A study of preschool children's motive orientation during science activities

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Abstract

The results presented here are part of a two-year longitudinal study with two main objectives: 1) designing subject-specific science activities that provide experience of chemical phenomena and support positive emotions of science and 2) exploring preschool children's emergent science. Science was introduced into the preschool setting in the form of conceptual play. Data was collected using visual-ethnography and analysed inductively to explore the dynamics of children's development of motive orientation over a year of science activities. Results show the significance of the social environment for developing motives and influencing leading motives. The discussion highlights the necessity of considering both cognitive and emotional aspects within preschool science activities in order to be able to create positive cultural motives for science.

Keywords

Motive, preschool, science

Résumé

Les résultats présentés ici font partie d'une étude longitudinale de deux ans avec deux objectifs principaux: 1) concevoir des activités scientifiques spécifiques à une matière qui offrent une expérience des phénomènes chimiques et soutiennent les émotions positives de la science et 2) explorer la science émergente des enfants d'âge préscolaire. La science a été introduite dans le milieu préscolaire sous forme de jeu conceptuel. Les données ont été recueillies à l'aide de l'ethnographie visuelle et analysées de manière inductive pour explorer la dynamique du développement

de l'orientation motrice des enfants au cours d'une année d'activités scientifiques. Les résultats montrent l'importance de l'environnement social pour développer des motifs et influencer les principaux motifs. La discussion souligne la nécessité de considérer les aspects cognitifs et émotionnels dans les activités scientifiques préscolaires afin de pouvoir créer des motifs culturels positifs pour la science.

Mots-Clés
Motif, préscolaire, science

Introduction

In recent decades, preschool education has gained particular attention worldwide with the recognition of the importance of high quality early childhood education for children's development (Siry, Ziegler, & Max, 2012). This attention has led to educational reforms emphasising different topics, such as language, maths and science. This study was performed in a Swedish context, where the subject-specific content of chemistry is included in the curriculum for preschool education. However, there is no further specification on how to translate this content into practice. The emergent curricula broadly formulate the goals as: "the preschool should provide each child with the conditions to develop: an understanding…of simple chemical processes" (Swedish National Agency for Education, 2019, p. 15). Very little research has been performed on preschool children's emerging subject-specific science (Fleer, 2014), especially for chemistry (Adbo & Vidal Carulla, 2019). This paper aims to explore this field.

Theoretical framework

Cultural-historical theory: a theory of development

This project is place within cultural-historical theory, which is based on Vygotsky's work concerning the origin and change of higher mental functions (Veresov, 2010). Differentiation between learning and development is important within this study. When discussing development in an early years' educational setting, it is useful to conceptualise this context from two different perspectives, namely, an institutional perspective and a child's perspective.

From an institutional perspective, the institution has specific (learning or developmental) demands and to meet these demands, teachers create different activity settings. From a child's perspective, the emphasis is on motives that lead the children in the activity setting. A motive is a dynamic concept and involves developmental perspectives as well as personal/social and emotional aspects. A motive is closely

connected to personal identity (Wardekker et al., 2012) and is here defined as including actions that are characteristic for a person, affecting how the person relates to the world in the moment, as well as over longer periods of time, even over time-spans as long as a lifetime. Increased understanding of children's motives is essential for learning and development, since they have an effect on the life-long learning process of the child. Analysis of the children's motive orientation within an activity setting is one way of exploring the tension between the demands of the preschool and the motives of the individual (Hedegaard, 2002).

Within this perspective, learning can be defined as a change in the child's "relation to another person and activities in specific settings" (Hedegaard & Fleer, 2013). In the present study, the activity setting involves science activities in the preschool environment. Development, however, implies a process that is more far-reaching, so that "children's motive orientation and engagement in different activity settings change qualitatively" and as such their dominating motive changes (Hedegaard & Fleer, 2013, p. 183).

Driving force of child development: leading motive

The driving force of child development can, from a cultural perspective, be described with the use of leading motives. This concept is derived from Vygotsky's work, but was expanded upon and elaborated by his followers. Elkonin (1999) suggested a series of activities that drive the child's development. Although development is a continuum, for theoretical purposes Elkonin divided it into stages. These stages are seen as general, inclusive and gradually changing.

The first leading motive is "the self". During this stage, the young child begins to establish a sense of self in relation to the external world. "The self" is gradually succeeded by "play" as the leading motive, and the sense of self continues to develop and includes changing to other selves in pretend play. The next leading motive is "learning" and is seen as driving development for children entering school (Elkonin, 1999). Play is regarded as essential for thinking, imagination, creativity and development of general emotions (Hedegaard, 2016), because with pretend play, the preschool child can change the meaning of objects, which is an act "relying on internal tendencies and motives, not on motives and incentives supplied by external things" (Vygotsky, 2016, p. 11).

Different types of motives

Motives are seen as the incentives for actions, and they are both emotional/individual and cultural/societal (Hedegaard, 2002). Children's motives are connected to society at large, as well as to the specific social context, personal identity and emotions of the child. The development of motives is traced back to the lower functions or primary needs of the child, and motives develop through interactions with objects and persons,

and in the process, they become culturally and societally linked (Fleer & Hedegaard, 2010). The different types of motives used within this study are meaningful motives, leading motives and stimulating motives/motivating conditions.

Meaningful motives are motives that give the child meaning and drive the child to explore his/her surroundings; these motives are always a part of the next category of motives, the dominant motives. Dominant motives are more general motives that recur over a number of activities, and they are the motives that describe the qualitative relation that a child has with his or her environment (Hedegaard, 2002). By analysing the motivating conditions (Fleer, 2020) within a specific activity setting, meaningful and dominant motives can be studied.

Previous research

Research literature concerning motivational conditions in preschool is limited (Fleer, 2020), and no research about children's motive orientation and motivational conditions in chemistry activities in a preschool context has so far been found. This lack of studies may be due to the fact that chemistry is viewed as being difficult to translate into a preschool context (Thulin & Redfors, 2017).

However, research concerning how teachers' attitudes towards natural science activities in preschool influence children's motives shows the significance of teachers moving beyond planning activities and actively participating together with the children. A science attitude has been found to be important for children's learning as a science attitude places focus on the relation between the concepts and not on the concept itself (Fleer, 2009). Teachers' attitudes and confidence in science may be more important for children's learning than teachers' knowledge (Fleer, 2009; Sackes, 2014). Indeed, curiosity and positive attitudes can cause children to develop positive motives and a sense of wonder towards science activities (Hadzigeorgiou, 2001).

Research questions

- How do the motivating conditions and science content develop over a year of science activities?
- How do the motivating conditions affect the science content over a year of science activities?

Methodological framework

A two-year longitudinal study was designed with two overall objectives in order to describe children's emergent chemistry (Siraj-Blatchford, 2001) and how children interact and make use of exploratory activities with a chemical content. Lessons were developed using the method of educational experiment (Hedegaard, 2008), in which activities are

continuously designed, implemented, analysed and revised together with the teacher in an iterative manner. The data presented here are the results of analysis of the different types of motivating conditions (Fleer, 2020) during one year of science activities.

Context

The study was performed in a preschool in the southern part of Sweden. Preschool education in Sweden is an important part of the school system, although it is not obligatory to attend school until the age of seven years old. Despite this, as many as 85% of all one to four-year-old children attend preschool. The number of hours spent at the preschool varies, but 15 hours per week is the usual minimum, since it is the number of hours allowed for children who have parents home on parental leave with other siblings (Sveriges Kommuner och Landsting, 2017). The preschool participating in this study has no special focus on science and technology, and all participants were native Swedish speakers.

Ethical considerations

The study was approved by the National Ethical Board (Linköping Dnr/451-31) and informed consent was obtained from the principal, teachers, parents and children involved. All data was handled in accordance with the GDPR (European Union, 2018). Regular staff participated in all of the activities to analyse body language and ensure the children's consent over the whole activity. The informed consent also included publishing rights and information regarding the handling of data, keeping the anonymity of the participants. All included parties were also informed about their right to end their participation in the study at any time. In order to protect the children's identity, alias have been used and illustrations have been provided instead of pictures.

Activity design

This research was designed as a longitudinal study, where the children initially were three to three-and-a-half years of age. Four children participated (two boys and two girls). The number of children who participated in the different activities varied between two and four, depending on various periods of illness and number of hours spent at the preschool (sometimes holidays and other forms of caregiving were prioritised by the parents).

This longitudinal study (currently ongoing) includes a series of 21 activities designed to explore the emerging concept of "small". Chemical methods and chemical content were derived from this core concept (Fleer, 2011), for the purposes of taking a holistic view of chemistry, including science skills as well as methods, such as, filtering and grinding. Conceptual play (Fleer, 2011) entails departing from children's interests and intertwining everyday and scientific concepts in a way that children can more

easily connect to them. The preschool teacher can achieve this by finding situations in the preschool daily practice (everyday concepts) that offer opportunities to discuss phenomena related to science (scientific concepts). This pedagogy is also known as sustained shared thinking (Siraj-Blatchford, 2009), in which children and the teacher work together to solve problems.

A story of the king and his birthday was used for contextualising the activities. The choice of using the story of the king as backdrop was initially made, because the children showed interest in princesses, princes, knights, kings and queens. The activities usually began with recollecting what had been done on the previous occasion together with a short story to introduce what the king was up to for the day; examples are provided in the results section.

Data collection

Visual ethnography was chosen as the approach for activities and data collection. This method provides means for active participation, and the researcher/teacher was one and the same person here. As emerging science and sustained shared thinking were our foci, active participation gives "active collaboration with the research participants in the process by which knowledge is produced" (Pink, 2014). Video-recording is essential when working with children this age, as body language is an important part of the data (Ochs, 1979). Furthermore, video-recordings provide means for recurring data analysis and for including multimodality (Mondada, 2018) and emotions (Goodwin, Cekaite, & Goodwin, 2012).

Activities were video-recorded and completed with field notes and children's pieces of artwork. The video-recordings were transcribed, and broad descriptions from field notes were added to complement the complexity of social interactions with non-verbal (body language) and contextual clues (such as the positioning of every child in the room) (Siraj-Blatchford, 2010).

Data analysis

The analysed activities come from the first year of data collection (when the children were three to four years of age). During this first year, a series of 21 science activities were recorded; the duration of each activity ranged from 9 to 40 minutes in length. From these 21 activities, five activities have been selected as representative of the data set and evenly spread over the first year of data collection (see Table 1).

Hedegaard's (2012) three levels of interpretation were used for analysing the data. In the initial level, the common sense interpretation level, the researchers chose several sequences in which motivating conditions (Fleer, 2020) were illustrated, spread throughout the whole year of data collection. This first level of interpretation resulted in the choice of the following vignettes:

TABLE 1

Selection of five vignettes

	Time of data collection
Vignette 1	30th of January 2018
Vignette 2	13th of February 2018
Vignette 3	15th of May 2018
Vignette 4	23rd of October 2018
Vignette 5	10th of January 2019

After this first selection, there was a second level of analysis, named situated practice interpretation, where the researchers analysed the selected vignettes trying to find patterns in the motive orientation (Hedegaard, 2002) that children displayed. This allowed the identification of the meaningful, dominant and leading motives, together with motivational conditions.

The third level of analysis, known as thematic and conceptual interpretation, involved the use of competence progression in terms of communication and collaboration established by (Siraj-Blatchford, 2007). Consequently, the analysis provided descriptions of the development of the children's motivating conditions throughout the intervention and how changes in the motivating conditions affected the scientific content.

Transcription conventions

Conversation analysis was chosen as a tool for transcribing the discourse in the play-based activities, because of the shared interest in the use of signs and symbols with cultural-historical theory (Veresov, 2010), as expressed by Goodwin (2000) that "human action is built through simultaneous deployment of a range of quite different kinds of semiotic resources" (p. 1489). The transcription conventions used in this paper were adapted from (Melander Bowden, 2019) and can be found in the Annex section.

RESULTS

Vignette 1

The first vignette was one of the initial activities during the first year of data collection. The children were three to three-and-a-half years of age at this time. The topic of this day was the king's magnifying glass and a treasure box where the king had collected a

variety of items to explore small things with the use of a magnifying glass (J: John, M: Maria, T: Teacher).

1 J: You know what, (teacher's name), Peter is not here today because he is sick.
2 M: Didn't you first notice that I was here first? (turns towards John, John looks at Maria but offers no reply)
….
5 T: Do you remember what we did last time?
….
13 T: There were tiny things, weren't there?
14 m+j: *nodding*
15 M: Baby bugs.
16 m *shows tiny with body language* (see Figure 1)
17 J: Then comes the fox and:: SAVE ME!
18 j *moving his hand quickly over the table running from the fox*
19 M: Tiny.
20 m *showing tiny with her hands*
21 J: But foxes are this big.
22 j *showing big with his hands*
23 M: But I am this big.
24 m *opening her arms wider* (see Figure 2)
25 J: I will soon be like this.
26 j *showing his arms opened wider*
27 J: Then I will be like this.
28 j *shows three fingers for age with his hand over his head to show height* (see Figure 3)
29 J: I am between::
30 M: I am three-and-a-half and you are only three.
31 t *brings out the king's chest*
32 T: Guess what this is.
33 M: Treasure box.
34 J: The king's chest!
35 T: Let's see what is in here::
36 T: What is this? *whispering*
37 M: A magnifying glass.
38 m *takes the magnifying glass and begins to look at things around her*
39 J: Can I try?
40 j *takes the magnifying glass and looks at the teacher*
41 J: Now you are bigger than Maria.

FIGURE 1, 2, 3

FIGURE 1	FIGURE 2	FIGURE 3
		
Showing tiny using body language	*Showing big as a size, using body language*	*Showing big as a width, height and age using body language*

Below is a summary of the motivating conditions and science content observed in this vignette (see Table 2):

TABLE 2

Analysis summary of vignette 1

	Meaningful motives (specific, short-term)	**Dominant motive** (general, long-term)	**Leading motive**
Motivating conditions	who is here, I am bigger than you, king's story, turn taking	competing	the self
Science content	big/small		

The vignette above describes one of a series of activities with the objective to provide experiences of small things. When using the magnifying glass, the children explored both "big" and "small", as things appeared to be big when the magnifying glass was used. Before the activity began, the children sat down and John was talking to the teacher. The motive that drove this activity forward was mainly the children delimiting themselves towards one another by competing concerning the word "big"; it was important for both of them to be bigger than the other. This suggests that the leading motive of the self was important. Stimulating motives in this activity were the story of the king, the magnifying glass and the magnifying effect.

Vignette 2

In this activity, the king was preparing for his birthday party. Unfortunately, when the King was making lemonade for the party, he had an accident and dirt fell into his lemonade. He asked the royal family to help him figure out a way to remove the dirt from the lemonade without using their fingers or a spoon.

1 T: Do you remember the king's birthday party?
…
5 J: You (looking at the teacher) and Maria and Peter, I am going to invite you to my knight birthday party.
6 M: I will invite you to my princess birthday party.
7 P: I will invite all of you to my king birthday party.
8 J: Do you have king-balloons?
9 M: Today we will celebrate me.
10 T: Is it your birthday, soon?
11 M: No, it was my birthday.
12 J: And then, we have to have a cake!
13 M: At parties you can't have a cake, it is only on birthday parties.
14 J: But what is that?
15 j *looking at the floor*
16 P: I don't like cake.
17 J: I like cake.
18 P: I don't like cake.
19 M: I like strawberry cake and chocolate cake and vanilla cake and ice-cream cake.
20 J: I like strawberry and caramel cake.
21 M: And I like chocolate, strawberry, vanilla and rainbow.
22 m *banging with her hands on the table*
23 T: How does rainbow taste?
24 M: Ice cream rainbow.
25 T: Now, the king is making lemonade for his birthday, but he had an accident and little pieces of dirt fell into his lemonade. He asked us to help him. How are we going to help him?
26 m *begins removing the dirt with her fingers*
27 T: We can't use our fingers.
….
30 t *brings out a filter*
31 J: You use that when you are cooking.
32 M: Can I try?

33 m *takes the filter*
34 J: I want to try as well.
35 T: Let's see what happens when we pour.
36 m+j *she holds the filter on the empty glass while he pours the contents in it*
37 T: What happened?
38 M: They got wet.
39 T: Where is the water?
40 J+P+M: Here (pointing at the glass with water).
41 T: Where are the balls?
42 J+P+M: There (pointing at the filter).
43 T: What's in here? (pointing at the filter)
44 J: There are small holes.
45 T: Can the balls go through the small holes?
46 P: No, they got stuck.
47 J: They are like this.
48 j *shows small with his hands*
49 M: Let's try it again.
50 J: I want to hold this one now (the glass). (see Figure 4)
51 P: I want to hold this one now (the filter).
52 P: But John gets to do all things:

FIGURE 4

Distributing the tasks

Below is a summary of the motivating conditions and science content observed in this vignette (see Table 3):

TABLE 3

Analysis summary of vignette 2

	Meaningful motives (specific, short-term)	**Dominant motive** (general, long-term)	**Leading motive**
Motivating conditions	what are we doing, birthday, cake, turn taking	competing	the self
Science content	filtering		

Vignette 3

The data presented below were collected in early spring. The king was sick and was lying in bed. The only thing he could do was listen to the sounds of the castle and smell the different smells surrounding him. The goal of the activity was to use senses for differentiation.

1 T: Today we are going to start with another story.
2 J: I want to be the knight.
3 M: I want to be a princess.
4 T: And you, Peter?
5 P: King.
6 M: And what will you be?
7 T: I'll be the queen.
8 t *tells the story of the sick king that can only lie in bed*
9 J: He can't even catch a dragon, he can't catch anything at all (in a sad voice).
10 T: No, poor king, he can only lie in bed and listen to the sounds and smell different scents.
11 T: Since the king smelled many scents but he did not recognise them, he needs your help.
12 t *shows four small containers covered with paper*
13 M: So, we open and then smell.
14 T: Yes. What do you think this is?
15 j *showing excitement to know* (see Figure 5)
16 M: It's cinnamon.
17 P: It's sugar.
18 J: It's cinnamon.

19 T: Let's take a look:
20 t *unwraps the paper covering the glass container*
21 T: It is cinnamon! Shall we take number two?
22 J: No, that is number three.
23 T: What do you think this is?
24 J: Salt.
25 P: Salt.
26 M: Salt.
27 t *unwraps the paper covering the glass container*
28 T: No, it is not salt… It is cheese.
29 m+j+p *giggle*
30 J: £Oh:: (says the teacher's name):: £
31 T: Let's take the next one. It is now Peter's turn.
32 M: I wonder what is in that one (number four).
33 J: Then, it is my turn.
34 M: No, then it is my turn. Peter and then me.

FIGURE 5

Body language showing the excitement of surprise

The children immediately sat down and decided on what character they had in mind for the day (lines 2-7). Smelling the mystery containers did indeed catch the children's attention. This was verified by body language (see Figure 5).

The elaboration of the story to include dragons is here seen as a play signal indicating the leading motive of play, and the children are collaborating with each other. The meaningful motive in this activity was the curiosity awakened by the mystery containers and the shared excitement over the thought of unpleasant smells.

Below is a summary of the motivating conditions and science content observed in this vignette (see Table 4):

TABLE 4

Analysis summary of vignette 3

	Meaningful motives (specific, short-term)	**Dominant motive** (general, long-term)	**Leading motive**
Motivating conditions	king's story, items, turn taking	collaborating	play
Science content	observing (smell)		

Vignette 4

A series of deconstructions were introduced to include the experience of dividing things into smaller and smaller pieces as a possible strategy to create an intuitive way of accessing an imaginary, non-visual level.

1 T: Today I brought these. What are they?
…
3 J+S: Balls.
4 P: I want the blue one.
5 J: I want the green one.
6 T: But they are hard.
7 M: And they smell.
8 T: What do they smell like?
9 S: It smells good.
10 M: It smells like candy.
11 s+j *bang theirs against the table*
12 M: It smells like shampoo.
13 T: Today we need to be careful because the balls are made of soap.
14 J: If you get it in your eyes and mouth, it burns:: BLEH! You think it is good, but it's not. It is really disgusting.
15 S: I think so, too, it smells like:: BLEH!:: Really disgusting.
16 T: It is a bath bomb, when you put it in water it breaks down into smaller pieces. Today we are going to take the mortar and look at these small pieces.
17 j *bangs his bath bomb against the table*
18 S: It is hard like a stone, and you may get it in and it may hurt your nose.
19 J: And the ears, and the hair.
20 P: And the legs and the toes.
21 M: Look at the bomb! BAM!
22 m *bangs her bath bomb against the table*

23 s+p+j *bang their bath bombs against the table*
24 M: Bombs can be cut like this.
25 m *shows a cutting movement with her hands*
26 M: We can ask the person in the kitchen for a knife.
27 T: Should we look at it with this?
28 t *brings a pocket microscope*
29 M: The microscope.
30 S: I see small ants that look like they're eating soap pieces. It is fine for them; it does not hurt them.
31 M: Here I have some.
32 m *looking at the crumbs through the microscope*
33 M: Blue ice.
34 J: I can see.
35 T: What do you see?
36 J: I can see shampoo.
37 S: I see small ants that like eating soap pieces. It is fine for them; it does not hurt them.

Imagination and the leading motive collaboration were evident throughout the entire activity, as could be seen with Maria's use of the bomb falling from the sky making noises (line 21) that became an act all children copied and when the children agreed on the bad smell of the bath-bombs (lines 14 and 15). Curiosity was evident even before the activity began when Sophie took the magnifying glass and explored the table and the pillow she was sitting on.

Below is a summary of the motivating conditions and science content observed in this vignette (see Table 5):

TABLE 5

Analysis summary of vignette 4

	Meaningful motives (specific, short-term)	**Dominant motive** (general, long-term)	**Leading motive**
Motivating conditions	itchy soap, small ants	collaborating	play
Science content	grinding, microscope		

Vignette 5

This activity took place one year after data collection began, and the children were four to four–and-a-half years of age. This vignette was chosen since it is representative for the set of data and concludes a full year of data collection for these children. The activities were again aimed at providing experiences of the concept of small, and this time the items for use were once again the magnifying glass, small pocket microscopes, sugar cubes and a mortar. The children present on this occasion were John (J), Maria (M), Peter (P), Sofie (S), and the Teacher (T).

1 s *takes a magnifying glass and looks at the table*
2 S: I see something on the table. I can see cracks there.
3 M: I see small cracks there (the table).
4 S: And I see the pillow (she is sitting on it) and the pillow is getting larger and larger.
5 s *she moves the magnifying glass to different distances from the pillow*
6 J: I can look here (holding the cloth bag of the magnifying glass).
7 S: I can look here (also holding the cloth bag of the magnifying glass).
8s+m+p+j *using their magnifying glasses*
9 t *shows a sugar cube*
10 T: What is this?
11S+M+P+J: Sugar.
12 T: How do you know?
13 J: You can:: If you eat too much sugar, then your stomach hurts.
14 S: And you can get teeth trolls. If you eat sugar, you have to brush your teeth every morning and every evening. You have to brush your teeth.
15 m *directs the sugar cube to her mouth*
16 T: No… don't eat it. We have to help the king.
17 M: I'll just pretend to eat it.
18 S: Can you show me?
19 s *turns towards the teacher*
20 J: This is how you do it.
21 j *shows Sofie how to use a magnifying glass*
22 S: I see something. I see a lot of sugar crumbs and a lot of small sugar bacteria that are gnawing on the crumbs.
23 T: Have you talked about bacteria during circle time?
24 S: Yes, because your bum has a lot of bacteria, and the sugar has it, too, but they don't like the bacteria. The bacteria get scared when you brush your teeth, and they jump away in different directions.
25 M: I see a lot of bacteria.

26 S: Lots and lots of bacteria.
27 M: And sugar crumbs.
28 P: How do you turn this one on (the light on a microscope)?
29 S: I see a lot of ice blocks as well.
30 J: I turned this one on by myself (light on the microscope).
31 S: I see a lot of holes in the sugar crumbs.
32 J: I see sugar beads. When you eat them, you become sick.
33 S: All bacteria are afraid of toothpaste. I have learned to spit out all the bacteria.
34 m *crushes her sugar cube in the mortar*
35 M: It is like the one we have at home (the mortar).
36 S: I can see the bacteria dancing.
37 P: I am going home at four.
38 J: Me, too, I am going home at four… Both of us are going a quarter to… four.
39 p *passes the mortar to John when he is finished*
40 J: Thank you:: dear friend:: (a comment said in a playful, deep voice)

The leading motive in this activity was collaboration, since the data give signals of play in that the bacteria were seen as dancing, or that they pretended to eat the sugar. The initial driving force for the discussion was not the teacher nor initially even the provided items, as the children instead explored the magnifying effect on everything around them, a task not prompted by the teacher. No emotional arguments and no competition were to be found during the activity. Even the discussion regarding at what point in time parents would pick up the children did not trigger any emotional responses amongst them.

Below is a summary of the motivating conditions and science content observed in this vignette (see Table 6):

TABLE 6

Analysis summary of vignette 5

	Meaningful motives (specific, short-term)	**Dominant motive** (general, long-term)	**Leading motive**
Motivating conditions	bacteria, helping	collaborating	play
Science content	bacteria		

Discussion

The development of the motivating conditions

Development in the leading motive from "the self" to "play" was derived from the data. The signals for "the self" as the leading motive were; the children delimiting themselves from each other by competing over items or concepts, like "big" or when they deliberately changed focus from the activity or another child towards themselves. Communication in the form of personal statements, such as, "I like cake" in response to "I don't like cake" were also interpreted as a delimitation, and therefore a sign of competition. The signals of play as leading motive were; the verbalised interactions in which children placed focus on things other than themselves, by using imagination to give items other meanings than their intended meaning, like the sugar crumbs becoming "bacteria dancing" or using expressions like "I'll pretend".

These results coincide with the model presented by Siraj-Blatchford (2007) showing the child's competence progression in terms of communication and collaboration while engaging in socio-cultural activities and making sense of the interactions and experiences that arise. At first, learning processes are related to the development of concepts of the self, and later on, through playing with partners, the child can learn about others and develop more sophisticated capabilities that require collaboration. This shows the importance of children interacting in a small group so that they can learn from each other.

The development of the science content

The science methods of mortaring and filtering, as well as the science skills of observation and communication, developed over the course of a year. Although the language development cannot be credited to the science activities, the intervention did provide increased experience of the concept "small" due to the magnifying glass. This way the small things that were initially called "baby bugs", eventually turned into "small holes in the sugar crumbs". The children easily connected methods, such as mortaring and filtering, to the kitchen and had no trouble describing the outcome of using these methods. The use of the magnifying glass and the portable microscope became a natural thing for all the children involved.

The effects of the motivating conditions on the science content

With the dominating motives developing from competition towards collaboration, the science content within the activities did not diverge into multiple descriptions and interpretations. Instead, it merged into common conclusions. This phenomenon actually enriched the discussions. The only hindrance to the emerging concept of "small" was the fact that the children's imagination did not take them further than their own experiences.

When looking at the emotions that recurred during the activities, such as curiosity, positive expectations and helping each other, they all contributed to the engagement of the children. Therefore, creating positive emotions related to science is essential and corroborates the argument made by Hedegaard (2016) about considering both cognitive and emotional aspects in children's development.

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Appendix

Transcription conventions adapted from Melander Bowden (2019)

,	Comma indicates rising or continuing intonation.
?	Question mark indicates rising intonation.
::	Colons indicate prolongation or stretching of the immediately prior sound.
ff	Pound signs indicate that the speech is produced with a happy, playful voice.
_____	Underlining indicates some form of stress or emphasis.
BLEH	Very loud speech is indicated by upper case.
* *	Descriptions of gestures and actions are delimited between two identical symbols.
T	Initial letter in upper-case indicates person is using verbal language.
t	Initial letter in lower-case indicates person is using non-verbal language.
…	Dot, dot, dot indicates breaks in the transcription.