11 CONTENT CHOICES WITHIN A CONCEPT-CONTEXT APPROACH IN PRIMARY SCIENCE EDUCATION

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Abstract

Trends in Dutch biology education have recently led to the development of a conceptual framework for primary science education in which a concept-context approach holds a central position. This study describes how choices can be made in the selection of concepts from the framework for curriculum inclusion with a focus on the concept animal. Its aim is to arrive at an elaboration of this concept in terms of underlying and related concepts. Especially guidelines were collected to justify these choices. Therefore, primary teacher educators for science education and primary school pupils were interviewed. Alongside, an analysis of methods for primary science education was carried out and experts were asked to fill in a questionnaire. This resulted in appropriate guidelines, underlying concepts and/or everyday life contexts interesting for pupils. With these outcomes two example elaborations for different age categories were made and subsequently presented, along with the guidelines found, to experts during a focus group discussion. Ultimately, the findings revealed three criteria (context, subject and didactics) to be taken into account when selecting concepts. To elaborate the concept animal the suggested procedure can be used, in which the interaction between selecting concepts and contexts is central.

1. Introduction

The concept-context approach was recently introduced in Dutch biology education to achieve coherent biology education from primary education to secondary education (Boersma, Kamp, Van den Oever, & Schalk, 2010). The concept-context approach takes the learner as its starting point and requires that the education on offer is meaningful for children (Van Graft, Boersma, Goedhart, Van Oers, & De Vries, 2009). In the concept-context approach contexts, activities and concepts are connected in a specific way. Contexts are defined as practices such as farming, cooking or investigating (Boersma et al., 2005). Several types of contexts are distinguished, including everyday life contexts (Boersma et al., 2005; Boersma et al., 2007). Everyday life contexts, like health care or family, are especially relevant for pupils in primary education, because in these practices children (potentially) participate (Van Graft et al., 2009). Within these practices specific activities are performed which ask for specific biological knowledge to be associated with one or multiple biological concepts. A concept is defined as "an important idea from biology with which relevant knowledge could be associated" (Boersma et al., 2005, p. 15).

A first step to translate the concept-context approach to primary education was the development of a conceptual framework. This framework provides an overview of combinations of everyday life contexts and 23 biological concepts for further application in primary science education (Van Graft et al., 2009). This study describes how choices can be made in the selection of concepts from the framework for curriculum inclusion and which guidelines can be followed to justify the inclusion in the curriculum of some concepts over others. Guidelines are therefore defined as arguments that support choices for content and concepts. Ultimately, this step of making choices could be the start of the development of a curricular strand for primary science education. In particular, the concept animal, one of the concepts making up the conceptual framework, is focused on in this paper. The research study aims to arrive at an elaboration of the concept animal in terms of relevant, underlying and related concepts for primary science education. Furthermore, the essence of the study is in collecting guidelines which support choices for specific content and concepts about the concept animal. The following research question was formulated: How can the concept animal be elaborated in Dutch primary science education according to the characteristics of the concept-context approach and which guidelines can be found to support this elaboration?

2. Research design and method

The qualitative research study is part of curriculum development and followed the communicative approach. This approach pursues a relational strategy where stakeholders play an important role. Their views and opinions about making choices for a curriculum can be identified in a consultation aiming to reach consensus (Thijs & Van den Akker, 2009). The method consisted of several components (Figure 1). First, guidelines which support choices for content and concepts, underlying concepts related to the concept animal, and everyday life contexts interesting for primary school pupils, were identified. As far as possible, guidelines

were selected on generality, so that they were applicable to multiple concepts related to the concept animal.

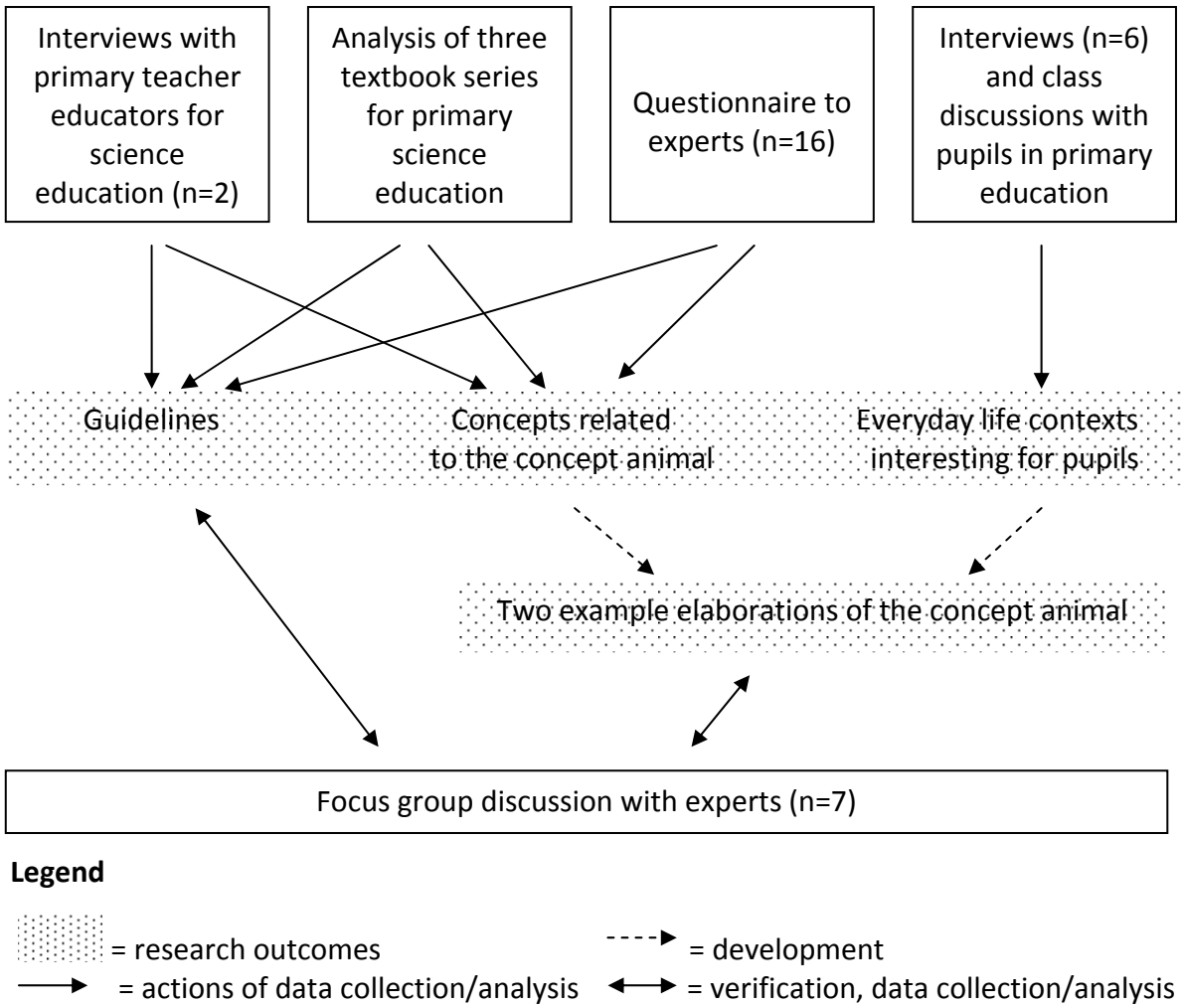

Figure 1. Schematic overview of the research method.

Developing an elaboration of the concept animal according to the concept-context approach, the aim of the study, requires working within an everyday life context. These everyday life contexts were selected from the results of the interviews and class discussions with pupils in primary education. An elaboration was made for children in the age of 4-8 years as well as for those aged 9-12 years, resulting in two example elaborations. The elaborations were defined as underlying concepts that can be connected to the concept animal, and were derived from other components of the research method. A concept was selected for inclusion in the elaboration when it met the criterion that it applied to the chosen context or was considered important by experts and primary teacher educators. Subsequently, the guidelines found for selecting concepts and the two elaborations were presented to experts during a focus group discussion. This approach investigated whether the elaborations and the guidelines were appropriate. For this study a 'policy' Delphi study was followed to systematically collect

arguments and opinions of experts about the proposed findings (Van Zolingen & Klaassen, 2003). Additionally, an audit trail, making research choices transparent, was kept.

2.1 Primary teacher educators for science education

Two semi-structured interviews were conducted with primary teacher educators for science education. These were selected non-randomly. Both work at a Dutch university for teacher education. They were interviewed following an interview scheme, which was not pilot tested, to determine concepts related to animals that they considered important to include in primary science education. In particular, they were asked for arguments supporting their choices. It was expected that most relevant arguments would be derived from these two interviews, because the respondents are part of a fairly homogenous group. The interviews were transcribed verbally and analyzed qualitatively together with field notes. To verify the data, a member-check with both teachers was carried out.

2.2 Analysis pupil textbooks for primary science education

To investigate how the concept animal is reflected in pupil textbooks for primary science education, three textbook series for primary science education have been analyzed on concepts related to animals. It is possible that concepts were missed, because no verification was carried out. Also, guidelines justifying content choices were searched for. Pupil textbooks and manuals of the textbooks *Leefwereld* (Van Bussel et al., 1999), *Natuurlijk* (Brijker et al., n.d.) and *NatuNiek* (Janssen et al., 2007) were used. *Leefwereld* and *Natuurlijk* are most often used. Each has a share of ten to twenty per cent in primary schools. *NatuNiek* has a share of 8 per cent (Thijssen, Van der Schoot, & Hemker, 2011). Textbooks for pupils aged 8-9 and 11-12 were used. In addition, for the method *Leefwereld* an activity book for kindergarten children was analyzed. The analysis was done by categorizing concepts in a matrix, that contains 23 biological concepts relevant for primary education, obtained from the conceptual framework (Van Graft et al., 2009). One of the supervisors of the study verified this categorization. It resulted in a reflection of the concept animal in pupil textbooks.

2.3 Questionnaire

To identify important underlying concepts connected to the concept animal and arguments supporting this, viewpoints of different experts were asked by a questionnaire. An expert was defined as someone with expertise in the concept-context approach, curriculum development, and/or primary science education. The non-random selection of experts followed a selection procedure described by Okoli and Pawlowski (2004). Initially 22 people were approached by email. A total of sixteen experts was selected for the questionnaire. Experts were also asked to participate in a focus group discussion. Eight of the selected experts participated in both the questionnaire and focus group discussion, according to Van Zolingen and Klaassen (2003) an appropriate number of participants in a Delphi study. Ultimately, one expert dropped out and only filled in the questionnaire, leaving seven experts for the discussion. The nine experts

who only filled in the questionnaire included two PhDs making use of the concept-context approach, a curriculum developer, a member of the commission for the reform of Dutch biology education (CVBO), working at the Institute of Bioscience, a secondary biology teacher and CVBO member, a CVBO member and teacher educator in secondary education, two primary teacher educators for science education, and one education specialist from the Netherlands Institute for Curriculum Development (SLO). Most of them had a background as biologist. The questionnaire contained different items to investigate what experts considered important concepts about animals for primary science education, for example 'What do you think pupils in primary education should learn about animals and why do you think that?'. The items were reviewed by the supervisors, but no pilot was conducted. The results of the questionnaire were qualitatively analyzed and summarized. Also, the frequency of guidelines was noted. No verification of the results has occurred. A report of the questionnaire outcomes of the seven experts who would participate in the focus group discussion, was sent back to them.

2.4 Primary school pupils

For the interviews and class discussions with pupils one primary school was selected on availability. The school in question is a Protestant school with 220 pupils in Amersfoort, a medium sized city. Three interviews with pupils, each with two pupils of the same age together, were carried out (ages 4/5, 8/9 and 12/13). The pupils, four boys and two girls, were selected by their teacher. Three classes, consisting of 22-27 pupils, aged 4, 8 and 12 years, participated in a class discussion led by the teacher to prevent contingencies in interview outcomes. Both the interviews and class discussions were held on the same day. The pupils were asked to choose one photograph out of six (Figure 2) that was appealing to them during both the interviews and class discussions. Each photograph depicted one of six everyday life contexts in which animals play a role. Whether the photographs were representative for the contexts was not verified. Subsequently, the pupils were asked, following an interview scheme, to explain their choices to identify interests. The interviews and class discussions were transcribed verbatim. A quantitative analysis was performed by selecting a photograph with the highest frequency of pupils' choices. Two everyday life contexts were selected based on these frequencies to develop the example elaborations. The findings were analyzed qualitatively to provide a contextualization of the quantitative findings. This contextualization consisted of pupils' arguments. The analyses were supplemented with field notes. Moreover, some concepts related to animals mentioned by pupils were used for the elaborations.

Figure 2. Six photographs, each depicting an everyday life context in which animals play a role. From left to right, top to bottom, the contexts excursion/holiday, examining nature, school, shop, family, and health care are displayed.

2.5 Focus group discussion

The experts who participated in the focus group discussion included three CVBO members, one education specialist at SLO, one employee of the primary education section at SLO, one test specialist for primary and secondary education at CITO, and one author of a textbook for science education content who also works at Science Center NEMO. Five of them graduated in biology, one in palaeontology and one had a background as education specialist. They were invited for a meeting to discuss the outcomes of the questionnaire of which they received a short report. Ground rules were indicated during the meeting. During the discussion the guidelines and elaborations were presented. The discussion aimed at reaching consensus about the significance of the guidelines that were found and discussing the elaborations on limitations and possibilities. The discussion was transcribed verbatim and analyzed qualitatively. The findings of the meeting were sent back to the experts to ensure member checking.

3. Results

3.1 Guidelines

The identified guidelines were classified into four categories. The categories were chosen and specified during the data analysis process. Three categories reflect the perspectives of Tyler (1973) for the selection of educational objectives, though these perspectives were not used explicitly during the analysis. The three distinguished perspectives from Tyler (1973) are: from the student, from society and from the subject discipline.

One category included pedagogical arguments, which take into account what is of importance for children. This is in accordance with the student perspective as described by Tyler (1973). For example, the level and experiences of children was considered as an important argument by experts who filled in the questionnaire and participated in the focus group discussion.

Another category contained social arguments, which are related with the society perspective. Outcomes of the questionnaire showed a social argument. That is, concepts can be selected when they are of social relevance, e.g. the concept health. Subject arguments constituted the third category and this category reflected the subject discipline perspective. This category contained arguments derived from the essence of animals or biology. For instance, an argument one primary teacher educator for science education put forward was that a particular concept can be selected when it belongs to the essence of organisms. The analysis of the primary science education textbook series also showed subject related guidelines, including the relevance of core objectives for primary education in choosing content. The fourth category consisted of didactical arguments. One argument in this category was made frequently by experts who participated in both the questionnaire and the focus group discussion, namely that you select a concept when it can be linked to other concepts. So, the described outcomes showed various guidelines that can be used to determine curriculum content of the concept animal.

3.2 Related concepts

Many underlying concepts and content can be connected to the concept animal. This varied from concepts as form and function, behaviour and reproduction of animals, besides the relation of animals with their environment. See Figure 3 for more concepts related to the concept animal, which were used in the elaborations.

3.3 Everyday life contexts

During the interview both kindergarten children selected the photograph displaying a veterinarian examining a cat. The girl (age 4) preferred it, because cats are appealing. The boy's (age 5) main reason was that he had a cat himself and he loved cats. During the class discussion most of the children, 13 out of 22, selected the photograph of a skeleton in a museum, with more boys preferring it than girls. Striking was that the two children in the interview also selected the museum in the class discussion instead of their previous choice. Some form of coping might be present in the behaviour of these two pupils. Pupils preferred this photograph, because the skeleton is beautiful or big. Also, some children saw it on television or have been in a museum as depicted themselves.

The two children aged 8-9 years selected the photographs of a veterinarian and the museum during the interview. The girl (age 8) favoured the veterinarian, because it was beautiful. The boy (age 9) chose the museum, because he liked it and the skeleton is big so you can observe it well. In the class discussion with pupils aged 8-9 years, the photograph of the veterinarian was frequently chosen, 12 out of 27, mainly by girls. Pupils explained that they had experienced the situation. The photographs chosen by the two pupils aged 12-13 years were the aquarium and the museum. One boy (age 12) preferred the aquarium, because he had fish of his own, he liked them and it looked beautiful. The other boy (age 13) chose the museum, because it looked very exciting to him due to the fact that dinosaurs are extinct. Also, in this

group the photograph of the veterinarian was chosen frequently by pupils (12 out of 24). There were more boys than girls choosing it. The opposite was evident with children in the age of 8-9 years. Pupils gave arguments, including liking cats, having a cat and having experience with the situation. Altogether, the kindergarten pupils were drawn to the museum, whereas the pupils of age 8-9 and 11-12 years were drawn to the veterinarian. Therefore the contexts of excursion/holiday and health care were chosen to develop the elaborations, which are shown in Figure 3.

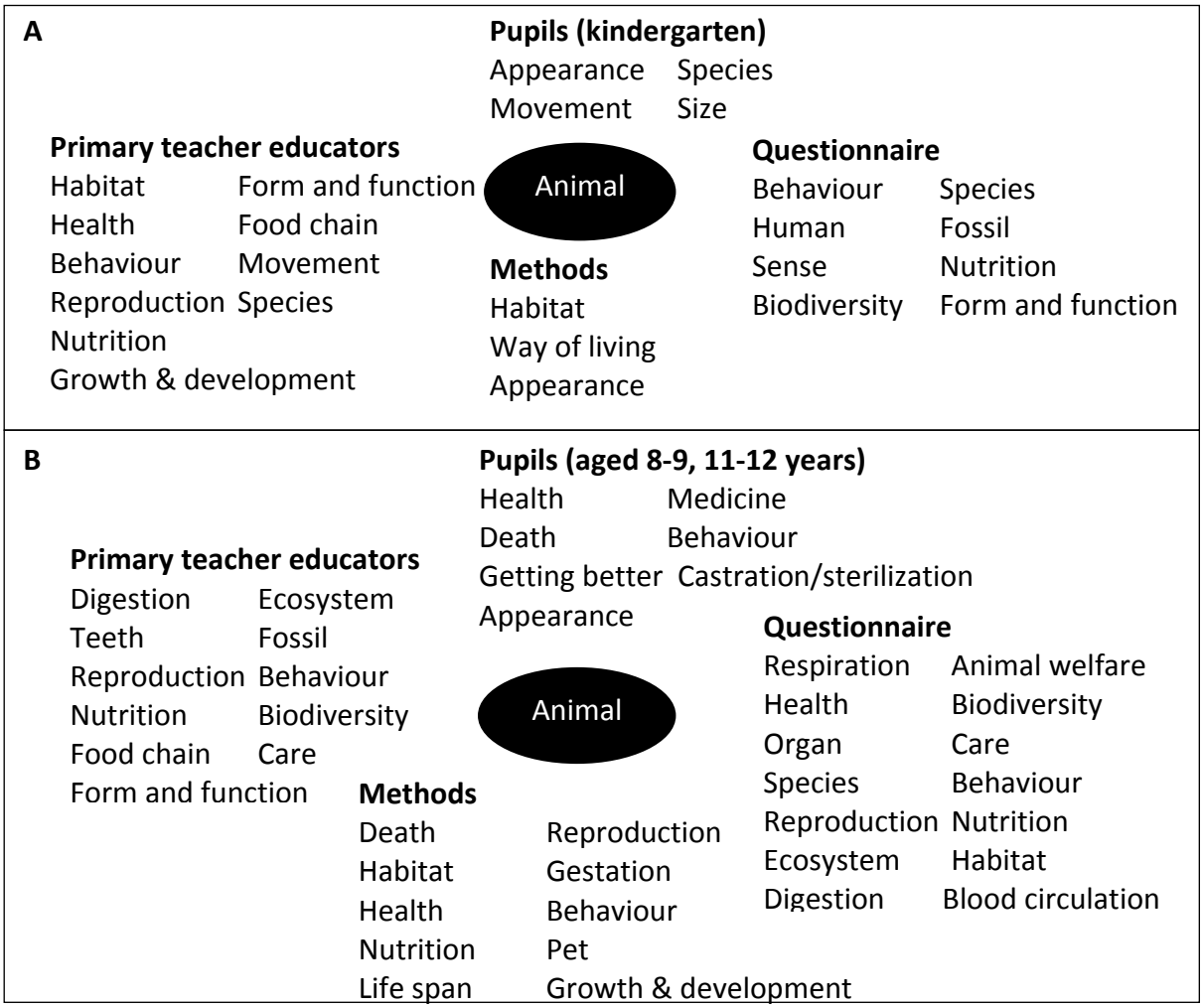

Figure 3. Example elaborations of the concept animal for pupils aged 4-8 years within the context excursion/holiday (A) and for pupils aged 9-12 years within the context health care (B).

3.4 Focus group discussion

In general, as an answer to the question why certain contents in education should be included the known classification of subject, student and society of Tyler (1973) was mentioned by the experts. A balance between these three should be sought. Also, didactical arguments, which made up the presented guidelines were considered important by experts. This category of arguments might be placed between subject and student in the aforementioned classification.

The issue reasoned from the concept-context approach is about visualizing and selecting of concepts in the context pupils participate in and which are functional for them. This functionality has a very high priority in the concept-context approach, and relates to knowledge that substantively is worthwhile. Therefore, it was recommended to look at how concepts are to be defined in a certain context with significance for children. In reaction to the presented guidelines it was stated that the guideline 'choose concepts that can be connected to the level and experiences of children' is perfect. Nevertheless, this guideline cannot be seen as independent from the other guidelines; they are all connected. So when selecting content or concepts it is about knowledge that on the one hand applies to children and on the other side is functional for them in a context. One expert argued that you should first determine a context instead of determining the knowledge in advance. It is important to take into account which context a pupil would participate in and what knowledge can be present in that context. The role of the pupils is very important in this. During the discussion it became clear that a concept cannot be separated from the context; it will vary in relation to the context. A concept will be enriched when a pupil experiences more of it. Various aspects of the concept animal thus can be worked out in different contexts. In addition, it was explicitly stated that a social perspective should be taken into account when selecting concepts. As a result of the discussion the most important argument to select particular concepts was the importance of a concept in the context in which pupils participate or which they orientate themselves on. Finally, the experts agreed that there are three interconnected cornerstones when selecting concepts, that is: the importance of concepts in the context with a social dimension, subject matter and didactics (Figure 4). The interaction between context and subject matter was mentioned explicitly by the experts. The pupil level and educational aims have to be taken into account.

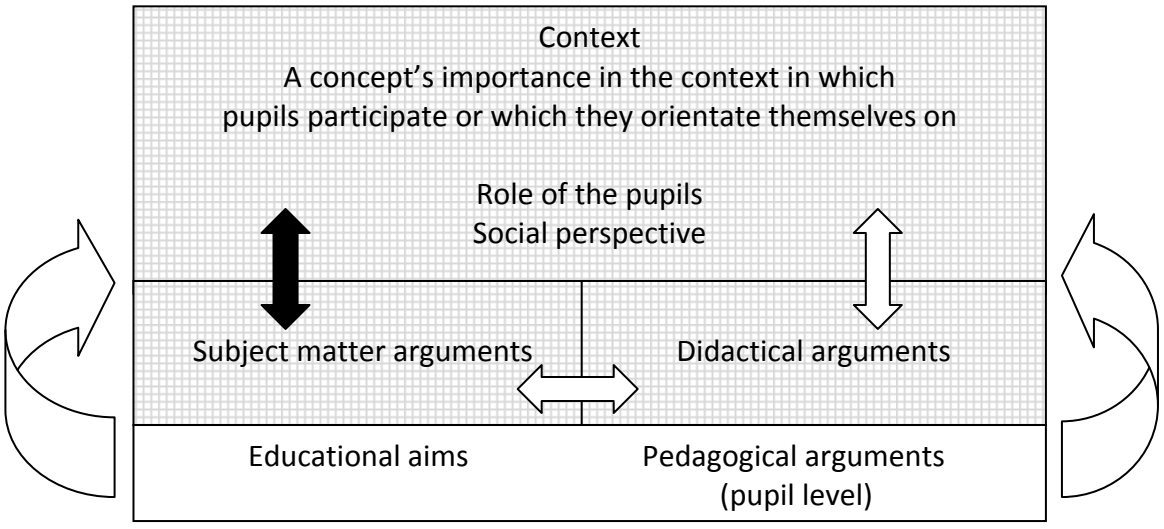

Figure 4. Schematic illustration of three cornerstones in selecting concepts. The white arrows indicate an interaction between cornerstones and the curved arrows indicate an influence on the process of concept selection. The black arrow indicates the explicit interaction between context and subject matter arguments.

The argument of a concept's importance in a context was most qualifying. It was the starting point of reasoning that the experts agreed on. When selecting concepts the discussion should be two-sided, with the sides not isolated from each other. On the one side meaningful contexts should be selected, while on the other biological content in relation to the concept animal present in the selected contexts should be determined. A procedure for selecting concepts was extracted during the discussion (Table 1). The starting point of a concept's importance in a context is clearly reflected in this. In the procedure some of the considerations that were mentioned are included. Above all, it must be said that one should not expect primary teachers to regularly select concepts and contexts in this way.

Table 1. The suggested procedure to select concepts within the concept-context approach

Step	Explanation	Some considerations
1. Select systematically several contexts important for pupils.	Deliberate choices of contexts have to be made to cover the area of contexts pupils should encounter.	- It is a matter of what pupils most often come into contact with (e.g. pets). - Which pupils' activities are possible in the context? - It is about well selected contexts which, when present, retain coherence with a social theme.
2. Determine which (functional) knowledge the pupil encounters in the selected contexts.	Make some elaborations of the selected contexts about present biological content. Which concepts are of importance?	
3. Use an agenda (an extensive description with aspects which should be included in primary science education) of the concept animal to determine whether concepts are sufficient or missing.	Determine from the elaborations (step 2) what concepts and content pupils should encounter. Use the cornerstones (Figure 4) to include or remove concepts.	- Choose a couple of concepts (2 or 3). There are different possibilities. In conceptual development it should be noted that not too much is included.
4. Return to the selected contexts.	Choosing contexts and concepts is an interaction.	

The example elaborations of the concept animal were discussed among experts. It appeared that it depends on many factors, like the activity of the pupils, which concepts can or should be selected in the elaborations. It was made clear that the elaborations cannot themselves lead to the selection of concepts. Therefore an agenda is needed. Holding on strictly to for instance the context of a museum many concepts can be removed. Some of these may yet be suitable for primary education and should therefore be addressed in another context.

4. Conclusions and discussion

This study focused on finding guidelines to make decisions about the concepts that make up the conceptual framework based on the concept-context approach. In particular, the study has described this for the concept animal. As was shown by the findings the three cornerstones (context, subject and didactics) can be used when defining content related to the concept animal, with an emphasis on the cornerstone of context. Regarding the research question, it can be concluded that to arrive at an elaboration of the concept animal the suggested procedure and the three cornerstones should be followed. The procedure should be used as an instruction guide to make decisions about the concept animal. A systematic back and forth movement between contexts and concepts follows from this procedure. With the procedure the example elaborations, and elaborations for other concepts, may be developed further for primary science education.

Since the results indicate that three cornerstones are of relevance, this can be considered as the research's main contribution to further work in this field. Other research has already indicated that different categories of guidelines are present in the field of curriculum choices. The findings are very similar with the three main sources on selecting aims and contents: knowledge, social preparation and personal development (Thijs & Van den Akker, 2009). The knowledge source can be compared with the cornerstone of subject matter, social preparation with the emphasis on a social perspective within selecting a context. The cornerstone of didactics is not evident in the three sources, however it may influence indirectly the personal development. The personal development source can be found in the most essential cornerstone, the context. In it is the position of the pupil. Pupil's experiences, interests and needs are central in this cornerstone, as well as the activities the pupils carry out in the context. The latter is a new aspect that co-determines the concepts that are relevant. Also, Tyler's categorization (1973) is reflected in the three cornerstones. Apparently, this indicates that the findings have a broad support. Still, it is not unimaginable that more or other arguments exist beyond this study. Another possible argument is taking into account the assessment and testing of concepts by pupils. Also, excellent or highly gifted pupils may require other concepts. This affects the selection procedure. Returning to the concept-context approach, the suggested procedure and cornerstones for selecting concepts obviously reflect the importance of the learner. The findings provide a rooted and systematic procedure to moderate the selection of concepts, and for that reason, contribute to a further continuation in working with the concept-context approach in educational practice. Even so, selecting contexts and subsequently concepts is not easy. The findings do not provide strict rules that lead directly to an overview of contexts and concepts for primary education. It can be questioned by whom the contexts and concepts are determined, for instance. Nevertheless, the procedure gives an opportunity to make an effort in selecting concepts, thereby using the three cornerstones as guidance.

Some limitations of the study are evident. Everyday life contexts were selected which were preferred by pupils. However, this does not mean that contexts which are less known or less popular should not be chosen or are not relevant. It may be very useful in introducing pupils to contexts in which they do not participate or which are unknown to them. This is in

accordance with a statement made by an expert during the focus group discussion, that pupils should encounter a broad range of contexts. The guidelines and the elaborations were verified by experts, who mainly had a background as biologist or participated in the commission CVBO. It might be interesting to discuss the issue with a broadly composed group of experts. Some of the guidelines that were found seem to appear as general guidelines, which may be useful to other concepts. It raises the question of whether the guidelines as well as the suggested procedure can be generalized for all other concepts. This is an important question for future research. The research study presents an incentive for a further development of the elaborations of concepts, starting with the selection of meaningful contexts and subsequently following the procedure considering the three cornerstones. It gives a potential for curriculum researchers and developers to use the concept-context approach in primary science education.

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