responses to the children's questions. For example, if the teacher responds by giving factual answers or by a responding question. These situations constitute the *micro-contexts*.

Reliability

The first author suggested, based on previous literature, categories of questions and relating definitions that could be relevant for this study. The two authors discussed the suggested categories jointly and refinements were made. Categorisations of the children's questions were then conducted: The first author categorised the questions from the two kindergartens and School 1 and 2, whereas the second author categorised the questions from School 3–6. Next, the results from each author's categorisations were discussed jointly by the two authors. Discrepancies were resolved through discussion and consecutive modifications.

Results

The intention of this empirical study is to identify and get examples of situations and contexts that stimulate question-asking behaviour in children. The results for each of the eight cases are presented in Tables 3 and 4 and are thereafter exemplified through

excerpts that illustrate some of the findings. Results are then discussed across the eight different kindergartens and schools.

First, we will present the amount and the two main types of questions asked by the children concerning natural science topics. Next, the categories developed from the analysis of the content of the subject matter questions asked by the children are presented and related to the different contexts.

Children's questions about science topics

Table 3 shows that the children in the kindergartens (K-1 and K-2) and the 2nd grade classes (S-1 and S-2) ask more questions about science topics per hour per child than the children in 3rd and 4th grade (S-3 to S-6). The children in K-2 stand out by asking considerably more questions than any of the other cases. The teacher in K-2 interacts closely with the children, helping and joining them in finding e.g. insects, spiders and leaves, and the children have access to a great variety of equipment. The children in S-4 ask only 0.3 questions/hour/child. The teacher was available to the children, and was constantly in dialogue with them, but the dialogues were off-topic (e.g. talking about going to the theatre) and the children's activities were not followed up.

The science topic questions asked by the children are categorised into questions that concern *subject matter* and questions about *practical* issues. Whereas the children in the two kindergartens mainly ask questions about subject matter (74–95%) (cf. Table 3), the majority of questions asked by the children in S-1 and in 3rd and 4th grade concerns practical issues. In S-2 grade, the amount of subject matter and practically questions are more evenly distributed. The subject matter questions constitute 3.1 and 5.3 questions/hour/child in K-1 and K-2, respectively, 1.4 (S-1) and 1.7 (S-2) questions/hour/child in the two 2nd grade classes, and between 0.1 and 0.4 questions/hour/child in the 3rd and 4th grade classes (S-3 to S-6).

With regards to the contexts of the different kindergartens and schools, it seems that in settings where the activities and tasks given by the teachers are few or easy to perform, or if children have a certain freedom in how to perform a task, the children ask relatively few practical questions. This is the case in e.g. K-1, where no organised activities and no equipment, except fact books, are used, and in K-2 and S-2 where the activities are uncomplicated and the children are relatively free in how to perform the tasks given by the teacher. Except from the Easi-Scope in K-2, the equipment is easy to use. In S-1, the children are dissecting fish, which seems to lead them to ask many practical questions (64%) related to how to dissect/how to use the equipment. Schools 3–6 have a large proportion of practical questions varying from 67–87%. They have defined goals and tasks for which the children are

Table 3. Categories and number of science topic questions asked by the children to their teacher(s).

Type of questions	K-1	K-2	S-1	S-2	S-3	S-4	S-5	S-6
Subject matter question	58	80	20	13	7	3	12	19
Practical question	3	28	36	12	49	16	24	77
Science topic questions (total)	61	108	56	25	56	19	36	96
Science topic questions/hour/child	3.3	7.2	4.0	3.3	1.3	0.3	1.1	1.7

Table 4. Categories and numbers of subject matter questions asked by the children. Numbers in parenthesis indicate the number of questions that are initiated by a specific finding or observation of a nature element.

Main category	Sub-category		K-1	K-2	S-1	S-2	S-3	S-4	S-5	S-6
Basic information questions	Factual	(a) Yes/No	12 (7)	10 (8)	12 (11)	2 (1)	0	3 (0)	8 (7)	8 (6)
		(b) Labels	13 (10)	31 (30)	3 (3)	4 (4)	2 (2)	0	3 (3)	8 (8)
		(c) Localisation	4 (4)	4 (4)	3 (3)	3 (3)	0	0	0	2 (2)
Wonderment questions	Explanatory		6 (5)	5 (5)	1 (1)	3 (3)	0	0	0	0
	Claim/ hypothesis		19 (16)	4 (3)	1 (1)	1 (1)	5 (0)	0	1 (1)	0
Action-seeking			0	26 (24)	0	0	0	0	0	1 (1)
Inform			4 (1)	0	0	0	0	0	0	0
Subject matter (total)			58 (43)	80 (74)	20 (19)	13 (12)	7 (2)	3 (0)	12 (11)	19 (17)

presented, and tasks are intended to help the children achieve those goals. The assignments are expected to be solved in certain ways, and at S-3, 4 and 5 the children should be able to refer to what they have written.

Subject matter questions

In the following, we will present excerpts from dialogues between children and teachers that illustrate the different categories of subject matter questions.

Basic information questions

As presented in Table 4, the results show that, except for in S-3, 50%–100% of the children's questions ask for basic information about a natural science topic. The results also show that in seven of the eight cases, the majority of these questions ask for information about a specific finding or observation of a nature element. The children ask questions about their own, as well as the teacher's finding. Questions like 'Is that a real fish?' and 'This looks like a snail. What is it?', show that the findings seem to trigger the children's curiosity and a wish of knowing more about the nature elements.

Wonderment questions

Explanatory questions. As indicated in Table 4, the children ask few explanatory questions. The results also show that all of these questions, except one (in K-1), come as a result of an observation of a nature element. An example of this is seen in excerpt 1.

In kindergartens, the explanatory questions occur after observing the nature element over some time, or during longer conversations. This is seen in K-2 where the exploratory questions occur after observing ants in an anthill for about 10 min (excerpt 1, line 3 and 7). A similar situation occurs in K-1, where two girls have been studying and observing ants in an anthill for about 15 min. They have put flowers and leaves on the anthill when one girl asks, *Why did he (the ant) pee on the leaf*?.

The importance of the teacher being available for and taking part in conversation with the child is seen in e.g. K-1 when a boy and a teacher are talking about the different insects they see. Some minutes later, the boy sees an insect he thinks is a moth or a butterfly. They start talking about the insect, and the teacher says that moths and butterflies are *in the same family* and the boy asks … *but how do they talk to each other, then?*. This indicates the importance of providing the children with time to observe and explore, as well being present and following up on the children's initiatives and observations. It also shows that providing information about the nature element may stimulate the children to ask explanatory questions.

Sometimes the children have asked a question (factual or hypothesis) in advance of the exploratory question (cf. excerpt 1, line 1). In excerpt 1, the child also asks permission to try herself (line 5). She thus gets hands-on-experience which, in turn, leads her to re-ask the explanation question. In S-1 and S-2, the children do not ask question in advance of the explanatory question, but (with one exception) the teacher has provided the children with information about the nature element previous to the question. This indicates that information in form of hands-on experience or facts may facilitate explanatory questions.

Excerpt 1:

Some children and the teacher in K-2 have been sitting next to an anthill for about 10 min, observing and talking about the ants. The teacher has an ant on her finger and a girl is observing.

1. Girl: Does it bite?
2. Teacher: No
3. Girl: Why doesn't it bite?
4. Teacher: I don`t know.
5. Girl: Can I try?
6. Teacher: Mhm (*puts the ant on the girl's finger*).
7. Girl: Hmm. Why doesn't it bite? (*observes the ant that is crawling on her hand*) … Maybe it is kind?
8. Teacher: (*Laughing*) … Yeah, well … I think all of them are kind, but I suppose they are … (*the teacher stops*).

Claims or hypothesis formulated as questions. K-1 and S-3 stand out in that 19 of 58 (33%) and 5 of 7 (71%), respectively, of the subject matter questions are in form of C/H-questions (cf. Table 4). Some of these are asked spontaneously (excerpt 2a), whereas others come as a response to the teacher's answer (excerpt 2b) or question (excerpt 2c). The spontaneously asked C/H-question in excerpt 2a, line 1, shows that the child has a certain knowledge of the topic. In this example, the teacher is available for the boy and has time to follow up on his initiative.

In excerpt 2b, the teacher responds to the child's initial question in a wondering manner. By signalling that the teacher does not know the answer, and by posing a hypothesis herself, this seems to trigger the child to pose a C/H-question as well. In K-1, 11 of the 29 basic information questions are responded to in a wondering manner.

As concerns S-3 all the C/H-questions are posed during summarising and reflecting over their results after having tested floating and sinking. This is exemplified in excerpt 2c. The teacher asks for the explanation (line 1) and responds to the child's answer by a question (line 3). The child responds by giving a C/H-question (line 4).

Excerpt 2a:

A boy and a teacher are walking along a forest road, talking about a caterpillar they saw earlier the same day and where it might be now.

1. Boy: Maybe it's inside a pupa? Because I think it was a butterfly caterpillar.
2. Teacher: Yes, I think so too. Butterfly, or moth or things like that.

Excerpt 2b:

1. Child: Is it possible to make something from cotton grass?
2. Teacher: I don't know? Maybe knit a sweater?
3. Child: Nest? Maybe a nest?
4. Teacher: Nest? That might be (*said in a questioning tone*).

Excerpt 2c:

1. Teacher: Was it tight, the snuffbox?
2. Child: No, it had no lid
3. Teacher: No lid?
4. Child: If water had come inside, maybe it would have sunk?

Action-seeking questions

As presented in Table 4, 33% of the questions asked by the children in K-2 are *action-seeking questions*. These questions occur when the teacher takes active part in the exploration of insects, spiders, and other small animals together with the children. When the teacher finds, sees, or tests something, or when she is looking in the Easi-Scope, the children want to take part in the experience and observations as well. This is expressed by questions like: 'Can I see?' or 'Can I hold it?'

Following up the children's explorations

In K-2, which is the case that has the highest frequency of subject matter questions, the teacher follows up the children closely by helping and joining them in their explorations of the nature elements (cf. excerpt 3). By lifting pallets and stones, and by suggesting new places to explore, the teacher provides the children with more opportunities to discover and explore new nature elements. This, in turn, may lead the children to ask questions related to their new findings and observations (cf. excerpt 3, line 5 and 6). This indicates that by being attentive to, and following up the children's findings and explorations, the teacher can facilitate question-asking in the children.

Excerpt 3

The children in K-2 are looking for insects and other small animals. A boy turns to the teacher, asking for help to search for animals.

1. Boy: Can you help me to find some animals?
2. Teacher: Yes. Of course, I will help you. Come … lets' see if we can lift this one over here (*points at some pallets*). They usually like themselves … (*they walk to a pallet and the teacher lifts it up*)
3. Boy: Wow! That was a long one! (*sees an animal under the pallet*)
4. Teacher: Wow! Yeah, that was a long one!

5. Girl 1: What is … what kind of animal is that?
6. Children: What is that? (*said loudly and eagerly by several children*)
7. Teacher: I don't know. Maybe we can find it out?

Discussion

Trees, grass, insects and bird song make the surroundings for the participants in this study as the children and teachers are situated in a natural outdoor environment outside their kindergarten or school's area. In this study, we examine what characterises the children's questions about science topics in these surroundings and in what contexts the subject matter questions are asked. In the following, we will discuss our findings and the implication of these.

The results show a large variation in both numbers, as well as types of questions asked by the children in the different kindergartens and schools. An interesting finding in our study is the large number of practical questions asked by the schoolchildren (3rd and 4th grade in particular) compared to the children in kindergarten. The design of the tasks and activities given by the teacher seems to be a crucial factor in this concern. Tasks and activities that are of a more practical nature (e.g. S-3), or are complex or unfamiliar to the children (e.g. dissecting fish in S-1), seem to elicit practical questions. This can be related to Chin and Brown (2002) who found that most of the children's questions concerned clarification of how procedural tasks should be done. However, we also find that tasks that are clearly defined and have clear directions on how they should be carried out seem to enhance practical questions, even if the tasks are easy to accomplish. One possible explanation may be that the schoolchildren focus more on performing the practical task within the framework provided by the teacher, rather than focusing on the subject matter content of the task (e.g. S-6).

In contexts where the children have a certain degree of freedom in how to perform the different activities and tasks given by the teachers (e.g. K-2 and S-2), this opens up for a variety of experiences and findings that may trigger the children's interest and curiosity to a larger extent than the more restricted tasks. In K-1, where the children are free to explore the nature phenomena or elements that seem to interest them, there are hardly any practical questions.

The results from this empirical study show that children's encounters with nature seem to elicit subject matter questions related to a specific finding or observation of a nature element (cf. Table 4). This supports the assumptions made earlier based on Chouinard et al. (2007) and Thulin's (2010) findings, that contexts where children are presented to both living and non-living objects originating from nature might enhance question-asking in the children. These findings are also in line with Skalstad (2020) and Waters and Maynard (2010), who found that nature elements seem to trigger engagement and interest in the children.

Asking for basic information and first-hand experiences

Common for both the pre-schoolers and the schoolchildren (except for S-3), is that they mainly ask for facts and not explanations. This corresponds with previous research on children's question-asking (Chin & Brown, 2002; Chouinard et al., 2007; Kurkul & Corriveau, 2018; Thulin, 2010).

In contexts where the children are presented to a variety of nature elements (and not just one or two), and have access to equipment for exploring various nature elements (e.g. in K-2 and S-6), the number of questions that ask for labels is higher than in most of the other kindergartens and schools. This might be explained by that by exploring a nature element further (e.g. by using equipment), and by being exposed to different nature elements, this provides the children with more and new discoveries and findings, and thus more opportunities to ask questions.

In these two cases, and in K-2 in particular, the teacher stands out by actively following up the children in their explorations by e.g. holding animals in her hands and helping children in looking for animals (cf. excerpts 1 and 3). This seems to trigger the children to ask factual questions about the findings as well as inspire them to hold the animal and thus get first-hand experiences. This may in turn, elicit more questions (cf. excerpt 1).

This indicates, and as found by Engel (2011), that the teacher can enhance curiosity and question-asking in the children by encouraging and guiding the children in their explorations.

The many action-seeking questions in K-2 may be indications of the children wanting first-hand experiences of the nature elements, and not just watching the nature elements from a distance. We therefore, as Thulin (2010), see this as indications of the children wanting to take part in the findings.

In K-1, the two teachers observe the children and often show interest in the children's findings and activities by asking questions and talking about the children's findings, but they rarely hold or explore these elements themselves. As the children are allowed to play and explore the nature environment freely, they observe, touch and pick up the nature elements that seem to interest them. This provides the children with many first-hand experiences and they do therefore not have to ask action-seeking questions as the children in K-2 did. This might be one of the reasons why the children in K-1 ask fewer questions compared to the children in K- 2, both in total and as for the action-seeking questions. Like K-1, the children in Fischer and Madsen's (2002) study had time and possibilities to explore freely, which may explain why the children in their study asked so few questions.

Wonderment questions

Explanatory questions

A large majority of the explanatory questions that occur in this study take place in settings where one child and teacher share attention to an observed or experienced nature element or phenomenon over some time. Most of these questions occur during dialogues where the teacher provides the child with information about the natural phenomenon being studied, and/or after the child's experience with the phenomenon (cf. excerpt 1). This confirms that having knowledge of something generates explanatory questions (cf. Chin & Brown, 2002; Scardamalia & Bereiter, 1992; van Zee et al., 2001). It might also be an example of that gaining knowledge may raise interest in a topic (cf. Hartmeyer & Mygind, 2016).

As both the children's experiences (cf. excerpt 1) and the information provided by the teacher may lead to exploratory questions, this indicates that *knowledge* may be in form of observations and hands-on experiences as well as facts. This underlines the importance

of opening up for children to make their own explorations of nature elements and phenomena, as well as of following up on the children's explorations and providing them with answers to their questions.

However, such a close following up by the teacher may be challenging in especially the higher grades in school where the number of children per teacher is larger than in kindergarten and in the lower grades (cf. Table 1). This may contribute to the larger number of exploratory questions in the youngest children, compared to in 3rd and 4th grade where no exploratory questions were asked.

Claims or hypothesis formulated as questions

In K-1 and S-3, where the aims of the activities focus on *exploring* and *wondering* about nature/a natural phenomenon rather than on fact-based scientific knowledge, the children pose considerably more C/H-questions compared to the children in the other kindergarten and schools.

In K-1, where the children explore freely, and where the topic and aim of the activity is relatively open ('Explore nature') the teachers largely follow up the children's findings and factual questions in a wondering manner. Rather than providing the children with facts on the children's factual questions, the teachers respond by a returning question or by indicating that they do not know the answer. This seems to encourage the children to reflect and find the answers themselves, which in turn may lead the children to pose questions in form of C/H-questions (cf. excerpt 2b).

Of all the eight cases in this study, K-1 spends longest time on their activities and has also the highest teacher-children ratio (cf. Table 1). This allows the teachers to spend time on e.g. longer and wondering dialogues with the children, and may therefore contribute to the high number of C/H-questions.

In S-3, where 5 of 7 questions are C/H-questions, the context is quite different from in K1. The number of adults per children and time spent on the task is less than in K-1, the children ask few subject matter questions, and the topic and aim of the task have a clear focus (cf. Table 1). Unlike in K-1, where the C/H-questions occur during dialogues and situations where children and teacher observe or experience nature elements as they occur/unfold, all the five C/H-questions in S-3 are asked when the children and teacher, in plenary, summarise and reflect over their results after having tested floating and sinking (cf. excerpt 2c). The teacher asks for explanations and the children respond by giving/providing C/H-questions. The questions thus occur in a defined part of the activity, which is planned by the teacher. This may explain why the children in S-3 ask relatively many C/H-questions despite less time available and larger children–teacher ratio.

Reflection is characterised by higher-order thinking and can be perceived as challenging for children (Metz, 1995). An answer given in the form of a question can be a strategy by the children to reduce the risk of answering incorrectly. On the other hand, it may be intended as a question as they believe it to be so and want the teacher to confirm it. Then one can look at these questions as part of constructing meaning (Chin & Brown, 2002).

Whereas none of the C/H-questions that occur in S-3 are asked spontaneously, but as a response of the teacher's questions (cf. excerpt 2c), some of the C/H-questions in K-1 were posed spontaneously (cf. excerpt 2a). These questions are asked by one boy that

appears to have knowledge about, and a special interest in, various science topics. He is the only child asking C/H-questions spontaneously. This indicate, as for the explanatory questions, that having some knowledge about a certain science topic seem to be essential for posing C/H-questions spontaneously. Shared attention about a specific phenomenon or topic over some time seem to enhance these situations.

Responding to the children's questions by facts or wonderment?

Our study shows that most of the children's subject matter questions ask for facts about a science topic and that getting answers to questions may in turn elicit questions of higher cognitive levels (wonderment questions). Thus, to gain new, as well as deep-level scientific knowledge it is important that the teachers provide the children with proper answers.

As *science knowledge* comprises of knowledge about scientific facts and concepts as well as how to practice scientific methods and processes, the teacher's response to the children's questions may depend on the aim of the task given by the teacher. If the aim of the task is to facilitate and get a deeper knowledge in how to practise science inquiry through exploratory dialogues, this can be facilitated by responding to the children's questions in a wondering manner, as this seems to encourage the children to pose claims or hypothesis formulated as questions (cf. excerpt 2b). If the aim of the task is to gain knowledge about scientific facts and concepts, both factual answers and responses in form of e.g. open questions may lead to increased factual knowledge in the children. It is, however, and as stated by Thulin (2006), important that if the teacher responds to the questions in a wondering manner (e.g. 'What do you think?'), the teacher must follow up the children's answers and hypotheses and confirm or corrects/guide the children to a correct answer in order not to create *misapprehensions/misconceptions* about scientific concepts or phenomena.

What happens from kindergarten to school?

As having knowledge of and experience with a topic seem to enhance question-asking in the children, one might assume, and as found by Chouinard et al. (2007), that the oldest children ask more explanatory questions than the children in kindergarten do. However, this is not the case in our study. In contrary, we find that whereas the youngest children in our study (kindergarten and 2nd grade) ask some explanatory questions, the children in 3rd and 4th grade ask no explanatory questions at all. Some of this difference from Chouinard et al.'s (2007) study may be explained by the great development of language from age 1–5 in Chouinard et al.'s (2007) study, compared to our study (age 4–10).

To facilitate children to ask explanatory questions, this requires a close follow up by the teacher. The larger number of children per teacher in 3rd and 4th grade compared to in kindergarten and 2nd grade might therefore, and as previously discussed, explain some of the difference in explanatory questions between the oldest and youngest children in our study.

As concerns time available, this does not seem to influence the number of lower order questions. It may, however, be an important factor when it comes facilitating C/H-questions (cf. K-1).

The differences in setting, topic and/or aim may also affect the results. The pedagogy in the Norwegian primary school emphasises a transition from a greater degree of child centring in the first years, to become more subject centred in the higher grades. This is

reflected in the difference in openness in aims and in the degree of freedom in the tasks provided by the different teachers in 2nd grade compared to 3rd and 4th grade in our study.

In the two kindergartens and 2nd grade classes, that ask the most subject matter questions, the aim of the task is relatively open (cf. Table 1). One exception is K-2 where the aim in addition to 'find and explore' also included 'identifying' various nature elements. However, during the activity, the main focus turned out to be on 'finding and exploring' and less on 'identifying'.

In 3rd and 4th grade, on the other hand, the aims of the tasks are focused on a specific phenomenon (cf. S-3) or on identifying certain species (cf. S-4 and S-5). In S-6, the aim is more open ('Get to know nature'), but the activity itself is quite specific and detailed, as the children shall 'map animals and plants within a 1 × 1 m area' (cf. Table 1). S-6 has, similar to K-2, a lot of equipment available for use, and the teacher follows up the children actively. The teacher is, however, focused on finding and *naming* the different animals, and not *exploring* the animals as e.g. the teacher in K-2 does.

When the task is directed towards e.g. specific species or phenomena, rather than on the children's own experiences and various nature elements, the chance of asking a 'wrong' or 'silly' question may lead the children to restrain from asking questions. In an open task, on the other hand, where the children can ask questions related to their own experiences and thoughts there will be no 'right' or 'wrong' questions, and the children may thus ask more questions. The size of the group/class may affect this even further, as asking 'wrong' questions in front of a large class can more frightening compared to in a smaller group.

These factors may therefore explain why the children in 3rd and 4th grade ask fewer questions compared to the younger children, and why e.g. the children in S-6, despite the active following up by the teacher and having a lot of equipment available, ask few subject matter questions compared to in K-2.

Conclusions and implications

This study provides new knowledge on how different contexts in various natural outdoor environments can facilitate children's questions about science topics in both kindergarten and in school. Providing the children with activities and tasks that are easy to accomplish and that offer some freedom in how to be performed, may facilitate the children to ask questions about subject matter rather than practical questions.

Activities that allow the children to explore a phenomenon over some time, give them first-hand experiences that in turn seem to enhance question-asking in the children. It is, however, essential that the teacher is attentive to, and follows up on the children's focus and explorations. By joining the children in their explorations and providing them with equipment that enhances explorations, this may elicit new findings and experiences which, in turn can increase the number of questions even further.

Our study shows that most of the children's subject matter questions ask for basic information about a science topic and that getting answers to questions (either by facts or in a wondering manner) may in turn elicit questions of higher cognitive levels.

We also found that the aim of the activity might affect both the types and number of questions asked by the children. Focusing on e.g. specific species or phenomena seem to

lead to fewer questions, whereas more open aims lead to more questions. When the aim of the activity is to wonder or practicing scientific inquiry/-methods, answering children's questions in a wondering manner may facilitate questions in form of hypothesis or C/H-questions.

Natural outdoor environments offer possibilities for exploring science phenomena and elements that may be starting points for shared attention and exploration that may enhance question-asking of both lower and higher cognitive levels in the children. We will therefore highlight natural outdoor environments as an important source for providing children with knowledge of and experiences with science topics, as well as to stimulate the children's curiosity.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Ingunn Skalstad http://orcid.org/0000-0002-8904-4100
Eli Munkebye http://orcid.org/0000-0003-0903-7814

References

Aguiar, O. G., Mortimer, E. F., & Scott, P. (2010). Learning from and responding to students' questions: The authoritative and dialogic tension. *Journal of Research in Science Teaching*, *47*(2), 174–193. https://doi.org/10.1002/tea.20315.

Bloom, B. S., Engelhart, M. B., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. Longmans Green.

Bruner, J. S. (2009). *The process of education. Cambridge*. Harvard University Press.

Chin, C., & Brown, D. E. (2000). Learning in science: A comparison of deep and surface approaches. *Journal of Research in Science Teaching*, *37*(2), 109–138. https://doi.org/10.1002/(SICI)1098-2736(200002)37:2<109::AID-TEA3>3.0.CO;2-7

Chin, C., & Brown, D. E. (2002). Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education*, *24*(5), 521–549. https://doi.org/10.1080/09500690110095249

Chouinard, M. M., Harris, P. L., & Maratsos, M. P. (2007). Children's questions: A mechanism for cognitive development. *Monographs of the Society for Research in Child Development*, *72*(1), 1–129. https://doi.org/10.1111/j.1540-5834.2007.00413.x

Dillon, J. T. (1988). The remedial status of student questioning. *Journal of Curriculum Studies*, *20*(3), 197–210. https://doi.org/10.1080/0022027880200301

Engel, S. (2011). Children's need to know: Curiosity in schools. *Harvard Educational Review*, *81*(4), 625–645. https://doi.org/10.17763/haer.81.4.h054131316473115

Fischer, U., & Madsen, B. L. (2002). *Se her!: Om barns oppmerksomhet og førskolelærerens rolle*. Pedagogisk forum.

Frazier, B. N., Gelman, S. A., & Wellman, H. M. (2009). Preschoolers' search for explanatory information within adult–child conversation. *Child Development*, *80*(6), 1592–1611. https://doi.org/10.1111/j.1467-8624.2009.01356.x

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

Hansson, L., Löfgren, L., & Pendrill, A.-M. (2014). Att utgå från frågor och situationer i förskolans vardag: Vilket naturvetenskapligt innehåll kan det leda til? [Starting from questions and everyday situations in preschool: What kind of science content could that lead to?]. *Nordic Studies in Science Education*, *10*(1), 77–89. https://doi.org/10.5617/nordina.634

Harris, P. L. (2012). *Trusting what you're told: How children learn from others*. Belknap Press/ Harvard University Press.

Hartmeyer, R., & Mygind, E. (2016). A retrospective study of social relations in a Danish primary school class taught in 'udeskole'. *Journal of Adventure Education and Outdoor Learning*, *16*(1), 78–89. https://doi.org/10.1080/14729679.2015.1086659

Kurkul, Katelyn E & Corriveau, Kathleen H. (2018). Question, explanation, follow-up: A mechanism for learning from others?. Child Development, *89*(1), 280–294. https://doi.org/10.1111/cdev.12726

Metz, K. E. (1995). Reassessment of developmental constraints on children's science instruction. *Review of Educational Research*, *65*(2), 93–127. https://doi.org/10.3102/00346543065002093

Mygind, E., Bølling, M., & Barfod, K. S. (2019). Primary teachers' experiences with weekly education outside the classroom during a year. *Education 3-13*, *47*(5), 599–611. https://doi.org/10.1080/03004279.2018.1513544

Scardamalia, M., & Bereiter, C. (1992). Text-based and knowledge-based questioning by children. *Cognition and Instruction*, *9*(3), 177–199. https://doi.org/10.1207/s1532690xci0903_1

Siraj-Blatchford, J., & Macleod-Brudenell, I. (2003). *Supporting science, design and technology in the early years*. Open University.

Skalstad, I. (2020). Oi! Sjå på den! – Funn av naturelement som utgangspunkt for utforskande naturfaglege samtalar mellom barn (5-6 år) og pedagogar. [Wow! Look at this! – Findings of nature elements as starting points for exploratory scientific dialogues between children (5-6 years) and teachers]. *Nordic Studies in Science Education*, *16*(2), 199–214. https://doi.org/10.5617/nordina.7396

Skarstein, T. H., & Skarstein, F. (2020). Curious children and knowledgeable adults –early childhood student-teachers' species identification skills and their views on the importance of species knowledge. *International Journal of Science Education*, *42*(2), 310–328. https://doi.org/10.1080/09500693.2019.1710782

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Thulin, S. (2006). Vad händer med lärandets objekt? En studie av hur lärare och barn i förskolan kommunicerar naturvetenskapliga fenomen. [What happens to the object of learning? A study of how teachers and children in preschool communicate scientific phenomena]. In *Acta wexionensia, 102*/2006, 1–134. Växjö University Press.

Thulin, S. (2010). Barns frågor under en naturvetenskaplig aktivitet i förskolan. [Children's questions during science education in ECEC]. *Nordisk Barnehageforskning*, *3*(1), 27–40. https://doi.org/10.7577/nbf.255.

van Zee, E. H., Iwasyk, M., Kurose, A., Simpson, D., & Wild, J. (2001). Student and teacher questioning during conversations about science. *Journal of Research in Science Teaching*, *38*(2), 159–190. https://doi.org/10.1002/1098-2736(200102)38:2<159::AID-TEA1002>3.0.CO;2-J

Waters, J., & Maynard, T. (2010). What's so interesting outside? A study of child-initiated interaction with teachers in the natural outdoor environment. *European Early Childhood Education Research Journal*, *18*(4), 473–483. https://doi.org/10.1080/1350293X.2010.525939