



Research paper

How to support young children's interest development during exploratory natural science activities in outdoor environments

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H I G H L I G H T S

- Children's interest in natural elements during exploratory activities develops through three phases.
- The different phases are characterised by how the children relate to the natural element:
- 1) gaining first-hand experiences, 2) are receptive for factual knowledge, 3) reflecting and applying knowledge.
- Teachers can support the children by showing subject matter expertise and social and cognitive congruence.
- The significance of the different interactional characteristics varies between the phases.

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This study examines how 4–8-year-old Norwegian children's interest in natural elements appears and develops during exploratory activities in various natural outdoor environments, and how teachers can support such interest in these settings. The results indicate that children's interest develops through three phases. Each phase can be recognised by how children relate to the natural element in question. They gain first-hand experience, are receptive to acquiring factual information and reflect on and apply their knowledge. Teachers can support children's interest by showing subject matter expertise and social and cognitive congruence. The significance of these different interactional characteristics varies between the phases.

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1. Introduction

Theorists and researchers have focused on the concept of interest and its relation to learning. Research shows that interest influences children's attention (e.g. Hidi et al., 2004) and levels of learning (e.g. Krapp, 2002) as well as increasing children's motivation for learning (Harackiewicz et al., 2016).

According to the Organisation for Economic Co-operation and Development (OECD, 2006), it appears that students' interest in science decreases over time. The OECD (2006) therefore highlights students' positive contact with science at an early age as being essential in order to increase their interest. A study by Maltese and Tai (2010) showed that a majority of graduate science students and scientists developed an interest in science before middle school

(1st–5th grades). This confirms that stimulating children's interest in science at an early age and supporting their initial enthusiasm for science is of great importance in science education.

Studies from school (Bølling et al., 2019) and summer camp settings (Jung et al., 2019) show that working with science-related tasks in nature areas (for example green parks and forests) stimulates children's interest in science, as they provide children with, for example, novel and surprising conditions and open and varied tasks, which trigger their interest. There is, however, little research on the youngest children, as well as on how teachers can scaffold children's triggered interest in science and maintain or develop it in natural outdoor environments. According to Hidi and Renninger (2006), interest develops through four different phases and needs support from other persons in order to evolve and deepen. More detailed knowledge about how young children's interest in science develops in natural outdoor environments and how teachers can support this development is therefore needed.

In our previous research on Norwegian kindergartens (4–6-

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year-olds) and primary schools (2nd–4th grades), we found that children's encounters with nature and natural elements (e.g. plants, insects, rocks) facilitate their question-asking (Skalstad & Munkebye, 2021) and participation in exploratory dialogues (Skalstad, 2020). These results indicate that being situated in a natural outdoor area can promote young children's interest in natural science topics. In this study, we investigate how teachers can support the development of children's interest in such topics during exploratory activities, and how children's interest is expressed in these settings. The term “teacher” used in this article includes both kindergarten teachers and schoolteachers, and “exploratory natural science activities” are defined as those where children have a certain degree of freedom in terms of how to perform the tasks. The teacher is open to and facilitates the expression of the children's own thoughts and explorations related to a natural science content or topic.

This study combines data from teachers and children in kindergarten and the 2nd grade of primary school and provides new and more extensive knowledge about how to support children's interest development in science. This adds valuable knowledge to the field of research on early childhood science education, as well as to research on interest in general.

The research questions are as follows:

1. How does children's (4–8-year-olds) interest in natural elements appear and develop during exploratory activities in natural outdoor environments?
2. How can teachers support young children (4–8-year-olds) in terms of their transition from having a triggered to a more developed interest in science topics?

The study focuses on activities where children experience and explore natural elements, such as plants and animals, in a natural outdoor environment. A “natural outdoor environment” is here defined as an area outside the kindergarten or school that is largely unaffected by human intervention (e.g. forests, seashores).

2. Theoretical perspectives

This study aims to identify how children's interest appears during exploratory settings in natural outdoor environments, and to show how teachers can support the development of their situational interest with regard to it evolving from triggered to well-developed interest. In the following, we will present Hidi and Renninger's (2006) four-phase model of interest development and Rotgans and Schmidt's (2011) interactional characteristics of social congruence, cognitive congruence and subject matter expertise. These are applied as the framework for our analysis.

2.1. Hidi and Renninger's four-phase model of interest development

Educational research often distinguishes between two types of interest: *situational* and *individual* interest. Situational interest is triggered by environmental stimuli, is temporary and is context-specific, whereas individual interest is activated internally, enduring and context-general (Hidi & Renninger, 2006). According to, for example, Hidi and Renninger (2006), situational interest supports the development of individual interest.

Krapp (2002) presents a model where the period of interest can be described as a continuum that begins with the interest *being triggered*, moves through a *learning phase* and ends with more sustained interest, which can result in a predisposition to participate in a certain object area of interest (*individual interest*). This model is further developed to give a four-phase model (Hidi & Renninger, 2006; Renninger, 2009; Renninger & Hidi, 2020). In

their model, Hidi and Renninger (2006) describe how interest can develop and deepen. The model is based on empirical studies of interest and learning and consists of four phases: *triggered situational interest*, *maintained situational interest*, *emerging individual interest* and *well-developed individual interest*.

A central characteristic of interest is that it includes both emotional and cognitive components. The different phases are thus characterised by varying amounts of affect, knowledge and value (Hidi & Renninger, 2006), where progression through the phases is related to deeper knowledge and value (Rotgans & Schmidt, 2017). By observing repeated engagement with certain content and the depth of engagement, one can get reliable indications of whether an interest is more or less developed (Renninger & Hidi, 2016).

In order for interest to be sustained in any of the four phases, support from others is needed (Renninger, 2000, 2009). However, as the phases differ in terms of their characteristics, the nature of the support required varies as well. The first two phases of interest development (triggered situational and maintained situational interest) are mostly externally supported, whereas the emerging and well-developed phases of individual interest (phases 3 and 4) are self-generated. However, a student with an emerging individual interest requires some external support in order to increase his/her understanding, as well as a learning environment that provides opportunities or challenges. Learners' characteristics and the support needed in the various phases of interest development are presented in Table 1.

2.2. Social congruence, cognitive congruence and subject matter expertise

Whereas Hidi and Renninger's (2006) model describes instructional and environmental conditions and, to some extent, the teacher's role in supporting and developing a person's interest, Rotgans and Schmidt (2011) found that situational interest is influenced by three factors: social and cognitive congruence and subject matter expertise. Descriptions of these three interactional characteristics are given in Table 2.

2.2.1. Interactional characteristics related to younger children

The studies presented in Table 2 are based on students in higher education, whereas our focus is on younger children. There is limited research on primary- and preschools, but some indicates that these interactional characteristics are also relevant in studies of younger children. Xu et al.'s (2012) study highlights a caring and trusting atmosphere as being important for promoting young students' interest in science. This indicates that a teacher's ability to show social and cognitive congruence coincides, to a large extent, with some characteristics that are central for creating good learning opportunities for young children. Research shows that to create such opportunities for preschoolers, it is important that teachers both pay attention to children and engage in their activities (Fridberg et al., 2019). This is labelled *intersubjectivity* by Rommetveit (1974). Intersubjectivity may be *sufficient*, where there is mutual understanding between the children and teacher and dialogue develops, or *illusory*, where the focus of the conversation diverges (Fridberg et al., 2019; Rommetveit, 1974). Being able to establish sufficient intersubjectivity can therefore be related to being *socially congruent*, as described by, for example, Rotgans and Schmidt (2011). It is also, according to Fridberg et al. (2019), important to create links between the child's perspective and the object of learning (cf. cognitive congruence).

Table 1

Children's characteristics and the support needed in the various phases of interest development, according to Hidi and Renninger (2006) and Renninger and Hidi (2020).

Phase of interest development	Children's characteristics	Support needed
Phase 1 Triggered situational interest	<ul style="list-style-type: none"> • Focused attention • May experience either positive or negative feelings. • May or may not be reflectively aware of the experience 	<ul style="list-style-type: none"> • Support to engage: <ul style="list-style-type: none"> - from others (e.g. group work, instructional conversations) - through instructional design (e.g. software) • Tasks that are surprising, complex or new to the students • Links between the students' existing interests and the new area of interest • Visible value
Phase 2 Maintained situational interest	<ul style="list-style-type: none"> • Are re-engaging with content that previously triggered attention • Have positive feelings about the content • Are developing knowledge of the content • Are developing a sense of the content's value 	<ul style="list-style-type: none"> • Support from others to find connections between the students' skills, knowledge and prior experience • Tasks that are surprising, complex or new to the students • Visible value • Opportunities for the learners to re-engage with content of interest • Opportunities that enable the learners to continue to deepen and expand their current knowledge
Phase 3 Emerging individual interest	<ul style="list-style-type: none"> • Are likely to re-engage with content independently • Have positive feelings about the content • Ask curiosity questions that engage them in seeking behaviour • Are focused on their own questions • Have stored knowledge and stored value regarding the content • May have little value for the canon ("rule", "precept") of the discipline and most feedback 	<ul style="list-style-type: none"> • Some external support (e.g. peers, experts) in order to increase the learners' understanding • A learning environment that provides opportunities or challenges for the students
Phase 4 Well-developed individual interest	<ul style="list-style-type: none"> • Re-engage with content independently • Have positive feelings about the content • Have curiosity questions that engage them in seeking behaviour • Seek feedback • Self-regulate to reframe questions and seek answers • Have stored knowledge and stored value regarding the content • Recognise others' contributions to the discipline • Can persevere to meet goals despite frustration 	<ul style="list-style-type: none"> • Some external support (e.g. peers, experts) in order to increase the learners' understanding • A learning environment that provides opportunities or challenges for the students • Time and opportunities for the students to explore, ask questions and seek answers

Table 2

Descriptions of interactional characteristics: social congruence, cognitive congruence and subject matter expertise.

Interactional characteristic	Description
Social congruence	<ul style="list-style-type: none"> • Teachers show a personal interest in and care for their students, which enables them to create a good social climate and mutual respect between themselves and students (Rotgans & Schmidt, 2011; Yew & Yong, 2014) • Being interested in the learners' academic workloads and daily lives (Loda et al., 2019) • Stimulates integration, interaction and individual accountability (Grave et al., 1998) • Respecting students' opinions, understanding their feelings and building good relationships (Kassabb et al., 2006)
Cognitive congruence	<ul style="list-style-type: none"> • A teacher's ability to present content to students using terms with which they are familiar (Rotgans & Schmidt, 2011). Examples: breaking down concepts that they know are difficult, asking questions to guide students and giving students a structure for the mind and confidence that they can master on their own • Allows a facilitator to recognise difficulties students encounter while working through subject matter content (Schmidt & Moust, 1995) • Stimulating, elaborating and directing the learning process (Grave et al., 1998) • Teachers who lack cognitive congruence also lack strategies to scaffold students' learning and do not understand what students need (Yew & Yong, 2014)
Subject matter expertise	<ul style="list-style-type: none"> • Is the strongest and most significant predictor of situational interest (Rotgans & Schmidt, 2011) • The teacher possesses a suitable knowledge base of specific content (Schmidt & Moust, 1995) • The amount of knowledge a teacher holds has a positive effect on student achievement in an active-learning classroom (Schmidt & Moust, 1995)

3. Methods

3.1. Participants and contexts

Data were collected from two Norwegian kindergartens and two 2nd grade primary school classes, and they comprise recordings of children's (4–8-year-olds), teachers' and assistants' verbal and physical actions and expressions during exploratory natural science activities in various natural outdoor environments. Except for the teachers in Kindergarten 1, who were former teachers of the researcher's (first author's) children, the participants were not known to the researcher. All the teachers that took part in this study were formally educated kindergarten- or schoolteachers and had worked as teachers for several years. In Kindergarten 1 and Schools 1 and 2, the nature area is used once a week during spring, summer and fall,

whereas Kindergarten 2 spends time in the nature area on a daily basis all year round.

In the steering documents for Norwegian kindergartens, playing, exploring and learning in nature are highly prioritised (Kaarby & Tandberg, 2017; Ministry of Education and Research, 2017). As concerns the equivalent documents for primary schools, outdoor learning, for example, in a nature area, is linked to curriculum educational objectives (Waite, 2020). In Norway, it is common that the youngest children (especially those in the 1st and 2nd grades) spend half a day or more per week outdoors, for example, in a nature area (Jordet, 2010). The number of participants and the settings and descriptions of the kindergartens and schools are outlined in Table 3.

Table 3
Number of participants, recording times and settings of the participating kindergartens and schools.

Kindergarten/ school	Description of context	Description of kindergarten/school
Kindergarten 1	<ul style="list-style-type: none"> • 8 children (5–6 years old), 2 teachers • Recording time: 140 min x 2 • Natural outdoor area: Open forest area • Aim of activities: Explore nature (in an open forest area) • Activities: Free play within a confined area 	<ul style="list-style-type: none"> • Approx. 70 children, 20 adults • Located in a residential area on the outskirts of a village (6000 inhabitants) • Situated at the edge of a forest area with hiking trails and some small lakes, only a few minutes' walk from the kindergarten • The kindergarten visits the nature area once a week in summertime
Kindergarten 2	<ul style="list-style-type: none"> • 9 children (4–5 years old), 1 teacher, 1 assistant • Recording time: 100 min • Natural outdoor area: Open forest area • Aim of activities: Find, explore and identify leaves, insects, spiders and other small animals • Activities: Find and explore insects, spiders and other small animals and find and identify leaves 	<ul style="list-style-type: none"> • Approx. 90 children and 20 adults • Located on the outskirts of a town (55,000 inhabitants) • The kindergarten is situated at the edge of a nature area comprised partly of an open nature area and partly of a forest area. There is a fire pit and a playing area at the nature area with ropes attached to trees for climbing/swinging
School 1	<ul style="list-style-type: none"> • 12 children (2nd grade, 7–8 years old), 1 teacher, 2 assistants • Recording time: 70 min • Natural outdoor area: The shore of a lake • Aim of activities: Get to know fish • Activities: Pull up fish traps from a lake and dissect fish 	<ul style="list-style-type: none"> • Primary school (1st–7th grades), approx. 240 children • The school is located on the outskirts of a town (13,000 inhabitants) and is situated at the edge of a forest area • About 15 min' walk from the school (on hiking trails/a forest road), there is a lake and a river in an open forest area
School 2	<ul style="list-style-type: none"> • 10 children (2nd grade, 7–8 years old), 1 teacher • Recording time: 45 min • Natural outdoor area: Riverbank • Aim of activities: Get to know insects, spiders and other small animals in the river • Activities: Look for and identify insects, spiders and other small animals in the river. The children work in peers 	<ul style="list-style-type: none"> • Primary and secondary school (1st–10th grades), approx. 300 children • The school is located in a nature area in a village (1500 inhabitants) • The nature area surrounding the school is varied and is comprised of an open nature area, a small forest area and a river

3.2. Data collection

The data were collected by means of action cameras (GoPro Hero/Hero+) mounted on the chests of the teachers and three children in each kindergarten/school class and one of the researchers (the main author). The researcher, whose role was that of an onsite nonparticipant observer (Roller & Lavrakas, 2015), also took field notes to be compared with and add information to the video recordings.

Consent forms were collected from the children's parents, and the first author visited the children before the data collection sessions to ask for their consent. As this was the first time the researcher had met the children, she introduced herself and informed them about the project and the data collection. The children had the opportunity to ask questions and try out the action cameras. The use of action cameras mounted on the chests of children and teachers provided data that included both children's verbal and physical expressions of interest and the identification of factors that triggered such interest as they moved around the nature area and stopped to observe or pick up natural elements. The recordings from the teachers' cameras were used in the analysis, whereas the children's cameras were used to add information in situations where the activities or dialogues were unclear.

3.2.1. Data reduction

The data material comprised approximately 42 h of video recordings, including around 8 h from the teachers' cameras. Data reduction was carried out in two steps:

1. All the conversations from the teachers' cameras that dealt with science topics were transcribed. A *science topic* is here defined as a topic that deals with, for example, plants, animals, puddles and/or various other natural phenomena.
2. The dialogues that occurred *between children and teachers* were extracted.

These dialogues, as well as the situations and contexts in which they occurred, were further analysed in order to identify I) episodes

where interest occurred, II) phases of interest and III) teachers' support in terms of developing interest. Information on the teachers' planning of and/or preparatory work for the activities is not included in this study.

3.2.2. Data analysis

To identify the children's interest, we applied directed content analysis, which is an analytical approach where theory or relevant research results are used as guidance for creating initial codes (Hsieh & Shannon, 2005). In this study, Hidi and Renninger's (2006) and Renninger and Hidi's (2020) descriptions of learners' characteristics (see Table 1) and Rotgans and Schmidt's (2011) characteristics of interactional characteristics (Table 2) constitute the theory used to identify the children's phases of interest and teacher support. As our study is on younger children, we have included the concept of intersubjectivity as this is related to social and cognitive congruence. This was inspired by Fridberg et al. (2019) and Rommetveit (1974). These theories provide the initial codes in this study. The *pre-interest phase* category was developed inductively.

I. Identifying episodes of interest

Episodes where children express interest are recognised according to visible and/or vocal aspects of the three central characteristics of interest: affect, knowledge and value (cf. Hidi & Renninger, 2006).

Affect. According to Silvia (2005, 2008), the emotional components of interest include facial expressions, concentration and approach-oriented actions. Based on this, Loukomies et al. (2015) developed a scoring system of visible expressions of emotions where positive emotions are recognised through the following: positive facial expressions (e.g. smiling), attention paid to the activity and displays of an active/positive attitude towards the activity. Silvia (2005) also includes vocal expressions, such as more rapid speech and a greater range of vocabulary, as expressions of positive emotions. These factors and children's verbal expressions that indicate, for example, liking or enthusiasm, were applied to identify affection in our study.

Value is recognised as situations where children choose to re-engage with content or a task that they have previously shown an interest in, for example, through utterances or actively approaching content that was previously observed or experienced. An utterance identifies content through oral communication (Bakhtin, 1986), such as when stating, “This one is nice!”

Knowledge is identified as utterances where children present information about content by exclaiming, for example, “It’s a caterpillar”, or when children ask or generate answers to curiosity questions or hypotheses.

II. Identifying phases of interest development

The various phases of interest development were identified by recognising the occurrence of affect, value and knowledge in the children. This was conducted by analysing the children’s utterances and physical actions and expressions according to the learners’ characteristics previously described.

III. Identifying the teachers’ support

The teachers’ support in terms of developing the children’s interest was identified by analysing the teachers’ verbal and physical actions and expressions according to the descriptions of social congruence, cognitive congruence and subject matter expertise provided earlier (see Table 2).

3.2.3. Data triangulation

Data triangulation was undertaken by means of comparing the data from several cameras. This enabled comparison when the data were unclear or inaudible and improved our interpretation of the children’s actions, since data were recorded before as well as after the conversations with the teachers. An example of triangulation can be seen in Example 4 (see Table 8), where lines 1–2 were recorded by a child’s camera and lines 3–16 were recorded by a teacher’s camera.

4. Results

In the following, we present an overview of the number of episodes where the children express interest (see Table 4). Next, four different excerpts from the data material are presented where the children’s interest in a natural element appears and/or develops during exploratory activities in various natural outdoor environments. The excerpts were chosen as they represent examples of dialogues and situations that illustrate how the different phases of interest appear in the children and how teachers can support the children in terms of maintaining or developing their interest. Excerpts 2 and 4 also show how a lack of appropriate support may hinder the children in developing their interest further. The numbers in parentheses refer to specific lines in the examples presented.

4.1. Episodes of interest

A total of 30 episodes of triggers for interest and 85 episodes of interest were identified (see Table 4). In episodes where interest progresses from a more basic to a more developed phase, the latter

is registered in the table. All the episodes are initiated by the children’s own discoveries or previous observations of various natural elements or by one of the teachers presenting or showing such an element to the children.

4.2. Examples of excerpts

4.2.1. Example 1: the caterpillar – development from triggered situational interest to individual interest

4.2.1.1. *From discovering to getting first-hand experience of the natural element.* The situation and dialogue in example 1 (Table 5a) is initiated by a girl, Anna (from Kindergarten 1), who finds a caterpillar on the forest road. She expresses positive emotions and engagement with the caterpillar as she utters, “Wow!” in a high-pitched voice (1) and crouches down to observe the caterpillar more closely. She points at the caterpillar and pays obvious attention to the animal. Anna’s affective utterance and the posture she uses to approach the caterpillar indicate that she is experiencing positive emotions related to the situation of discovering the larva. This is further confirmed as she calls for others’ attention (3; 5).

One of the teachers (T1) actively follows up Anna’s first call for attention and pays attention to the situation, uttering “Wow! Look!” (2) and pointing at the caterpillar. She speaks in a low but engaged voice (2; 4; 6) and points at the caterpillar. The teacher thus expresses how she shares the child’s interest as well as her positive feelings with regard to discovering the caterpillar. The other children and teacher (T2) pay attention to the situation and express similar reactions (7; 17).

After these first affective utterances, the children start commenting on the caterpillar in relation to, for example, *what it is* (8) and *how it looks* (10; 16). This indicates that their focus is directed towards the natural element itself and that the children have gained first-hand experience of the caterpillar. The teachers follow this up by answering Ben’s question (8–9) and confirming the children’s observations (10–11; 16–17) and utterances (12–13) about the caterpillar. The teachers thus express that they share the children’s focus in terms of the natural element that has triggered the children’s attention.

The shared affection and attention regarding the topic that interests the children can be related to the teachers’ *social congruence*. By confirming (9) and adding information (13), Teacher 1 also shows *subject matter expertise*. The teacher thus shows that she takes the children seriously, which further confirms this teacher’s social congruence.

In this example, Teacher 1 alternates between socially congruent responses and others related to her subject matter expertise. The teacher thus demonstrates *cognitive congruence* as she is able to adjust her support according to the children’s needs (cf. Yew & Yong, 2014). By doing so, the children’s attention is maintained on the caterpillar, which indicates that they have developed *triggered situational interest*.

Establishing shared affection and experience seem to be essential in order to maintain the children’s attention on the object that first triggered their interest. The teacher’s ability to show social congruence therefore seems to have a particularly large influence at this early point of interest development, where the children’s focus seems to change from the experience of discovering the caterpillar to focusing on the caterpillar itself and gaining first-hand

Table 4
Number of episodes in terms of the different phases of interest (including triggers for interest).

Phase of interest	Trigger for interest	Phase 1	Phase 2	Phases 3 and 4
Number of occurrences	30	44	34	7

Table 5a
Example 1: the caterpillar, lines 1–17.

Line	Speaker	Content
1	Anna:	Wow! (<i>crouching down, looking at a caterpillar on the forest road</i>).
2	T1:	Wow! Look! (<i>pointing at the caterpillar, said in a low, engaged and intense voice</i>).
3	Anna:	Look!
4	T1:	Wow. We must not step on it or touch it (<i>said in a low, engaged voice</i>).
5	Anna:	T1, I found an animal.
6	T1:	Hush (<i>said in a low voice</i>). Don't frighten it ... and don't touch it.
7	Mary:	Wow! (<i>several children pay attention to the situation and crouch down. T1 stands back</i>).
8	Ben:	What kind of animal is that?
9	T1:	It's a caterpillar.
10	Daniel:	A huge caterpillar.
11	T1:	Mhm (<i>acknowledging</i>).
12	Ben:	It is not wise to touch them ...
13	T1:	No ... we must not poke it with a stick or anything, because the caterpillar probably has some spines.
14	Eric:	What? (<i>Eric and T1 pay attention to the group</i>).
15	Daniel:	(... <i>unclear</i> ...) found a caterpillar!
16	Ben:	A huge caterpillar!
17	T2:	Wow! That one is huge!

experience of it (how it looks).

4.2.1.2. *From triggered to maintained situational interest – supporting the children by asking authentic and open questions.* The focus on the caterpillar continues in lines 18–31 (Table 5b). Teacher 2 responds to the boys' comments in lines 18 and 19 by asking what they think the caterpillar might become (20). By asking for the children's thoughts, and by adding the word *might*, the children experience this as an *authentic question* (Elfström et al., 2016). This question seems to engage the children as many of them simultaneously and loudly answer, "Butterfly". The teachers follow this up by confirming the children's answers (24; 31) and by asking an open question that refers to a children's book about a caterpillar (22).

The authentic question asked by Teacher 1 (20) seems to mark a change in the children's interest. When the teacher asks for the children's ideas, this signals a personal interest in the children and their thoughts, as well as in the topic that seems to interest them (the caterpillar). The teacher thus shows *social congruence*. This is also evident when the teachers confirm the children's answers and comments (24; 28; 31), which indicates a shared and maintained focus on the topic.

By showing social congruence, the teachers maintain the children's attention on the caterpillar, and the situation is prolonged. The sustained observation of and positive feelings towards the caterpillar (e.g. simultaneous and loud speaking, line 21) and the children's active approach towards the caterpillar (e.g. Matt takes pictures, line 25) indicate that the caterpillar holds some *value* for

the children. These are characteristics of maintained situational interest as described by, for example, Hidi and Renninger (2006).

The authentic and open questions asked by Teacher 2 (20; 22; 29) can also be related to the teacher's *cognitive congruence* as they bring forth the children's knowledge (21; 23) and personal experiences/observations (30) regarding the content (the caterpillar). This is in line with Grave et al.'s (1998) description of cognitive congruence as a teacher's ability to stimulate, elaborate and direct the learning process. Support from the teacher in drawing connections between the content of interest and the children's previous knowledge is one characteristic of maintained situational interest (20–24).

By showing social and cognitive congruence and subject matter expertise, the teachers facilitate the children's interest and the development of triggered situational interest into maintained situational interest. Subject matter expertise is demonstrated through the question in line 20, which indicates that the teacher knows that the caterpillar is the starting point for the adult stage of several insect groups, and in line 24, when she confirms that it might be a moth.

4.2.1.3. *Individual interest – supporting the children by providing answers and additional information.* Seventy-five minutes later, the children and teachers are on their way back to the kindergarten (Table 5c). As they pass the spot where the caterpillar was found earlier on (32–37; 38–47), Daniel and three other children re-engage with the caterpillar. This is seen when Daniel spontaneously asks where the caterpillar is (32). Teacher 2 supports Daniel

Table 5b
Example 1: the caterpillar, lines 18–31.

Line	Speaker	Content
18	Eric:	That was a huge caterpillar.
19	Ben:	A huge butterfly.
20	T2:	What do you think it might become?
21	Children:	Butterfly! (<i>several children simultaneously</i>).
22	T2:	"The very hungry caterpillar", or? (<i>referring to a children's book</i>).
23	Eric:	Or a moth?
24	T1:	... or a moth, yes.
25	Matt:	I took three pictures of it (<i>he has an iPad</i>).
26	T2:	You must be careful with the small animals.
27	Daniel:	If we leave, the caterpillar might cross the road.
28	T1:	Yes. It is about to do so.
29	T2:	Maybe it will still be here when we are on our way back?
30	Daniel:	It moves so slowly.
31	T2:	Yes.

Table 5c
Example 1: the caterpillar, lines 32–47.

Line	Speaker	Content
32	Daniel:	But where is the caterpillar? (<i>speaking loudly</i>).
33	T2:	Yes, we have to pay attention to that. We must look in the middle of the road so that we don't step on it.
34	Daniel:	What will happen if we do?
35	T2:	To the caterpillar? Then it will be dead.
36	Daniel:	Then it won't be able to become a nice butterfly.
37	T2:	No ... so we have to be careful.
<i>Teacher 1 and Eric are walking a little further behind the others, and the following dialogue takes place:</i>		
38	T1:	If we have a look over here now, I think this is where the caterpillar was.
39	Eric:	Can you see the caterpillar? I can't.
40	T1:	I think it's gone.
41	Eric:	It was over here we saw it (<i>pointing</i>). But now it's not here. Maybe it is over here? (<i>turning towards the ditch edge</i>).
42	T1:	It has probably gone away now.
43	Eric:	Yes. I think so. It is far over there.
44	Eric:	... or maybe it's going to pupate? ... Maybe it's inside a pupa?
45	Eric:	Because I think it was a butterfly caterpillar.
46	T1:	Yes, I think so too. A butterfly or moth or something like that.
47	Eric:	Moths can be taken by bats. Bats can be far away.

by providing him with an answer that includes additional information (33). This leads Daniel to ask a curiosity question, which requires reflection (34). He also shows reflection as well as stored knowledge through his statement in line 36. This also indicates that Daniel has positive feelings and stored value related to the animal.

4.2.1.4. The teacher's support in lines 32–47. The dialogue in lines 38–47 is initiated by Teacher 1, and Eric re-engages with the caterpillar as he responds to the teacher's utterance concerning where the caterpillar might be (39; 41; 43–45; 47). In line 44, Eric poses questions that are in the form of a hypothesis, and in line 45, he provides reasoning to reinforce his statement.

The teacher supports Eric by answering and acknowledging his questions and contributions (40; 42; 46). The teacher also provides Eric with additional information (46), which leads him to present information about a topic related to the caterpillar (47). This shows that Eric has stored knowledge about the topic and that he is able to apply this knowledge.

Subject matter expertise. The teachers support the children by answering their questions and by providing them with additional information. This stimulates the children to ask curiosity questions (34; 44). It also leads Eric to present information about a topic related to the caterpillar (47), which shows that he has stored knowledge about the subject. Stored knowledge also appears in lines 44–45 and from Daniel in line 36. According to, for example, Renninger and Hidi (2020), asking curiosity questions and having stored knowledge are learners' characteristics of an emerging individual interest. The same applies for re-engaging with the content (32; 39) and the children focusing on their own questions (44–45). This indicates that the children's interest has developed into *emerging individual interest* and that the teachers' subject matter expertise supports this development.

Social congruence. When the teachers answer the children's questions, confirm their statements and add information, they signal that they take the children seriously and respect and understand their contributions to the conversation (37; 46). This may help create a social climate where children ask curiosity questions (34) and suggest answers and hypotheses (44), instead of being afraid to ask "silly" questions or provide "wrong" statements and answers.

Cognitive congruence. It is also important that the teachers answer the children's questions and present information in a way that the children understand (cf. cognitive congruence).

Based on this, our results indicate that in order for children's maintained situational interest to deepen and develop into

emerging individual interest, teachers' subject matter expertise plays an important role (see line 46). However, the teachers' ability to show both social and cognitive congruence contributes as well.

Eric seems to have knowledge about the topic, and he reframes questions and seeks answers (44–45). Based on the teacher's contribution in line 46 (providing additional information), Eric extends the topic (47). According to Renninger and Hidi (2020), these learner characteristics are, in addition to the aforementioned characteristics of emerging individual interest, typical of the well-developed phase of interest. The results in this study thus indicate that during this individual phase of interest, the boys relate to the caterpillar in the form of reflecting on and applying the knowledge they have acquired about the caterpillar, for example, through the teachers' support in the form of subject matter expertise.

4.2.2. Example 2: the frog – when children's interest does not develop further

In example 2 (Table 6), Teacher 1 (from Kindergarten 1) discovers a frog by the forest road. She expresses a positive affective utterance and calls for the children's attention (1). The teacher also points at the frog to show the children where it is. The children show great enthusiasm with regard to the discovery of the frog. They express this by speaking loudly and eagerly, and several children talk at the same time (4–11).

The children pay active attention to the frog, and when Teacher 1 encourages the children to catch the frog in line 3, they pick it up, show it to others and start commenting on it (5; 25–27). By directing the children's attention towards the frog, and by encouraging the children to catch the frog (that is, providing them with hands-on experience of the animal), the teacher's support seems to have helped the children's initial experience of and attention paid to the frog to evolve into a triggered situational interest.

In line 12, Teacher 2 expresses that she wants to have a look at the frog, and she comments on it. She also indicates that she does not want to touch it. As the frog jumps out of Anna's hand, this creates laughter, and the children gather around it. On the video recordings from some of the children's cameras, it appears that the children clearly pay attention to and get first-hand experience of the frog, as some of them hold it in their hands while others sit down, observe it closely and "talk" to it (25).

Meanwhile, T1 asks a question related to the frog (13). Anna, who is observing it, hears the question and turns around to look at the teacher. She seems to be uncertain of the answer (14), but as the

Table 6

Example 2: the frog.

Line	Speaker	Content
1	T1:	Wow! Look here! Frog! Frog! (<i>pointing at the ground</i>) ... a small frog.
2	Two boys:	Let me see.
3	T1:	It jumps into ... there! ... Can you catch it? Careful!
4	Anna:	I saw it! Oh!
5	Mary:	A baby frog!
6	Mary:	I think I've got it! It's jumping away! (<i>said eagerly, holding the frog in her hand</i>).
7	Anna:	Let me have a look! Let me have a look!
8	Ben:	Oh! Yeah!
9	Daniel:	We must show it to the others.
10	Children:	We have caught a frog! We have caught a frog! (<i>repeating this in a singing tone as they run towards the other children and T2</i>).
11	Anna:	I have got a frog in my hands!
12	T2:	Let me have a look! ... but I don't want to have it on me, only ... Wow. That's a small one. (<i>The frog jumps out of Anna's hand. The children and the teacher laugh</i>).
13	T1:	How do we know it's a frog?
14	Anna:	Because ...
15	T1:	Because?
16	Anna:	... it can jump?
17	T1:	Yes. So, if we ...
18	T2:	How many legs does it have?
19	Anna:	I want to let it go. (<i>She lets the frog go. The children gather around the frog, observing it closely</i>).
20	T1:	... So if we see a frog or a toad, how can we tell the difference between them, Anna?
21	T1:	Anna, how could we tell the difference if it were a toad?
22	Anna:	I have no idea.
23	T1:	... no idea? (<i>the children are focused on letting the frog go</i>).
24	T1:	... so if you touch it carefully on its back and it does not jump, then it's a toad. A toad cannot jump ... only frogs jump ... So if it jumps, then it's a frog.
25	Daniel:	Hello little frogman (<i>the children are crouching down, observing the frog</i>).
26	Ben:	T2, it is over there. It is almost jumping under ...
27	Anna:	It is going to its family.

teacher encourages her to respond (15), she makes a suggestion (16). She then turns back to the frog and the other children. In line 17, the teacher confirms Anna's answer and follows up with another question related to the frog (20). Teacher 2 also asks a question (18). The questions, which are all closed questions, are partially answered by Anna (22) or are not answered at all.

As a response to Anna's answer, "I have no idea" (22), Teacher 1 gives a long and thorough answer to the question herself (24), which shows that the teacher has subject matter expertise. However, the children are occupied with observing and commenting on the frog (25–27) and do not seem to pay attention to the information provided by the teacher.

In lines 11–27, the children and the teachers all pay attention to the frog. However, whereas the children are occupied with exploring and gaining first-hand experience of the frog (observing and touching it), the teachers focus on facts related to the animal (13; 18; 24). This is also seen in lines 18 and 19, where instead of answering the teacher's question in line 18, Anna utters that she wants to let the frog go (19).

This indicates that, despite both the children and the teachers paying attention to the frog, their focus is somewhat different. The teachers thus do not focus on what really seems to interest the children. This indicates that the teachers only show social congruence to some extent and that the strategies applied by the teachers to support the children's needs and learning are not sufficient in this phase of interest. This indicates a lack of cognitive congruence.

The children's attention and positive feelings with regard to the frog are maintained throughout the whole situation. However, as the teachers' support through social and cognitive congruence is lacking, and because the children continue focusing on exploring the animal, it may seem like the children's interest in the frog does not develop further and remains a triggered situational interest.

4.2.3. Example 3: the crayfish – developing maintained situational interest

In example 3 (Table 7), twelve schoolchildren (School 1), one teacher and two assistants are studying fish from a lake. The children have pulled up fish traps containing many perch, and among the fish is a large crayfish. The crayfish is in a plastic tub filled with water, and one assistant and two boys are studying the animal. The teacher is also paying attention to the situation.

The children ask many questions about the crayfish and continue to observe it for some time. In lines 3–11, the children's questions and comments are related to the crayfish's characteristics (3; 7) or to gaining first-hand experience of it (5; 9; 11). In lines 12–26, on the other hand, the children's focus seems to change towards what the animal is (12), and they ask for explanations (14; 23).

The assistant sits on the ground together with the children and provides them with answers that include additional information (2; 8; 13). She thus, along with the children, pays attention to the crayfish and takes the children's interest seriously. This is consistent with the characteristics of *social congruence*.

By answering the children's questions and providing additional information, the assistant also shows subject matter expertise. The additional information given in line 13 seems to be essential for the explanatory question asked by Sam in line 14. By being attentive to what seems to interest the children at any given time, and by "levelling" with the children, the assistant is attentive to what responses the children want and need. She alternates between answering questions (2; 13), providing information (8), asking questions (24) and encouraging the children to explore (20). In this way, she provides the children with new knowledge and experiences and encourages them to reflect (24). She thus shows cognitive congruence. The assistant also has active body language, using her hands to illustrate her statements about the crayfish (8; 13; 24), which may help the children to focus on and observe its characteristics.

Table 7
Example 3: the crayfish.

Line	Speaker	Content
1	Peter:	How ... how did you find a lobster?
2	Assistant:	No, it was inside ... together with the fish. It had crawled into it (<i>the fish trap</i>).
3	Peter:	Is it alive?
4	Assistant:	Yes, it is alive. Don't you remember that we were here last year, but then it was much smaller?
5	Peter:	We can touch its back.
6	Assistant:	Yes, but we have to let it go, because we are not allowed to take it.
7	Sam:	What is under ... bsss (<i>making sounds and moving his hands</i>).
8	Assistant:	Those are his legs. He can bend them like this, you see (<i>showing with her hands</i>).
9	Sam:	Touch it once more.
10	Assistant:	Shall I touch it again?
11	Sam:	Yes
12	Peter:	Is it a lobster? ... Is it a crayfish?
13	Assistant:	It is a crayfish. Look what he can do with those long horns (<i>showing with her arms</i>). He can even bend them.
14	Sam:	Why does he need them?
15	Assistant:	Maybe he can sense his way by using them?
16	Teacher:	Such small claws on those forelegs.
17	Assistant:	We were wondering about those. He can bend them in a strange way.
18	Sam:	Those ... those hands can pinch (<i>showing with his hands</i>).
19	Assistant:	Maybe he can catch some small animals and eat with those claws?
20	Assistant:	... but those eyes ... Come a little bit closer, Sam. See if you can see his eyes.
21	Sam:	I can see them.
22	Susan:	I can't.
23	Susan:	Why does he have such ... ?
24	Assistant:	... those horns? (<i>shows with her hands</i>). Why do you think?
25	Susan:	I don't know. They look like ... (<i>inaudible</i>).
26	Assistant:	Yes, and he has also got some other small claws as well. But the other one over there, he uses it to sense his way.

By showing social congruence, subject matter expertise and cognitive congruence, the assistant seems to contribute to a more developed interest in the children as they are able to do the following:

- re-engage with the content by, for example, showing sustained attention with regard to the crayfish by repeatedly asking questions
- develop their knowledge of the crayfish by getting answers to their factual questions (e.g. 3; 12) and observing (e.g. 18)

This is consistent with the characteristics of learners' *maintained situational interest* (Renninger & Hidi, 2020). The question in line 14 indicates that Sam's interest might have evolved even more, as this is a curiosity question that indicates reflection on his part.

4.2.4. Example 4: the caddisfly – different phases of interest need different support

In example 4 (Table 8), ten schoolchildren and one teacher from School 2 are looking for insects and other small animals in a river. The children are working in peers, using scoop nets to collect the animals. The animals are placed in a plastic box filled with water.

Jack finds a caddisfly (*Trichoptera*) in a girl's hair (1) and expresses enthusiasm and wonderment with regard to his discovery as he calls for attention and runs towards the teacher to show her his finding (2; 5; 6). The teacher pays attention to the insect by holding the caddisfly in her hand and by spending time observing and commenting on the insect. She also sits on the ground together with the two girls. In this way, she expresses that she is sharing the children's experience and paying attention to the insect. She thus shows social congruence.

The teacher also shows subject matter expertise, as she is able to identify the insect as a caddisfly and provide facts about it (9; 11;

Table 8
Example 4: the caddisfly.

Line	Speaker	Content
1	Jack:	You've got an animal in your hair (<i>said to a girl</i>). Jack takes the insect out of the girl's hair, and they both run towards the teacher.
2	Jack:	I found this ... I found this! (<i>shouting loudly to the teacher as he runs</i>). At the same time, the teacher and two girls (Alice and Ella) are observing some insects in a small plastic box filled with water.
3	Alice:	There is an animal! (<i>looking in the small plastic box</i>).
4	Teacher:	Yes. You have found a (<i>bending forward</i>) ... it must be a caddisfly larva (<i>looking in the plastic box</i>).
5	Jack:	Look! I have found an animal! I found an animal! (<i>said enthusiastically and with a tone of wonderment as he comes running</i>).
6	Jack:	I found it in her hair! (<i>showing the insect to the teacher</i>).
7	Teacher:	(<i>Laughing</i>) Yes ... but, hello ... shall I tell you something? (<i>she takes the insect in her hand</i>).
8	Jack:	Yes. (<i>Jack's peer calls him and he runs off</i>).
9	Teacher:	That the one that is swimming down there (<i>in the plasticbox</i>) is going to be like that (<i>the insect in her hand</i>).
10	Ella:	Ooh!
11	Teacher:	You see, this one is young (<i>pointing at the water</i>), and when it is an adult, then ...
12	Ella:	... is it a mosquito?
13	Teacher:	No, it is not a mosquito. It is a ... caddisfly.
14	Ella:	Cool!
15	Alice:	Why can't you put it in there? (<i>pointing at the water</i>).
16	Teacher:	Because it can't live in water. Now it is going to live in the air and ... I don't know if it's a boy or a girl, but now it is going to get a girlfriend or boyfriend and make babies ... and then it'll die ... So it has a rather short and awesome life. The They actually live the longest in the water.

13; 16). Before she presents information about the insect, she gets the children's attention by asking, "... shall I tell you something?" (7). When she provides the facts, she uses words that are familiar to the children and relates to the two different caddisflies by pointing at them. This corresponds to characteristics of cognitive congruence.

As the teacher starts to talk about the caddisfly (9), Jack's peer calls him over from a distance. He runs back to his peer and does not wait for the information provided by the teacher. This may indicate that the experience that triggered his attention (that is, the discovery of the caddisfly) has not developed into triggered situational interest. This can be interpreted as the pre-interest phase, an inductively developed phase, not included in Hidi and Renninger's (2006) model. The two girls, on the other hand, seem to have triggered situational interest concerning the insect, as they continue to listen to the teacher and make short affective comments in response to the information provided by her (10; 14).

In line 12, Ella expresses that she knows what it is, and in line 15, Alice asks a curiosity question, which shows that she has acquired knowledge about the topic and is able to relate it to the animal. Their responses and questions indicate that they have some knowledge related to the topic (12) and that they are able to reflect on it (15). Their maintained attention towards the caddisfly and the affective utterances expressed by Alice indicate that they have positive feelings and may also indicate that they are developing a sense of value with regard to the animal. This, as well as the indications of their developing knowledge, shows that the girls' interest in the caddisfly has developed into *maintained situational interest* (the curiosity question might even indicate that their interest has deepened even further).

The results thus show that by having subject matter expertise, and by being cognitively congruent, a teacher can facilitate the development of children's interest from triggered situational to maintained situational interest. Social congruence is also important in order to establish shared attention with regard to the topic of interest.

5. Summary of the findings

All the children's activities in this study are based on the finding and exploration of natural elements. The results in this study show that the children's focus on natural elements varies between the different phases. In the first phase, triggered situational interest, the children focus on gaining first-hand information about the natural element. In the next phase, maintained situational interest, they are more receptive to gaining factual knowledge about the natural element, whereas in the most developed phases, individual interest, the children reflect on and apply the knowledge they have acquired about the natural element. We have also identified a pre-interest phase, which constitutes a trigger for interest, where the children's focus is directed towards the experience of discovering the natural element. By identifying the children's focus on the natural element, this enables the teachers to recognise their phase of interest and provide them with the support needed. A summary of the results is presented in Table 9.

6. Discussion

The aim of this study is to examine how children's interest in natural elements develops and appears and how teachers can support it and deepen and develop it when situated in an outdoor environment. The results show that the different interactional qualities of teachers (social congruence, subject matter expertise and cognitive congruence) are needed in various degrees as children's interest develops.

6.1. The development and appearance of children's interest in natural elements

Natural elements trigger children's attention. This is apparent in examples 1–4 and is in line with previous studies by, for example, Jung et al. (2019), Renninger and Hidi (2020) and Skalstad (2020). It is therefore important that teachers are attentive to what these triggers are and are able to identify and adjust their support according to children's phases of interest. In the following, we will discuss how children's interest in natural elements appears and develops.

6.1.1. Developing triggered situational interest: from discovering to gaining first-hand experience

Whereas some children's attention with regard to content is sustained after the first brief moment of discovery, and after sharing their discovery with others (see examples 1 and 2), other children change their focus and attention. This is seen in example 4, where Jack runs back to his peer who is calling him. According to Renninger and Hidi (2020), a learner that has a developing interest is likely to already be seeking information. In example 4, when Jack finds the caddisfly in the girl's hair, it seems as if it is the surprise of finding the insect in her hair that has triggered his attention, rather than the insect itself. In order for Jack to become interested in the insect and experience a need for information, the teacher has to be able to keep Jack focused on it, as this can provide him with more experience and opportunities to develop a need for information and knowledge, which will create triggered situational interest in Jack.

At this stage, the pre-interest phase of discovery, it is essential that a teacher is able to identify what really interests children. In example 4, the experience itself seems to be Jack's focus. In order to support Jack in developing triggered situational interest in the caddisfly, the teacher must show social congruence by sharing his affection and enthusiasm. However, instead of responding with an utterance that corresponds to this, as seen in examples 1 (2; 17) and 2 (1), the teacher in example 4 focuses on the caddisfly and starts providing facts about it, which are not Jack's focus.

A teacher's ability to show cognitive congruence is also important when it comes to transitioning from the pre-phase of discovery to developing an interest in the natural element in question. This is seen in example 2, where the teacher shows cognitive congruence as she encourages the children to catch the frog (3). This is in line with what is the focus of the children's attention—the experience of discovering—and, at the same time, it encourages the children to gain first-hand information about the frog (how it feels and what it does). This, in turn, can lead them to seek more information through further exploring the natural element, thus developing a triggered situational interest, which is characterised by the children gaining first-hand information by exploring the natural element themselves. A teacher's subject matter expertise is less prominent in the pre-interest phase of discovery.

6.1.2. Developing maintained situational interest: from gaining first-hand experience to acquiring factual knowledge

Whereas the pre-phase of interest is characterised by children relating to a natural element by focusing on the experience of discovering, the children's focus changes towards the natural element itself in the triggered situational phase of interest. When children start exploring content more closely and are commenting on a natural element's characteristics (see example 1, lines 10, 18 and 30; example 3, line 18), the knowledge the children have acquired through observing and exploring the animal is reflected, and their interest is directed towards *gaining first-hand experience* of the natural element.

Table 9

Overview of children's characteristics and teacher support in various phases of interest development during exploratory activities related to a natural element. The phases of interest correspond to Hidi and Renninger's (2006) four phases of interest development.

Phase of interest	Characteristics of how the children relate to the natural element	Teachers' support
Trigger for interest ("Pre-interest phase")	They are focused on the experience of discovering a natural element: <ul style="list-style-type: none"> Affective verbal and physical expressions Calls for attention 	<u>Social congruence:</u> • Sharing the child's affection and attention with regard to the discovery <u>Cognitive congruence:</u> • Encouraging the child to explore the natural element
Phase 1: Triggered situational interest	They are focused on gaining first-hand experience of the natural element: <ul style="list-style-type: none"> Observing/exploring the natural element Commenting on the characteristics of the natural element (e.g. how it looks, what it can do) 	<u>Social congruence:</u> <ul style="list-style-type: none"> Sharing the child's affection and attention Taking part in explorations <u>Cognitive congruence:</u> <ul style="list-style-type: none"> Encouraging explorations <u>Subject matter expertise:</u> <ul style="list-style-type: none"> Confirming/disconfirming children's subject matter statements Providing additional information
Phase 2: Maintained situational interest	They are receptive to factual knowledge about the natural element: <ul style="list-style-type: none"> May ask factual questions May answer (preferably) authentic or open questions 	<u>Social congruence:</u> <ul style="list-style-type: none"> Sharing the child's attention Showing interest by asking authentic or open questions <u>Cognitive congruence:</u> <ul style="list-style-type: none"> Alternating between answering questions/asking authentic or open questions. providing information and encouraging explorations Presenting natural science content in an understandable and interesting manner Relating present knowledge/experiences to new knowledge <u>Subject matter expertise:</u> <ul style="list-style-type: none"> Answering questions Confirming/disconfirming children's subject matter statements Providing additional information/facts
Phases 3 and 4: Individual interest	They are reflecting on and applying the knowledge they have acquired about the natural element: <ul style="list-style-type: none"> Asking curiosity questions Stating hypotheses Presenting information 	<u>Social congruence:</u> <ul style="list-style-type: none"> Being available for the child Acknowledging the child's contribution <u>Cognitive congruence:</u> <ul style="list-style-type: none"> Presenting facts in an understandable manner Stimulating reflection by providing answers that include additional information <u>Subject matter expertise:</u> <ul style="list-style-type: none"> Answering questions Presenting natural science-related facts/additional information

If supported sufficiently by a teacher, the children's interest can develop further and enter into a phase where they are receptive to gaining factual knowledge about the natural element. This transition, from the triggered to the maintained situational phase of interest, may, however, be demanding as the children's expressions are not as obvious and explicit as in the previous phases.

In the following, we will present and discuss more closely how a teacher can support children in transitioning from the triggered situational phase of interest, where they focus on gaining first-hand experience, to developing a maintained situational interest, where the children are receptive to gaining factual knowledge.

6.1.2.1. Identifying the focus of a child's interest. For the triggered situational phase of interest to develop, it is essential that a teacher is attentive to what really interests children and what is the focus of their attention and that he/she directs his/her attention and support according to this. This can be related to establishing mutual understanding (sufficient intersubjectivity; Fridberg et al., 2019; Rommetveit, 1974), which can be seen in examples 1 and 3. In example 2, on the other hand, the children's and teachers' focuses diverge (cf. illusory intersubjectivity; Fridberg et al., 2019; Rommetveit, 1974). Whereas the children's focus is directed towards the frog itself (what it does and how it feels), the teachers' focus is on facts related to the frog. Even if Teacher 1 in example 2 shows subject matter expertise by providing facts related to the frog, this information does not seem to be acquired by the children and may even prevent the children's interest from developing further.

6.1.2.2. Presenting facts. Providing facts about the natural element can result in increased knowledge in children in the early phase of interest. It is, however, important that a teacher can achieve the following:

- identify the focus of the children's interest
- maintain the children's attention on the natural element
- present the information in an understandable way

Example 4 illustrates the challenges teachers face when they meet children with different needs and in distinct phases of interest. Whereas the two girls, who seem to be in the triggered situational phase of interest, are focusing on the caddisfly, Jack's attention is on the experience of discovering the insect, and facts do not support him in developing triggered interest regarding the caddisfly.

6.1.2.3. Asking authentic or open questions. Teachers can also support children's interest development by asking them science-related questions. It is, however, crucial that the questions are open and/or authentic (cf. example 1, line 20) and not closed, such as in example 2. When the teachers in example 2 ask closed questions, they ask for specific answers and thus focus on specific areas (for example what is the difference between a frog and a toad?). The children, on the other hand, pay attention to what the frog is doing and where it is going, and thus do not seem to pay attention to the teachers' questions.

Asking authentic or open questions, on the other hand, provides the opportunity for various answers and may thus open up various

focus areas as well. This prolongs the situation and the attention paid to the natural element and leads to the children coming up with answers to the questions themselves. This is in line with Schmidt and Moust's (1995) and Yew and Yong's (2014) descriptions of being cognitively congruent. The dialogue that occurs between Teacher 1 and the children in excerpt 1, in lines 18–31, is in line with exploratory talk and sustained shared thinking, as described by Siraj-Blatchford and Sylva (2004) and Skalstad (2020). Subject matter is presented by the children (21; 23) and confirmed by the teachers in line 24 and, to some extent, in line 22. The teachers' subject matter expertise is thus present.

By asking for the children's thoughts, the teacher also indicates that she is interested in the children's ideas and not one specific answer that they might not know or that does not interest them. Based on this, the support provided by Teacher 2 in example 1 demonstrates that being socially and cognitively congruent seems to be important when supporting the further development of children's interest.

The teachers in example 2 do not therefore show the same degree of social congruence and cognitive congruence as Teacher 2 in example 1. Whereas the authentic questions asked in example 1 prolong the situation, asking closed questions may result in bringing things to an end and thus prevent children's interest from developing further.

6.1.2.4. Answering children's questions. Some children start asking factual questions about, for example, what the natural element is and what it can do (e.g. example 3). These are clear indications that the children are open to gaining factual knowledge about such elements. This is in line with Skalstad and Munkebye (2021), who found that most children's questions about science topics in a natural outdoor setting asked for basic information.

According to Renninger and Hidi (2020), developing content knowledge is one of the characteristics related to maintained situational interest. By contributing to the children's focus on getting factual knowledge about the natural element in question, a teacher thus shows that he/she takes the children seriously, which may facilitate the development of the children's interest.

A teacher must therefore be able to answer children's questions and provide additional information, as this can facilitate the asking of further questions (e.g. examples 1 and 3). A teacher thus needs subject matter expertise. At the same time, the answers must be presented in a language that is understandable to the children, which can be interpreted as a teacher being cognitively congruent (cf. Rotgans & Schmidt, 2011; Schmidt & Moust, 1995). Being socially congruent is less prominent when supporting the children by answering their questions but appears when a teacher is attentive to the question itself.

As children's questions are a source of gaining new information, this implies that stimulating children to ask questions can be a way to scaffold the further development of children's interest. The many questions that occur in example 3 might be caused by that as, whereas frogs and insects are more commonly seen, not so many children have seen a live crayfish. This indicates that novelty is a trigger for interest and an important factor when further developing such interest (Bølling et al., 2019; Renninger & Hidi, 2020) as it seems to enhance children's question-asking. This is also related to our previous studies where we found that children's encounters with nature and natural elements facilitate children's question-asking (Skalstad & Munkebye, 2021).

6.1.3. Developing individual interest

We see few examples of emerging and well-developed individual interest in our material. One reason might be that it requires time for situational interest to develop into individual interest.

However, in example 1, in relation to the caterpillar, several of the characteristics related to individual interest occur, including independently re-engaging with content (32), asking curiosity questions (34; 44) and having stored knowledge of content (36; 44–45; 47). Curiosity questions are also present in examples 3 (14; 23) and 4 (15), which might indicate that the children's maintained situational interest has deepened.

In the individual phase of interest, where children have stored knowledge and recognise the value of content, they are already focused on this and do not need the same support as in earlier phases in the form of establishing shared attention, emotions or understanding. As children in the individual phase of interest ask curiosity questions, present hypotheses and formulate assumptions (e.g. example 1, lines 32–47), teachers get a clearer picture of the knowledge the children possess compared to, for example, in the maintained situational interest phase.

Support in the emerging and well-developed individual interest phase consists of answering children's curiosity questions and presenting facts and additional information as these increase the children's understanding of the topic. Subject matter expertise is therefore important. Cognitive congruence is less prominent but appears as being able to present answers to questions using terms with which children are familiar (Rotgans & Schmidt, 2011; Schmidt & Moust, 1995). Providing children with additional information may stimulate them to reflect and can thus be seen as cognitive congruence as well. With regard to the well-developed individual phase, we found that when a teacher is available, this seems to trigger children to present their thoughts and knowledge (e.g. Eric, example 1). These results are in line with Hidi and Renninger (2006), who found that emerging, as well as well-developed, individual interest requires some external support.

When the children in this study ask questions that require reflection (e.g. "why-" and "how-" questions) and make hypotheses or statements where they apply their knowledge (e.g. example 1, lines 44 and 47), this indicates that their knowledge has deepened. This confirms that interest has an impact on children's levels of learning (cf. Krapp, 2002).

6.2. Teachers' support in developing children's interest

6.2.1. Social congruence

According to Rotgans and Schmidt (2011), social congruence and subject matter expertise influence cognitive congruence. They also state that whereas a teacher's social congruence is, to a large extent, a dispositional quality of the person and thus "challenging to be manipulated via short-term interventions" (p. 41), subject matter expertise is more easily acquired.

However, in this study, we find that a teacher's ability to show social congruence is crucial in terms of developing children's interest in a natural element during exploratory activities. We also find that different types of social congruence are needed in the various phases of interest development. The ability to share children's feelings, engagement, attention and experience is essential in the pre-interest phase of discovery and in the triggered situational phase, where children focus on gaining first-hand experience. To develop maintained situational interest, where children are receptive to gaining factual knowledge, establishing mutual understanding and a good climate for exploratory dialogues is most important. In the individual phase of interest, where children start reflecting and applying their knowledge, social congruence is visible in the form of the teacher being available for the children and acknowledging their contributions. It is therefore essential that teachers obtain knowledge and practice in terms of how to perform social congruence and what type is needed in the various phases of interest.

6.2.2. Cognitive congruence

As concerns cognitive congruence, the results in this study confirm Rotgans and Schmidt's (2011) results that it is influenced by both a teacher's social congruence and subject matter expertise. According to Grave et al. (1998), cognitive congruence includes being able to stimulate, elaborate on and direct children's learning processes.

In this study, where children are exploring natural elements in a natural outdoor environment, being cognitively congruent is related to encouraging their explorations and a teacher's ability to create links between the children's present experiences or knowledge and their new experiences or knowledge. This is of particular importance in maintained situational interest as this is a phase where children, according to Hidi and Renninger (2006), are developing knowledge and value. In this study, this phase appears in the form of being receptive to gaining factual knowledge about the natural elements. To support children in developing their knowledge, a teacher must be attentive to and identify the children's present experience and knowledge (cf. be socially congruent), and he/she also needs subject matter expertise to present new knowledge. Ways to create the link between present and new experiences and knowledge can vary.

6.2.3. Subject matter expertise

Subject matter expertise is most prominent in the maintained situational and individual phases of interest. This can be seen in relation to Hidi and Renninger's (2006) as well as our own results, where developing knowledge/having stored knowledge is a central learner characteristic of maintained situational and individual interest. It is evident in our study that interest and knowledge are closely related, which coincides with previous research (Krapp, 2002). If children in the maintained situational phase of interest do not receive support in the form of information (e.g. responses to their questions or extra information), their interest cannot be expected to develop into individual interest. The teachers therefore need knowledge of the subject being studied.

This can be more challenging when situated in a natural outdoor environment, compared to inside a classroom. In a classroom, tasks and topics are planned and decided on by a teacher before a lesson. In a nature area, on the other hand, the environment offers large variety in terms of both flora and fauna, and unexpected happenings and children's questions related to these are unpredictable. Being knowledgeable "enough" can therefore be demanding for a teacher.

7. Conclusion

The results in this study show that children's interest in natural elements during exploratory activities in various natural outdoor environments develops from a pre-interest phase of discovery (which constitutes the trigger for interest) to individual interest by transitioning through three phases. These three phases coincide with Hidi and Renninger's (2006) phases of interest: triggered situational interest, maintained situational interest and individual interest (that is, emerging and well-developed individual interest).

In this study, we have identified some central characteristics that appear in children in the different phases of interest, which describe how they relate to natural elements in these various phases. In the first phase, children focus on *gaining first-hand* experience of the natural element. They observe, explore and comment on the natural element's characteristics. In the second phase, children are receptive to gaining factual knowledge about the natural element. In this phase, they may ask factual questions and answer other questions. In phase three, the children reflect on and apply the knowledge they have acquired about the natural

element. In this phase, the children ask curiosity questions and present hypotheses and information related to the natural elements.

Identifying learners' characteristics adds valuable knowledge concerning how the youngest children's interest appears in exploratory settings in an outdoor environment. The different characteristics are indicators of children's phases of interest and can be important tools for teachers when deciding on adequate strategies for supporting the development of children's interest. These strategies are presented and discussed above. The results in this study show that the significance and types of interactional characteristics vary between the phases.

This study indicates that teachers in early childhood education need qualifications in terms of how to be socially and cognitively congruent, as well as subject matter expertise, to support the development of children's interest in natural elements during exploratory activities in natural outdoor environments. These qualifications include practising dialogues with children, being able to identify their focus and getting experience in performing outdoor activities together with them. This implies an increased focus in terms of teacher education as well.

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Declaration of competing interest

The authors declare that there is no conflict of interest. Ingunn Skalstad (first author) and Eli Munkebye

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