

An approach resulting in a deliberated elaboration of the concept animal according to the concept-context approach in Dutch primary science education

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Abstract Recently, developments in Dutch biology education led to a conceptual framework for primary science education in which the concept-context approach holds a central position. The framework includes combinations of concepts and contexts. This study describes how choices can be made in the selection of concepts of the framework to include in the curriculum and which guidelines can be followed. The focus lies on the concept animal. It is aimed to arrive at an elaboration of the concept animal in terms of underlying and related concepts for primary science education. Especially guidelines were collected to justify choices for including certain concepts in the curriculum over others. Primary teacher educators for science education and primary school students along a range of ages (4, 8, and 12 years old) were interviewed, alongside an analysis of methods for primary science education and a questionnaire to experts was carried out. This was done in order to identify guidelines, underlying concepts and/or everyday life contexts interesting for primary school students. With this two example elaborations for different age categories were made and subsequently presented, along with the found guidelines, to experts during a focus group discussion to discuss it on possibilities and limitations. The findings revealed that various guidelines can be used. Ultimately, three cornerstones (context, subject and didactics) should be taken into account when selecting concepts. To elaborate the concept animal, a suggested procedure, in which the interaction between selecting concepts and contexts is central, can be used. This might be a further step to translate the concept-context approach to the educational practice in primary science education.

Introduction

A consultation in 2003 of Dutch education performed by the Biological Council [Biologische Raad] indicated that biology as a school subject needs a re-evaluation and redefinition, because various problems have been identified in biology education for students from 4 to 18 years (Biologische Raad, 2003). Results of the consultation showed that current biology education is subject to the following three major problems: a curricular overload, a lack of relevance for students and a lack of coherence (Boersma et al., 2005). The three problems are of influence on students' learning processes. An overload of learning content leads to surface learning and simultaneously to less coherence of the content. Thereby students are less involved in learning due to a lack of relevance (Boersma et al., 2005). These problems are identified in primary education as well (Van Graft, Boersma, Goedhart, van Oers & de Vries, 2009).

The subject biology in primary education is part of science education [natuuronderwijs] together with the subjects physics, chemistry, earth sciences and technology (Van Graft et al., 2009). A recent report from Thijssen, van der Schoot, and Hemker (2011) about a regular survey of biology education in primary education showed that teachers are spent average 45 minutes a week on biology. Along primary education less than 3 per cent of school time is spent on science education (M. van Graft, personal communication, December 20, 2011). Especially along primary education students develop an interest in nature and technology (Biologische Raad, 2003, p. 12). Therefore, the above situation is not in line with the importance of science education for primary school students. Another problem in current primary education is that there is insufficient attention for basic characteristics of science education and to the development opportunities and the interests of students (Van Graft et al., 2009). These characteristics are elaborated in a guideline for content and activities belonging to the core objectives for science education.

The Biological Council argued for coherent biology education from primary education to secondary education in response to the identified problems (Biologische Raad, 2003). Next, the commission CVBO [Commissie Vernieuwing Biologie Onderwijs] was installed and developed a longitudinal curriculum for students from 4 to 18 years based on the concept-context approach (Boersma, Kamp, van den Oever, & Schalk, 2010). The concept-context approach is a content-based solution to the aforementioned problems. This approach requires a context and related activities, which are meaningful for students, to introduce a biological concept (Boersma et al., 2010). The relevance of biological content can be shown with meaningful contexts for students. When the content is limited to several concepts a reduction of the curricular overload would be pursued. The use of combinations of concepts and/or contexts could make the biological content more coherent (Boersma et al., 2005).

For a translation of the concept-context approach to primary education a first step has been made by making a conceptual framework for science education commissioned by the program 'Verbreiding Techniek Basisonderwijs' (VTB) of Platform Bèta Techniek (Van Graft et al., 2009). Such a framework gives an overview of combinations of contexts and concepts for the application in education (Van Graft et al., 2009). Furthermore, two series of lessons have been developed according to the concept-context approach to show the possibilities of this approach in primary education (Van Graft, 2009). However, the conceptual framework, with 23 biological concepts, does not indicate how and in which order concepts must be taught and research hereof is lacking.

Ultimately, curricular strands are needed to translate the approach to the educational practice (Van Graft et al., 2009). A curricular strand is needed to serve as a directive both for curriculum developers and teachers to decide when certain concepts are introduced. A necessary first step to arrive at a curricular strand is to know which concepts of the conceptual framework should be included in the curriculum and why. This is necessary, because only

then it can be determined which learning goals should be part of a curricular strand. To know which concepts should be included in the curriculum it is needed to investigate how choices can be made from the broad elaboration of the concept-context approach by the CVBO for implementation in primary education. Also, it is necessary to look for a justification of these choices for including some concepts in the curriculum over others. When it is certain which concepts should be part of the curriculum developers of curricula can use these choices as a justification for their curricular products. Additionally, such research could give more insight into curriculum development research and curriculum content choices.

Research aim and research questions

In this research study the focus lies in particular on the concept animal. A concept is defined as “an important idea from biology where relevant knowledge could be associated with” (Boersma et al., 2005, p. 15). The concept animal is one of the concepts making up the conceptual framework. The aim of the study is to arrive at an elaboration of the concept animal in terms of relevant underlying concepts related to the concept animal for the curriculum of Dutch primary science education for children from 4 to 12 years. With this the concept-context approach can be further worked out for primary education. Furthermore, the essence of the study lies on collecting guidelines which support choices for specific content and concepts about the concept animal. Developers of teaching materials for primary education and teachers have to take into account these guidelines when they introduce children to the concept animal. Ultimately, these guidelines can contribute to the reformulation of core objectives and development of textbooks in the near future. The research question is defined as: *How can the concept animal be elaborated in Dutch primary science education according to the characteristics of the concept-context approach?*

The sub questions addressed are the following:

1. Which guidelines can be used to determine the curriculum content of the concept animal in primary science education?
2. Which underlying concepts are related to the concept animal?
3. How is the concept animal reflected in student textbooks for primary science education?
4. Which everyday life contexts are relevant for children in the age of 4 to 12 years in which animals play a role?
5. What do the outcomes of sub questions 2, 3 and 4 mean for the choices to determine concepts in the intended curriculum?

Theoretical background

Science education

Science education in primary education aims to give children insight in the coherence of material reality that is inseparably connected to human life. Naturally, children are curious about concrete things around them and deal intensively with these things. Science education connects to the natural needs and interests of children for their environment (De Vaan & Marell, 2010, p. 19). In science education it is common to connect to the life world of children (Van Graft et al., 2009, p. 6) Science education must therefore focus on contents that are recognizable for children (De Vaan & Marell, 2010). Characteristics of science education are also elaborated in the Dutch core objectives for primary education (Ministerie van Onderwijs, Cultuur en Wetenschap, 2006).

Concept-context approach

Biological knowledge has to be offered in contexts in which children participate or orientate themselves on (Boersma et al., 2007). The concept-context approach works particularly from the learner itself and demands that the offered education is meaningful for children. The starting point is therefore the meaningful life world of children (Van Graft et al., 2009). For that reason, the approach is in line with the characteristics of science education.

In the concept-context approach three structures are central: contexts, activities and concepts (Boersma et al., 2005). A context is defined as “a ‘practice’ in which several cultural-historical determined activities are performed focused on realizing the aims pursued in that context” (Boersma et al., 2005, p. 14). Specific (biological) knowledge, materials and tools are needed when performing these activities. In addition, values and standards of the context are of importance. Three types of contexts are distinguished: everyday life, professional and scientific contexts (Boersma et al., 2005; Boersma et al., 2007). The everyday life contexts are especially relevant for students in primary education, because in these contexts children (potentially) participate (Van Graft et al., 2009). In general, an everyday life context is directed to the fulfilment of primary and secondary needs of participants, like physical needs or going on a holiday (Boersma et al., 2005). Ten everyday life contexts for primary education are defined and in six contexts the concept animal can be present. These are: excursion/holiday, family, health care, examining nature, school, and shop (Van Graft et al., 2009).

An activity which is relevant in a context can be defined as “an activity whereby biological knowledge is needed to perform it adequately” (Boersma et al., 2005, p. 15). An activity can be seen as the physical and mental actions needed in performing that activity. These actions are performed by humans with an object, like an organism, and have mostly a fixed pattern. Such a pattern appears as a way of thinking and practices. It should be stated that for primary education activities are specified by relating types of activities with objects, like organisms, products or phenomena (Boersma et al., 2007; Van Graft et al., 2009). When performing an activity in a context specific knowledge is important. The knowledge is situated in an activity and the meaning of it will be determined by the use of it in a context. Therefore, knowledge in one context could have a different meaning in another context (Boersma et al., 2007). The relevant knowledge will be given in a coherent manner reflected in concepts. A concept is defined as “an important idea from biology where relevant knowledge could be associated with” (Boersma et al., 2005, p. 15). In figure 1 a matrix is given with 23 biological concepts of the conceptual framework of which one is the concept animal (Van Graft et al., 2009). This concept is defined as: “an (multicellular) organism, equipped with senses, that obtains his energy by eating plants and/or other animals. Most animals move, need oxygen and react on each other” (Van Graft et al., 2009, p. 40). Two additions have to be made. First, animals are also capable of moving to other places and secondly animals will be influenced by their environment, like abiotic factors.

Levels of organization	System concepts				
	Biological unit	Self regulation and self organization	Interaction	Reproduction	Evolution
Molecule					
Cell					
Organ system	Organ	Respiration Blood circulation Digestion	Sense		
Organism	Plant Animal Human	Nutrition Life cycle Health	Behaviour Interaction with (a)biotic factors	Reproduction Heredity	Fossil Form and function
Population	Species				
Ecosystem	Ecosystem	Food chain			
Biosphere	Biosphere	Sustainable development			Biodiversity

Figure 1. Matrix with 23 biological concepts for primary education (Van Graft et al., 2009).

The three structures (contexts, activities and concepts) are connected. The activities which are performed in a context ask for specific biological knowledge, which could be associated with one or multiple concepts (Boersma et al., 2005). This relation is illustrated in figure 2. The concept animal is related with various other underlying concepts, like organ or health, which are in turn concepts themselves that belong to the 23 concepts of the conceptual framework.

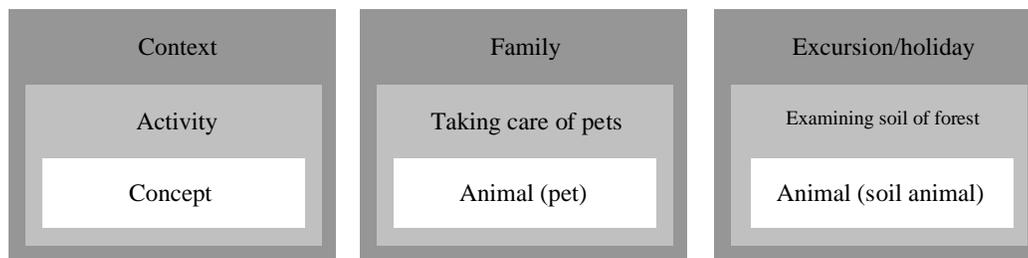


Figure 2. A schematic overview of the relation between contexts, activities and concepts. The process of 'recontextualization' is symbolized by an arrow. From Van Graft et al. (2009).

According to the concept-context approach students should be able to use concepts in different contexts other than the context in which the concept originally has been taught. However, concepts can have a different meaning in other contexts. To make it possible to use the concept in another context the meaning have to be abstracted and then have be used in the new context with its new meaning. This process is called 'recontextualization', as illustrated in figure 2 (Boersma et al., 2005; Boersma et al., 2007). If students learn to use the concept animal in the two illustrated contexts they will learn that both pets and soil animals are animals and extend therefore the meaning of the concept animal. Altogether, the concept-context approach holds, specific for primary education, that there are combinations of objects (organisms, products or phenomena) in a context with types of activities and concepts (Van Graft et al., 2009).

Selection of curriculum content and concepts

Curriculum research can relate to different levels and components. At macro (national) level the question 'What are they (children) learning?' is directed toward the content of the curriculum, one of the components of a curriculum (Thijs & van den Akker, 2009). This question has historically been regarded as the central question in curricula. However, all curriculum components are equivalent to each other and are interrelated. This means that the 'what' question cannot be disconnected from other components, like learning activities (Dillon, 2009). The components are preferably consistent with each other (Van den Akker, 2003, p. 4).

The knowledge which is of most worth for learning is considered by many different stakeholders, ranging from parents to politics. They are involved in the question about what we should teach students. Each group has its own considerations about the issue, pedagogical, societal and political considerations for instance. Also, own educational experiences shape their arguments (Thijs & van den Akker, 2009). An example of a study about curriculum content whereby different stakeholders were taken into account is the study of Osborne, Collins, Ratcliffe, Millar, and Duschl (2003). The aim was to determine what nature of science entails by consulting an expert community of scientists, science communicators, philosophers and sociologists of science, and science educators. These experts were consulted in a three stage Delphi study in order to achieve consensus about aspects of the nature of science considered essential for science education. This resulted in a broad agreement of nine themes about aspects of the nature of science which students should encounter (Osborne et al., 2003). A study of Clemente, Ramírez, and Domínguez (2000) focused specifically on the criteria Spanish teachers of infant and primary education are using in the selection of educational contents. Criteria they used were categorized as epistemological, factual, pedagogical, pragmatic, socio-ideological, and psychological (Clemente et al., 2000).

Curriculum content and objectives can be chosen for different reasons. Tyler (1973) distinguished three perspectives for the selection of educational objectives; from the student, from society and from the subject discipline. The study of this paper addresses only the perspectives of subject and student. The three perspectives have to be in balance for considering a curriculum. In addition, an educational philosophy and a learning philosophy are helpful for further selection of objectives (Tyler, 1973). These perspectives are reflected in three main sources for selection and prioritizing aims and content. These are:

- Knowledge: the academic and cultural heritage for learning and future development.
- Social preparation: issues relevant for inclusion from the perspective of society.
- Personal development: elements of importance for learning and development from the needs and interests of learners themselves.

(Thijs & van den Akker, 2009, p. 14)

There has to be searched for a balance between these three sources. There is a risk of an overloaded and fragmented curriculum when an excess of wishes exists for inclusion in a curriculum (Van den Akker, 2003).

Another way to determine science curriculum content are the seven curriculum emphases of Roberts (1988). A curriculum emphasis is a curricular context in which the science content is taught, like the process of generating scientific knowledge. An example of a curriculum emphasis is 'Everyday Coping' whereby the science content is needed to comprehend everyday objects and events (Roberts, 1988). The curriculum emphases can be used to justify choices for curriculum content.

In a study to verify if different curriculum development models lead to different content of science curricula, content selection criteria were used as a basis to evaluate science curricula (Searles, 1981). These criteria are obtained from many professional sources and are summarized in table 1.

Table 1. Criteria for content selection (Adopted from Searles, 1981, pp. 80-81)

Contemporary	Contemporary content of the discipline?
Fundamental	Content that provides for the acquisition of new knowledge?
Inquiry	Investigative procedures common to the discipline?
Social and culture	Content associated with social and cultural perspective of nation?
Breadth and depth	Appropriate balance between breadth of topics and the depth of their treatment?
Objectives	Its coverage of a wide range of objectives?
Appropriateness	Material suitable for the intellectual development of student?
Social and cultural norms	Information relates to social and cultural norms of students?
Student's needs	Content meets student's needs?
Student's interests	Content meets student's interests?
Sequence	Logical development of the disciplines' content?
Utility	Content can be utilized by the student in his everyday environment?
Nature of man	Material related to the nature of man's affairs?
Human development	Content aids man in growth needs of human development?
Sanction	Knowledge is sanctioned by governing authorities?

Directed to concept selection Black and Harlen (1993) give four main criteria when selecting concepts for primary science education in order to specify concepts as learning targets. These criteria are (Black & Harlen, 1993, pp. 216-218):

- The concepts should help students to understand everyday events and the world around them. The concepts should be applicable to their experience.
- Children should be able to generate and test concepts by using process skills.
- Concepts should be at a level which children can learn with understanding. Their limited experience and maturity have to be taken into account.
- The concepts should provide a foundation for future learning in science.

Method

The qualitative research study is part of curriculum development and followed the communicative approach. This approach pursues a relational strategy whereby stakeholders play an important role. Their views and opinions about the situation, of 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, which are outlined in figure 3. The first part consisted of interviews with primary teacher educators for science education, an analysis of student textbooks for primary science education, a questionnaire to experts, and interviews and group discussions with primary school students. Each was done in order to identify guidelines, underlying concepts related to the concept animal, and/or everyday life contexts interesting for primary school students. As far as possible, guidelines were selected on generality, this means that guidelines are applicable for multiple underlying concepts related to the concept animal.

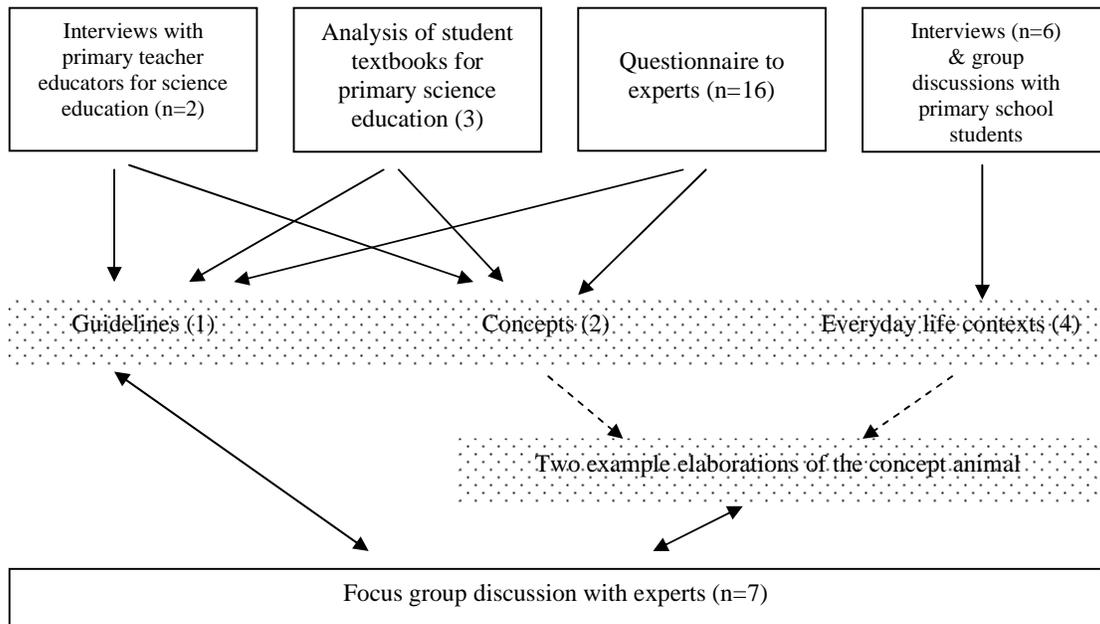


Figure 3. Schematic overview of the research method. (Dotted bars are research outcomes, black arrows indicate actions of data collection and analysis, striped arrows show a development, two-way arrows indicate a verification and data collection/analysis. Sub questions are indicated in parentheses, except sub question 5. This question follows from the answers on the other sub questions).

Developing an elaboration of the concept animal according to the concept-context approach, the aim of the study, asks to work within an everyday life context. These everyday life contexts were selected from the results of the interviews and group discussions with primary school students. An elaboration was made for children in the age of 4 to 8 years as well as for children in the age of 9 to 12 years, resulting in two example elaborations. The elaborations were defined as underlying concepts that can be connected to the concept animal, derived from the other components. A concept to include in the elaboration was selected when it met the criterion that it connects to the chosen context. Also, concepts considered most important according to experts and primary teacher educators were used. Subsequently, the guidelines for selecting concepts and the two elaborations were presented to experts during a focus group discussion. Following this approach it was investigated if the elaborations and the guidelines in making choices for curriculum content are appropriate. For this study a ‘policy’ Delphi study was followed to collect systematically arguments and opinions of experts about the proposed findings (Van Zolingen & Klaassen, 2003). Additionally, an audit trail had been kept making research choices transparent.

Primary teacher educators for science education

Two semi-structured interviews were conducted with primary teacher educators for science education. They were non-randomly selected. Both work at an university for teacher education (Pabo) in the Netherlands. They were interviewed in order to determine concepts that they considered important to include in primary science education about the concept animal. In particular, there has been asked for arguments supporting their choice. It was expected that most relevant arguments were derived with two interviews, because the respondents are part of quite a homogenous group. In appendix A the interview scheme is shown. No pilot was conducted to test the interview scheme. The interviews were transcribed verbally and qualitatively analyzed together with field notes made during the interviews. The guidelines they provided to argue for their choices and the chosen concepts were identified. To verify the data, a member-check with both teachers was carried out.

Analysis student textbooks for primary science education

To investigate how the concept animal is reflected in student textbooks for primary science education, three science education methods for primary education have been analyzed on concepts related to animals. It is possible that concepts were missed, because no verification was carried out. Also, guidelines were searched for that justified content choices. Student textbooks and manuals of the methods *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 10 to 20 per cent in primary schools. *NatuNiek* has a share of 8 per cent (Thijssen et al., 2011). Textbooks for students in the age of 8 to 9 and of 11 to 12 were used. In addition, for the method *Leefwereld* an activity book for children from kindergarten was analyzed. The analysis was done by categorizing found concepts in the matrix of the conceptual framework (see figure 1). One of the supervisors verified this categorization. It resulted in a reflection of the concept animal and related concepts in student textbooks.

Questionnaire

A questionnaire was developed (appendix B) and reviewed by the supervisors. However, no pilot was conducted. To identify important underlying concepts connected to the concept animal and arguments supporting it viewpoints of different experts were asked. An expert was defined as someone with expertise in the concept-context approach, curriculum development, and/or science primary 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 16 experts were 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 size. Ultimately, one expert dropped out and filled in only the questionnaire, remaining on seven experts for the focus group discussion. The other nine experts filled in the questionnaire. The experts included two PhD's making use of the concept-context approach, a curriculum developer, a CVBO member, working at NIBI, 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 of SLO. Most of them had a background as biologist. The questionnaire contained different questions to investigate what experts considered important about animals for primary science education. The results of the questionnaires were qualitatively analyzed and summarized. Also, the frequency of guidelines was noted. No verification of the results has taken place. A report of the outcomes of the questionnaire filled in by the seven experts, who would participate in the focus group discussion, was send back to them.

Primary school students

To conduct interviews and group discussions with primary school students one primary school was selected on availability. The selected school was a Protestant school with 220 students located in Amersfoort, a medium sized city. A total of six students (4 boys and 2 girls), selected by the teacher, were interviewed: two children of age 4 and 5, two of age 8 and 9, and two of age 12 and 13. These ages were chosen to cover the whole range of primary education. Each interview was held with two children from the same class. The amount of students of the three classes for the group discussions, with children from the same ages as the children from the interviews, was respectively 22, 27 and 23 students. Both the interviews and class discussions were held on the same day. Interests of primary school students about animals were examined to make a selection of relevant everyday life contexts for the elaborations of the concept animal. During an interview students were asked to choose one

photograph out of six different photographs that was appealing to them. Each photograph depicted one of the six everyday life contexts in which animals play a role (see appendix C). However, no pilot was conducted to check whether the photographs were representative for the contexts. Subsequently, the students were asked to explain their choices to identify interests. In appendix D an interview scheme is shown. To hedge against contingencies a group discussion in each of the three classes was held by the teacher, whereby students were asked to choose one of the photographs they liked. Subsequently, the teacher asked some or all of the students about their arguments for choosing a particular photograph. The interviews and group discussions were transcribed verbally. A quantitative analysis was performed by selecting a photograph (context) with the highest frequency of students' choices. Also the findings were qualitatively analyzed to provide a contextualization of the quantitative findings. This consisted of given arguments by students. The analyses were supplemented with field notes. Moreover, some concepts in relation to the concept animal mentioned by the students were identified.

Focus group discussion

The experts of the focus group discussion consisted of three CVBO members, one education specialist of SLO, one employee of primary education section of SLO, one test specialist for primary and secondary education at CITO, and one author of a textbook for science education content (*Natuuronderwijs Inzichtelijk*) who also works at Science Center NEMO. Five of them studied biology, one paleontology and one had a background as education specialist. They were invited for a collective meeting to discuss the outcomes of the questionnaire of which they received a short report with results. During the meeting ground rules were indicated. The aim of the meeting was to present the guidelines found in other parts of the study and to discuss these guidelines to reach consensus about the significance of it. Further, the two example elaborations were presented and discussed on limitations and possibilities. The discussion was transcribed verbally and qualitatively analyzed. The findings of the meeting were sent to the experts to ensure member checking.

Results

The results are presented in five parts. First guidelines are given that were identified in the several components. The guidelines are classified into five categories. Pedagogical arguments include arguments which take into account what is of importance for children. This is in accordance with the student perspective of Tyler (1973). This also applies to the category of social arguments, which are related with the society perspective. The category of subject arguments contains arguments derived from the essence of animals or biology. The fourth category of didactical arguments relates to didactics. The last category of remaining arguments includes arguments which do not fit in one of the other categories. The categories were chosen and specified along the process of data analysis. In the categories the division of Tyler (1973) is reflected, though this was not explicitly used during the analysis. Secondly, an overview of concepts and content related to the concept animal found in each part is shown. Thirdly, everyday life contexts interesting to primary school students are presented which formed a basis for the developed elaborations, which are shown subsequently. Finally, results from the focus group discussion are given whereby prior results were discussed.

1. Guidelines

Primary teacher educators for science education

Two primary teacher educators for science education were interviewed about their views on important content and concepts about animals in primary education. The arguments

they gave are presented in table 2. According to the first primary teacher educator the accent for the concept animal in primary education lies strongly on experiencing and discovering. When children have an experience with animals more will be achieved. The knowledge can be connected to an experience and therefore anchors better in memory. The argument 'choose concepts that can be connected to the experiences of children' can be extracted from this. Another argument he brought forward suits especially to younger children. They orientate intuitively on the appearance of animals. Form and function is a concept that followed this argument. Curiosity of children is another argument that can be used to select concepts. The concept fossil is a concept that often fascinates and excites children. Further, a logical line of concepts was an underlying argument why he selected concepts. Concepts like nutrition and food chain are related to each other. Therefore when it is about nutrition, the concept of food chain can also be discussed, because they succeed one another.

The accent for the concept animal in primary education, according to the second primary teacher educator, is that children have a view at and knowledge about organisms in their own environment, like a pet. This is stated in the core objectives for primary education. This is an argument to use when selecting concepts. The main points in primary education concerning animals are the concepts behaviour and form and function (like adaptations). These are concepts that stand closest to children and which they encounter. It is logical that attention is paid to these concepts. The underlying idea is that observations, knowledge and fascination about these concepts learn children to take care. Also a concept that belongs to the essence of organisms was an argument. A concept as behaviour falls under this argument, for instance. Two didactical arguments named by this teacher state that concepts offer reference points for observation or can be examined. Form and function, behaviour and species are concepts that suit these arguments. He thought also that a concept as nutrition is interesting to include in primary education.

Table 2. Guidelines derived from primary teacher educators for science education.

Pedagogical arguments

Choose concepts that:

- can be connected to the experiences of children
- can be connected to the exterior of animals (especially young children are looking at)
- can be connected to the curiosity of children
- are close to children or which they encounter

Subject arguments

Choose concepts that:

- belong to the essence of organisms
- are in a logical line
- can be connected to core objectives; children have a view at and knowledge about organisms in their environment

Didactical arguments

Choose concepts that:

- can be examined
- can be connected to experiences
- are a reference point for observation

Remaining argument

Choose concepts that form a wholeness

Analysis student textbooks for primary science education

Guidelines which were found in the three science education methods for primary education (see table 3) were derived from the manuals and sometimes from student textbooks. Guidelines will probably be aimed at all content present in a method and not specific at the subject of animals. In all three methods it was indicated that the core objectives were of relevance. The method *Leefwereld* contained especially didactical arguments. It was clearly indicated what accent there is in the various grades, also for children in kindergarten. One theme in *Leefwereld* for students of the last grade was about animal rights. This was illustrated by bio-industry. Although not explicitly named it might reflect a guideline about social relevance. The method *NatuNiek* was brief about underlying reasons. There was indicated that connecting knowledge to experiences (by experiments) is central in the theme lessons of the method. In the student textbooks examination and the relation between humans and animals were seen. This may reflect some consideration of the authors for inclusion this content. *Natuurlijk* was a method with an extensive overview of underlying considerations, as well as for content choices. It was indicated that the content has to be concrete to make it comprehensible to children. This can be done by choosing an appropriate context. Further, when choosing content they took into account, beside the core objectives, the essence of the subject and the content in secondary education. Apart from this *Natuurlijk* elaborated content by relying on concepts which hold a central position in nature, these are diversity, maintenance and consistency. These concepts formed an important selection criterion for underlying concepts and contents.

Table 3. Guidelines derived from three methods for primary science education.

Pedagogical arguments

Choose concepts that can be connected to the way children from kindergarten discover and experience their life world

Subject arguments

Choose concepts that:

- can be connected to the essence of the subject
- hold a central position in nature (diversity, maintenance and consistency)
- can be connected to core objectives
- can be connected to the content in secondary education

Didactical arguments

Choose concepts that:

- can be connected to examination, like differences between teeth of animals
- can be related to concrete experiences to arrive at concept development
- can be related to an accent (for children of age 8 to 9) on discovering and formulating
- can be related to an accent (for children of age 11 to 12) on examining and clarifying

Social arguments

Choose concepts that:

- have a focus on the relationship between humans and animals (taking care of the environment)
 - have a focus on society, like bio-industry
-

Questionnaire

In table 4 an overview of guidelines is presented derived from experts who participated in both the questionnaire and the focus group discussion. The frequency of the guidelines is also indicated. The given arguments ranged from the importance of concepts in

the experiences of primary school students to concepts belonging to the essence of animals, like the concept behaviour. Another argument to choose a concept was to include an action perspective. Therefore, the concept of sustainable development can be selected. A concept as form and function can be chosen because of the possibility to make a relation with other subjects (technology or arts). This revealed another guideline. Also, concepts can be selected when they are of social relevance (concepts like health and nutrition). Arguments which were mentioned by the other experts, who only filled in the questionnaire, resembled the arguments presented in table 4. Except some arguments like: select concepts for preparation on secondary education and that fascinates children (e.g. life cycle). One expert stated that the meaning of a concept is determined by use of it in a context.

Table 4. Guidelines derived from the experts who participated in the focus group discussion and who filled in the questionnaire. In parentheses the frequency of arguments is shown. The asterisk indicates the argument with the highest frequency.

Pedagogical arguments

Choose concepts that:

- are of importance in life world practices primary school students are participating or orientating on (5)
- can be connected to the level and experiences of children (7)

Subject arguments

Choose concepts that:

- are unique for animals (4)
- are a key concept or ordering principle in biology (8)
- can be used for taking care of and to deal with animals (11) *
- can be connected to the essence of animals (life) (9)
- show connections (e.g. form and function) (4)
- can indicate consistency in the living nature (5)
- can be used to think in systems (e.g. ecosystem) (1)
- can be important for the general development of children, for the awareness of consistency in nature, and/or for respect to living organisms (3)

Didactical arguments

Choose concepts that:

- have an opportunity to let children examining, for a development of a critical attitude (1)
- can have an action perspective (1)
- can be used to experience astonishment (7)
- can be a reference point to enter a conversation (about values) (1)
- can be easily observed (3)
- can have opportunities to relate with other subjects, like technology and arts (e.g. form and function) (1)
- can be related to other concepts (9)
- can be serve as a basis for other concepts (4)

Social argument

Choose concepts that can be of social importance (e.g. nutrition) (5)

The outcomes described above show various guidelines that can be used to determine curriculum content of the concept animal. Therefore, it provides an answer to the first sub question.

2. Concepts related to the concept animal

Primary teacher educators for science education

The concept animal in primary education had a broad scope according to the first primary teacher educator. Most important was that children learn to look at an animal. Apart from this they need to get a feeling with: what is an animal, how to take care of an animal, where lives an animal, and which animals are living in their own environment. Important concepts for the concept animal for children in kindergarten, named by this primary teacher educator, were respect for animals, the occurrence, amount of paws, form, and sometimes nomenclature. For seven to eight year olds it could be more about 'higher' animals and reproduction, the kind of animal, movement, habitat, and kind of food. For children of age 9 to 10 digestion, teeth and bird migration were main concepts. For eleven to twelve year olds content about cycles and life in soils or water can be present. When the teacher was asked to give five concepts in order of significance the concept form and function was placed first for children in the age of 4 to 8 years. For children from 9 to 12 years it was the concept reproduction. According to the second primary teacher educator the main points in primary education were the concepts of form and function and behaviour. The concept animal covered the following: animals live, move, reproduce, can adjust to their environment and to changing circumstances, have a finite life, and can be classified in various (sub)species. When choosing five concepts in order of significance the concept form and function was most important for children in the age of 4 to 8 years, likewise for children in the age of 9 to 12 years.

Analysis of student textbooks for primary science education

The analysis of student textbooks was performed to reveal concepts in the methods *NatuNiek*, *Leefwereld* and *Natuurlijk* that relate to the concept animal. This answers the third sub question about how the methods reflect the concept animal. In table 5 an indication of the emphases on (underlying) concepts that were related to the concept animal in the three methods is shown. When a particular concept is emphasized in a method, this does not necessarily mean that it was not present in one of the other methods. It can be seen that concepts as blood circulation, plant and human did not appear in themes about animals in all three methods.

Table 5. An overview of the three methods *NatuNiek*, *Leefwereld* and *Natuurlijk* with an indication of the emphasis on the concept animal. (Bold concepts indicate an emphasis of *NatuNiek*, cursive concepts of *Leefwereld* and underlined concepts of *Natuurlijk*). In appendix E a more detailed overview is presented.

Levels of organization	System concepts				
	Biological unit	Self regulation and self organization	Interaction	Reproduction	Evolution
Molecule					
Cell					
Organ system	<i>Organ</i>	<u>Respiration</u> <i>Blood circulation</i> <i>Digestion</i>	<u>Sense</u>		
Organism	Plant <u>Animal</u> Human	<u>Nutrition</u> <i>Life cycle</i> <u>Health</u>	<u>Behaviour</u> <u>Interaction with (a)biotic factors</u>	<u>Reproduction</u> <u>Heredity</u>	Fossil <i>Form and function</i>
Population	<i>Species</i>				
Ecosystem	<u>Ecosystem</u>	<u>Food chain</u>			
Biosphere	Biosphere	Sustainable development			<u>Biodiversity</u>

The method *NatuNiek* contained for eight to nine year olds two themes that relate to animals. One theme was about the food chain and how animals obtain their food. The relation between carnivores, herbivores and omnivores was discussed. Students were asked to compare teeth of these animal groups. The other theme was about the way animals use their senses. For instance, the olfactory organ is for most animals more important than sight. For the last grade one theme about animals was present. It focused on the impact of changing circumstances on plants and animals when they can no longer maintain themselves. Concepts as habitat, natural equilibrium and extinction were treated.

Leefwereld was the only method with material for students in kindergarten, which consisted of an activity book and panels with images. As a common thread two bears were appearing in the themes. Subjects about small animals and their habitat, way of life and appearance were raised. Also, a theme was included about juveniles. The textbook for students of age 8 to 9 years contained themes about the appearance and the way of life of spiders and bats. The difference between bats and birds was discussed as well as the differences between spiders and insects. One theme discussed the role of soil animals and decomposers, and the digestion of animals. Another theme was about the skin covering of animals. Finally, the life cycle, the appearance and the way of life of frogs and toads were discussed. For students of age 11 to 12 years a theme was included about the interaction between animals and plants. Insects are playing a role in the pollination. Attention was paid in a theme about the geese migration. In another theme the form and function of vertebrates' skeletons was treated. A theme, not present in other methods, was about the (mis)use of animals, like animal testing. Further, the communication between animals and the meaning of animal behavior was explored in a theme. Another theme treated social insects (e.g. bees) and the characteristic task differentiation and collaboration among these animals. At last a theme addressed the coast and the animals that live there. In particular, attention was paid to the feeding adaptations of beaks of water birds.

The method *Natuurlijk* consisted of many themes about animals, more than the other two methods. For eight to nine year olds themes discussed the life phases of animals, life characteristics, locomotion and the relation with energy, and senses of animals. Also a theme was present about the health and sickness of organisms, whereby a veterinarian was addressed. Also, the sight of prey and predators which is determined by the place of the eyes was treated. Further, the fact that animals are adjusted to their environment was explained using for instance the life of a stickleback. Also, it was treated that animals are dependent of other organisms for their food. At last it included a subject about hunting and breeding care of animals. For students in the last grade of primary education the following themes were present: the reproduction of animals, the first life phase and breeding care, regulation of body temperature, life of water animals, food chain, soil animals, and collaboration of and competition between animals. The interaction between insects and plants in terms of pollination was also discussed. Next a theme was about the natural distribution of animals, like the introduction of (exotic) animals. Further there was content about the biorhythm of animals. A small part addressed the subject of breeding animals to pass on desired features. Attention was also paid to different death causes of animals.

Questionnaire

In the questionnaire the experts were asked to give their views about the content and concepts they considered essential for primary school students in relation to the concept animal. The outcomes of the questionnaire are presented in the sequence of the questionnaire. When asked what content students should learn about animals diverse responses were noted. Overall, many aspects were present among the majority of experts. Examples are the behaviour of animals, diversity of animal species and taxonomy of animals, and the

characteristics of animals, which can be in relation to their environment (form and function e.g.). One expert named that the appreciation for animals as living things is important, because animals are part of the world and have an instrumental meaning. The care for animals should also be included, named by two experts. Furthermore, it was named that animals are in relation to their environment, like a part of the food chain, and are adapted to nutrition and seasons, for instance.

Next, the experts were asked to name and order five important concepts in relation to the concept animal. Many different orders were given. It goes beyond the purpose of this paper to display this orders. The concepts reflected the aforementioned content of animals. The following exemplifies this, the concept behaviour is an indicator for humans to make contact with an animal and to assess the well-being of an animal. Other concepts as welfare, adaptation, food pyramid, and appearance were also named.

The experts were asked to make an order (of significance) of five concepts from the 23 concepts of the CVBO that they considered essential for the concept animal, both for children from 4 to 8 and for children from 9 to 12 years. For the first group of children the experts named mainly concepts that relate to the basis aspects of animals. Also, the concept plant is named once, because of the fact that some animals eat or use plants, like nesting. One expert explained that the concepts for older students have a higher complexity than the concepts for younger children. Also, it can be seen that concepts such as ecosystem and sustainable development were not mentioned in the orders for younger students.

In general the content and concepts named by the experts are reflected in the answers of the questionnaire filled in by the other experts. The kinship between humans and other animal species (evolution), as important content, was more explicitly named by the other experts. Also, it was important according to one expert that students learn to treat animals with care and respect. The relation between animals and humans, and the relation between animals themselves is another aspect which was stated. Further, an aspect more clearly stated was that animals can become sick.

Altogether, the outcomes show that many underlying concepts can be connected to the concept animal and provide an answer to the second sub question addressed.

3. Selection of everyday life contexts

The two children from kindergarten both selected the photograph displaying a veterinarian with a cat during the interview. The situation was not familiar to the interviewed girl (age 4), although some day her rabbit had to go to a veterinarian. She preferred the photograph, because cats are appealing and she loved them. The boy (age 5) also favoured the veterinarian picture. His main reason for choosing it was that he had a cat himself. Also, he loved cats. He recognized a vet on the photograph, but had never saw it before. However, his cat was some day very ill and had to go to a veterinarian. During the interview the two children reacted on each other. When the girl said that she loves cats, the boy responded that he loves them too. Furthermore, the boy told that he knows a lot about dinosaurs. This was in reaction to the photograph with the skeleton, which he recognized as a dinosaur. He knew that this dinosaur once lived. During the class discussion most of the children selected the photograph with a depiction of a museum with a skeleton of a sperm whale, see figure 4A. More boys than girls chose this picture. Striking was that the two children of the interview selected this time the photograph of the museum instead of their previous choice. Some form of coping might be present in this situation. Students preferred this photograph, because the skeleton is nice, beautiful or big. Some children saw it on television or computer or have been in such a museum themselves. Because of the photograph with a museum was chosen mostly, the context of excursion/holiday was used to make an elaboration for this age category.

The two children in the age of 8 and 9 years selected the photographs of a veterinarian and the museum. The girl (age 8) chose the veterinarian. She recognized the situation, because she had two cats herself of which one had been to a veterinarian. She favoured the picture, because it was beautiful. She thought it is sad for animals that they have to go to a veterinarian for an examination, although she knew that it is good. The boy (age 9) chose the picture with the museum, because he liked it. He never saw it before and thought it was a skeleton of an extinct animal. He chose the picture, because it is very big and you can observe it well. Also you can learn from it. He would like to know what kind of animal it was and when it lived. In the class discussion with children from the same age group the veterinarian followed by the museum were frequently chosen (see figure 4B). The two children from the interview were consequent in their choices during the class discussion. Not every child was asked to explain his or her choice. The students who got the opportunity explained that they chose the photograph with the veterinarian, because they had an experience with the situation. More girls than boys preferred the veterinarian.

The photographs which were chosen by the two children of the last grade in primary education were the photograph of an aquarium and of the museum. One boy (age 12) preferred the aquarium, because he had fish of his own, he liked them and the aquarium looked beautiful. He clearly explained how fish should be cared for. The other boy (age 13) chose the museum, because it looked very exciting to him due to the fact that dinosaurs are extinct. He told that dinosaurs, which he recognized on the picture, lived in the past and the other pictures displayed animals that live nowadays. During the class discussion 23 children were present. However, 24 choices were indicated, including the choice of one of the boys from the interview who was absent during the class discussion. The teacher indicated his choice. Also, in this group the photograph of the veterinarian was chosen frequently by the students (figure 4C). In contrast, there were more boys than girls choosing it. The opposite was evident with children in the age of 8 and 9 years. Arguments of the students for their choices ranged from liking cats, having a cat to an experience with the situation. Someone thought it is sad when animals are sick and have to be treated. The context healthcare was selected to make an elaboration for students from 9 to 12 years, because this context of a veterinarian was chosen mostly by students of these ages.

The everyday life contexts, in which animals play a role, of excursion/holiday and health care were relevant for respectively students with an average age of 5 years and for students with an average age of 8 and 12 years. This answers the fourth sub question.

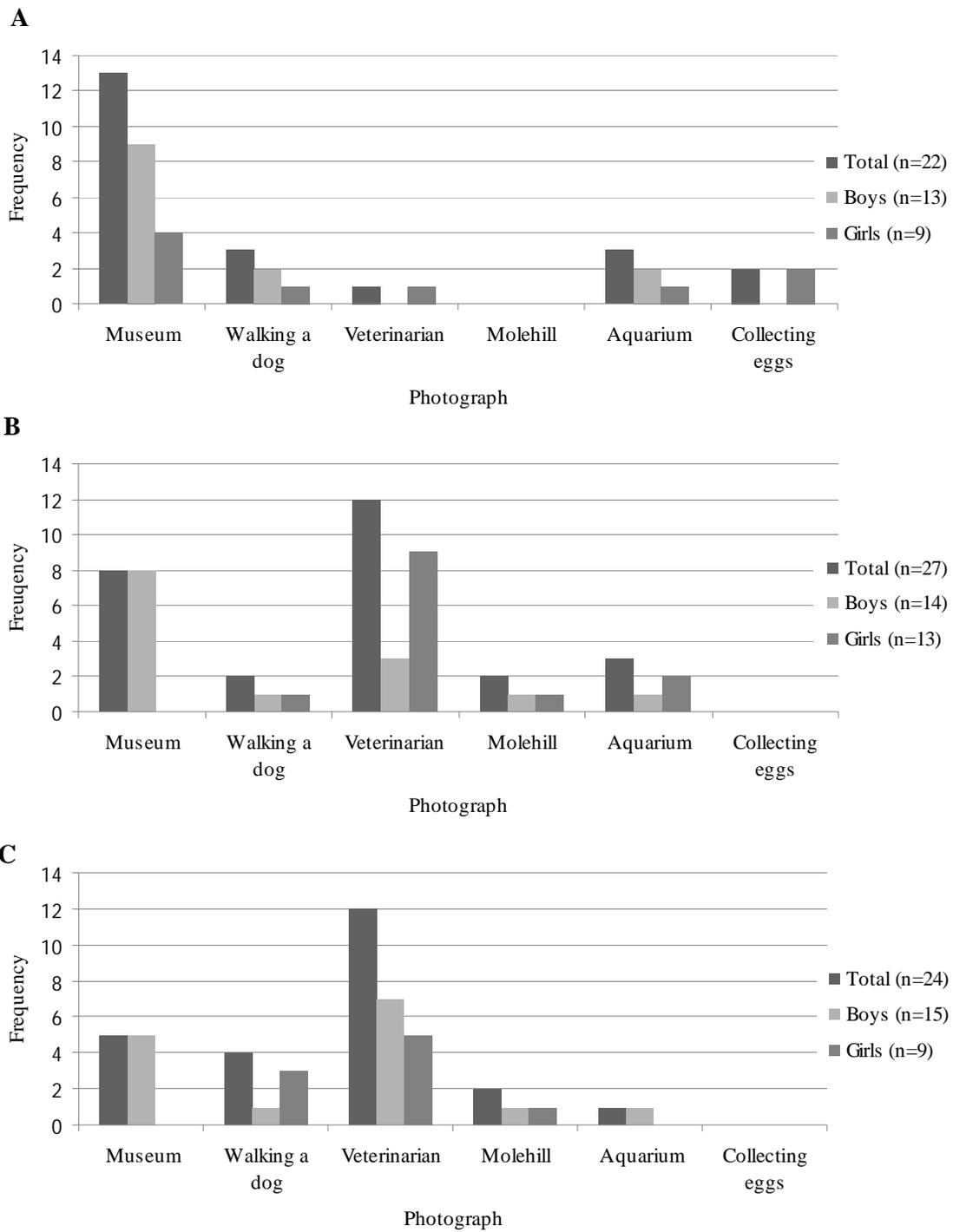


Figure 4. Frequencies of students' choices (age 4 to 5 (A), 8 to 9 (B) and 11 to 12 (C)) of the six presented photographs depicting everyday life contexts.

4. Two elaborations of the concept animal with underlying concepts

There has been made two elaborations of the concept animal, one for children in the age of 4 to 8 years and one for children in the age of 9 to 12 years. In figure 5 and 6 the elaborations are shown. The two elaborations are presented in terms of underlying concepts that can be connected to the concept animal. These underlying concepts were derived from the prior findings.

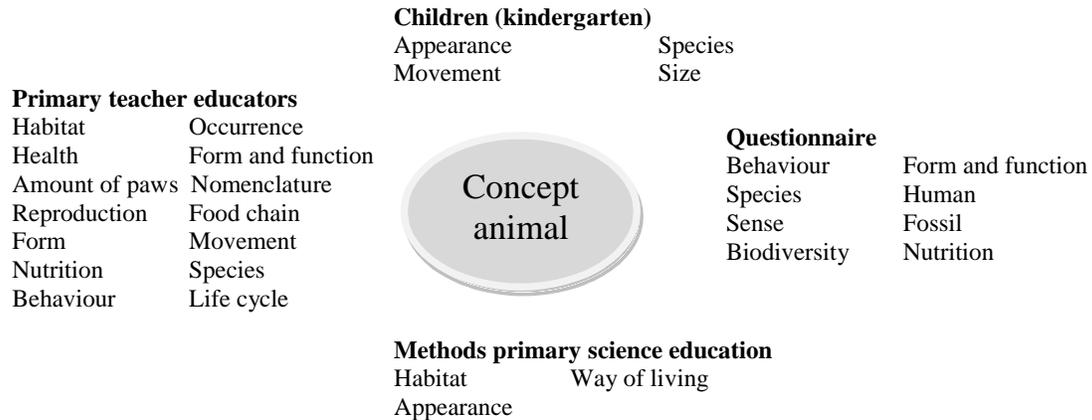


Figure 5. Example elaboration of the concept animal for children in the age category 4 to 8 year olds within the context excursion/holiday, like a museum with a skeleton of a sperm whale.

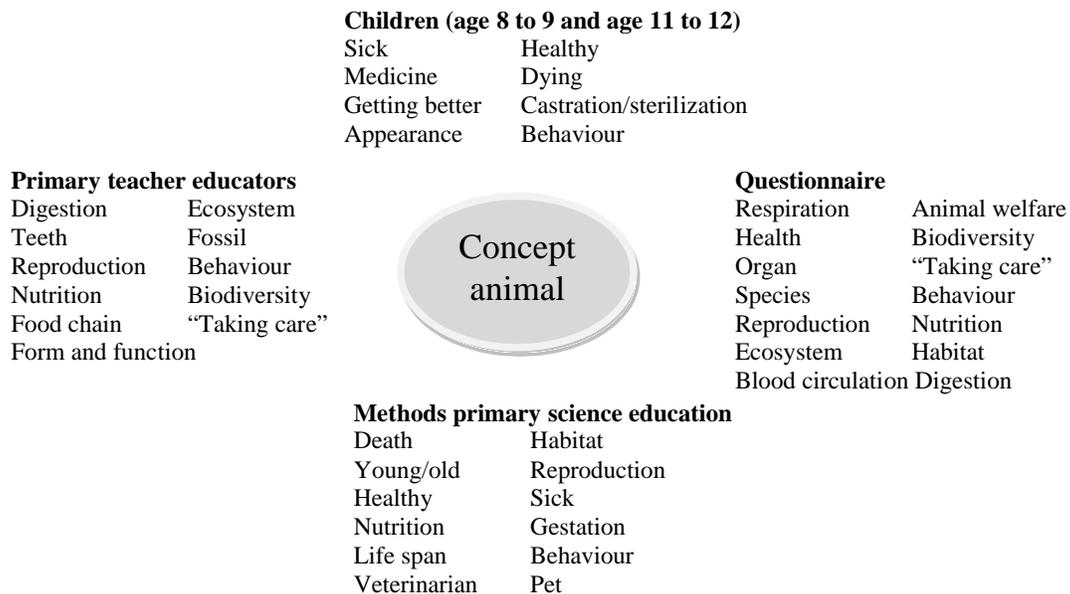


Figure 6. Example elaboration of the concept animal for children in the age category 9 to 12 year olds within the context health care, like a veterinarian treating a cat.

5. *Outcomes focus group discussion*

The aim of the meeting with seven experts was to present and discuss the guidelines found in prior components of the study and to reach consensus about the importance of guidelines. In addition, the two example elaborations of the concept animal were presented and discussed on limitations and possibilities. During the discussion a remark was made that although 23 biological concepts are already chosen it is still interesting to discuss the concepts that make up the conceptual framework. The concepts belong to an applied reasoning elaborated for primary education to the last grades in secondary education. It is wisely to deviate reasoned from it, therefore choosing several concepts instead of others. Furthermore, it was indicated that the concepts defined by the CVBO for primary education are related to each other. Therefore, they cannot independently be chosen. It is connected to the definitions of the concepts. Also, an expert recommended to discuss the question with a broadly composed group of experts. In general, as an answer to the question why certain contents in education should be included the known classification of subject, student and society was mentioned. A balance between these three should be sought. Didactical arguments, which made up the presented guidelines (see table 2, 3 and 4), to select a particular concept were also named by experts as important. This category of arguments might be placed between subject and student in the aforementioned classification.

Reasoned from the concept-context approach it is about visualizing and selecting of concepts (knowledge) in the context students are participating and which are functional for them. This functionality has a very high priority in the concept-context approach. It is about 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 of 'choose concepts that can be connected to the level and experiences of children' (see table 4) is perfect. Nevertheless, it is not independent of the other guidelines, they are connected with each other. So it is about knowledge that on the one hand applies to children and on the other side is functional for them in a context. It was reasoned by one expert that you should first determine a context instead of determining the knowledge on forehand. It is important in which context a student would participate and which knowledge can be present in it. The role of the students is very important in this. What is the student suppose to do in the context? Subsequently, the context and the role of the student characterizes whether it is about young or older children. During the discussion it was clarified that a concept cannot be separated from the context, it is different dependent of the context. A concept will be enriched when a student experiences more of the concept. Various aspects of the concept animal thus can be worked out in different contexts.

Choosing concepts essential for primary education during filling in the questionnaire one expert made clear that he tend to choose concepts that are often forgotten when the topic of animals is addressed. The concepts that are more frequently present are not chosen which can result in a loss of concepts. It was explicitly stated that a social perspective should be taken into account in selecting concepts. It is important that primary school students create an insight about the fact that everything in nature is connected (e.g. the concept biodiversity). This might be a reason to pay attention to particular contexts with social topics, in particular in the higher grades of primary education. Yet the conceptual complexity of such topics increases rapidly. It is abstract and complex for primary school students. It should be taken into account that such concepts are not unintended included in primary education. Besides, contexts with a social perspective could be forgotten. It could happen that unintended only the 'simple' contexts, as a veterinarian clinic and taking care of pets, are chosen.

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 students participate or orientate themselves on. This is illustrated by the following citation:

“..when it is your question to say with which arguments are you going to select concepts, then says [name expert], and I think that there is much agreement on, that the most important argument in selecting concepts is the importance of concepts in the context in which students engage or orientate themselves on.” (a CVBO member)

At the end, the experts agreed that there are three cornerstones in selecting concepts, that is: the importance of concepts in the context with a social dimension, subject matter and didactics. All cornerstones are interconnected, this is illustrated in figure 7. The interaction between context and subject matter was explicitly named by the experts. The student level and educational aims must be taken into account. Subject matter arguments were also evident in several studies (Thijs & van den Akker, 2009; Tyler, 1973). As well as the importance of pedagogical arguments, like the level of students Black and Harlen (1993) referring to. Besides this, didactical arguments of the experts were not clearly reflected in literature. Although interests and needs of students are of importance in selecting content or concepts as indicated by literature and reflected in the cornerstone of context, the context itself is a novel insight. In this cornerstone a social perspective is present, which is in turn in accordance with the society perspective of Tyler (1973).

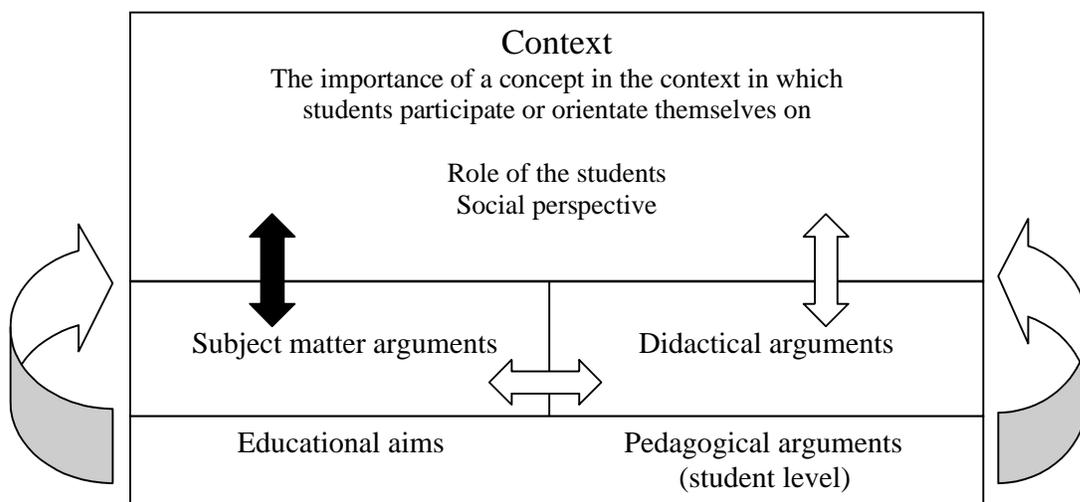


Figure 7. Schematic illustration of three cornerstones in selecting concepts. Black arrow indicates the explicit interaction between context and subject matter arguments.

The argument of the importance of a concept in a context was most qualifying. It was the starting point of reasoning. Here on the experts agreed on. When selecting concepts the arguing should come from two sides, which are not isolated from each other. On the one side meaningful contexts should be selected. On the other side biological content in relation to the concept animal present in the selected contexts should be determined.

It was suggested to make a concept map of concepts related to the concept animal and to indicate which of these concepts are present in different contexts. The result is a kind of a blueprint of contexts that may be addressed with students. Subsequently, an agenda of the concept animal can be laid over the concept map to assess in which contexts parts of the agenda are found. The agenda can be interpreted as an extensive description of the concept animal with aspects which should be included in primary science education. The definition of

the concept animal as defined by the CVBO could be a basis for this agenda, although experts indicated that this definition has some problems for primary education. In various contexts aspects of the agenda can then be addressed. A procedure for selecting concepts was extracted during the discussion and is presented in table 6. The starting point of the importance of a concept in a context is clearly reflected in this. In the procedure mentioned considerations and implications are included. Above all, it must be named that you should not ask too much of primary teachers to select concepts and contexts in this way.

Table 6. A suggested procedure to select concepts proceeding from the concept-context approach.

1. Select systematically several contexts important for primary school students.

Deliberate choices of contexts have to be made to cover the area of contexts students should encounter.

- a. It is a matter of where students come most often into contact with (e.g. zoo or pets).
- b. Which activities are possible in the context?
- c. It may be useful to focus on specific contexts whereby more time is spend to certain aspects.
- d. It is about well selected contexts whereby, when present, the coherency with a social theme is kept.
- e. Teachers are free in choosing a context. They must select relevant contexts for the school environment.
- f. The choice of a context gives implications for the subsequent choice of contexts. A proposal of contexts would be a service for schools to choose from different trajectories of a sequence of contexts (curricular strand for contexts).

2. Determine which (functional) knowledge the student encounters in the selected contexts.

Make some elaborations of the selected contexts about present biological content.

Which concepts are of importance?

3. Use the agenda for the concept animal to determine if concepts are sufficient or missing.

Determine from the elaborations (step 2) what concepts and content students should encounter. Use the cornerstones (see figure 7) to include or remove concepts.

- a. 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.
- b. In selecting concepts it is important what students are supposed to do. It is dependent of age and child which concepts can be or should be present.
- c. Make a restriction in each context and take time for the concept development of students. The availability of time is always a limitation.

4. Return to the selected contexts.

Choosing contexts and concepts is an interaction.

Further the elaboration for children in the age of 4 to 8 years was discussed by the experts. They stated that the context of excursion/holiday is a difficult one. The context is in some cases atypical, it is not easy to visualize participants in this context other than visitors. Secondly, it does not differentiate, because many concepts can be related to this context. Also, the school is placed in another context, the museum. Children visit more often a zoo than a museum, therefore another possibility is to select a zoo in this everyday life context. The elaboration as presented lead not to a choice of concepts on its own. Therefore you need an agenda. Holding strictly to the context of a museum many concepts can be removed. Some of

them are yet suitable for primary education and should therefore be addressed in another context. There can be a variety of concepts related to the concept animal, but it is about what is most logical. Also it depends on what further can be seen in the museum and the type of activity of the student. Concepts as movement, form and function and fossil fit in this context. But the concept habitat much less, for instance. In another concretization of this context, like an excursion to dunes where rabbits are living, the concept is more evident. So, it is strongly dependent of which contexts are selected which biological content is present.

The elaboration for students in the upper grades was based on the context of health care. This contained a social component. Because of the fact that girls find health care more often interesting, the experts brought forward that contexts should be selected that are interesting for both boys and girls. In addition, they must encounter a broad range of contexts and no stereotypes should be enhanced. Furthermore, it was remarked that this context rather can be connected to content about humans, because children are experiencing illness themselves. The choice of concepts in this elaboration is dependent on what happens to the animal. Here it is also necessary to know what the student does or where he is orientating on. This defines concepts. In particular, concepts that are related to health belong to this context, like relations to anatomy and physiology. Also the concept behaviour can be included, however it is more suitable for the context of taking care of pets. Then you have to assess if an animal is sick enough to attend a veterinarian. It was evident during the discussion that concepts as ecosystem and biodiversity do not belong in this context. Altogether, the focus group discussion provided various suggestions and viewpoints. For that reason it contributed to a verification of the findings.

Conclusion

First, guidelines were identified to justify the selection of certain concepts or content in the curriculum. The guideline 'choose concepts that can be connected to the experiences of children' was obvious among the outcomes. Only in the primary science education methods this was not evident. Other guidelines were categorized under subject, didactical or social arguments. These guidelines were verified in a focus group discussion with experts. There was an agreement on guidelines that are of importance for selecting concepts, which were summarized as three cornerstones (figure 7): context, subject matter and didactics. The importance of a concept in a context in which students participate or orientate themselves on was a significant point the experts agreed on. The knowledge has to be functional for children and has to be connected to the level and experiences of children. Mainly, the functionality is something that holds a central position in the concept-context approach. Nevertheless, it is connected to the other categories of arguments, and in particular to subject matter. The social perspective was an issue which was made explicitly. As well as the role of students in a context. This is of major importance to know which biological content must be present. All things considered, a concept cannot be chosen isolated from the context in which it is present. Therefore, a first conclusion, and an answer to the first sub question, is that the three cornerstones can be used when defining content related to the concept animal, with an emphasis on the cornerstone of context.

Two elaborations of the concept animal were made by identifying important underlying concepts. This answers the second sub question: which underlying concepts are related to the concept animal? The findings provided an extensive and diverse overview of concepts and content that can be related to the subject matter about animals. The findings of the analysis of primary science education methods provided different reflections of the concept animal. All three methods were focusing on many different aspects of the concept animal. Some similarities were evident, like a theme about food chains. The senses of animals

were both addressed in *NatuNiek* and *Natuurlijk*. In *Leefwereld* and *Natuurlijk* the interaction between insects and plants was included as well as the way of life of social insects. Differences were more clear. Adaptations of animals to their environment were evidently addressed in *Natuurlijk*. Only health and sickness of animals was present in *Natuurlijk*, whereas *Leefwereld* was distinctive in treating the (mis)use of animals and communication behaviour. *NatuNiek* on the other hand paid attention to natural equilibrium. The methods reflected the concept animal in different ways, but overall they addressed a broad range of basic aspects of animals and their relation to the environment. This outcomes provide an answer to the third sub question about how the concept animal is reflected in student textbooks for primary science education. A next step in the development of elaborations was the selection of everyday life contexts relevant for primary school children of different grades, thereby answering the fourth sub question. The interests of students from kindergarten were directed to the museum with a skeleton, whereas either students of age 8 to 9 and 11 to 12 years were directed to a veterinarian. The elaborations were discussed among experts. It appeared that it depends on many factors which concepts can or should be selected in the elaborations. It was made clear that the elaborations cannot lead in itself to the selection of concepts. Based on the concept-context approach the experts suggested a procedure to select concepts (table 6) whereby two lines of thoughts were evident: selecting meaningful contexts and determine biological content in the collection of contexts. The use of an agenda was a major aspect in this procedure. Furthermore, several considerations and implications to take into account were included.

What does this mean for making choices for concepts in the intended curriculum, as was stated by sub question 5? As was shown by the findings a broad scope of the concept animal is present. Guidelines and the procedure can contribute to the selection of concepts in intended curricula from this broad scope of underlying concepts. Some considerations as a limited amount of concepts, a determination of the role of students, and the set up of an agenda should be taken into account in the selection procedure.

Regarding the research question ‘How can the concept animal be elaborated in Dutch primary science education according to the characteristics of the concept-context approach?’, 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 is what follows from this procedure. With this the example elaborations may further be developed for primary science education. This can be the basis for a continued elaboration of the conceptual framework in primary science education proceeding from the concept-context approach.

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. Since the results indicate that three cornerstones (context, subject matter and didactics) are of relevance in this process, this can be considered as the 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 to select 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. The personal development source can be found in

the most essential cornerstone, the context. In it is the position of the student. The experiences, interests and needs of students are central in this cornerstone. Also, the categorization of Tyler (1973) is reflected in the three cornerstones. This categorization was also named during the focus group discussion. 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 of students. Also, excellent and highly gifted children may require other concepts. This affects the selection procedure. And what about the coherence between concepts, something the concept-context approach is concentrating on? So, what is new about these outcomes? 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. This shows the importance of the research outcomes. Still, selecting contexts and subsequently concepts is not that 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 it is determined, for instance. Nevertheless, it gives an opportunity to make an effort in selecting concepts, thereby using the three cornerstones as a guidance.

Nevertheless, some limitations of the study are evident. In the process of the development of elaborations primary school students were interviewed about their interests about animals. First, it can be questioned if the followed procedure really reveals interests of students. Besides this, the photographs used might not be represent the desired everyday life contexts. The photograph of a child collecting eggs would probably not represent the context of a shop, for instance. This raises questions about the outcomes of the interviews and group discussions with students of different grades. The use of different photographs in different grades connected to the age and level of students might have been better. Furthermore, everyday life contexts were selected that were preferred by students. However, this does not mean that contexts which are less known or less preferable should not be chosen or are not relevant. This may be very useful in bringing students in contexts in which they do not participate or are unknown to them. This is in accordance with a statement made during the focus group discussion, that students should encounter a broad range of contexts. Coping of students can be seen in their choices for photographs. This affects the interpretation of the findings. The development of the example elaborations was based on choices of the researcher regarding the guideline of taking into account the subject matter. It should have been verified by a biologist. The analysis of the primary science education methods resulted in a narrow range of guidelines. It is recommended to consult the authors of the science methods to identify more precisely the arguments for including specific content in the methods.

The guidelines and the elaborations were verified by experts, which had mainly a background as a biologist. What would the outcomes have been when experts of different disciplines, like pedagogues, discussed it? Also, CVBO members participated in the discussion. On the one hand this brought the opportunity to test whether the findings reflected the concept-context approach correctly. Still, on the other hand it limits the findings. The following exemplifies this, during the focus group discussion especially the three CVBO members contributed to the procedure that followed from their viewpoints. Although the other experts agreed on it, it might be interesting to know how other experts approach the selection of concepts. This was also a suggestion of an expert, namely to discuss the issue with a broadly composed group of experts.

Implications

An important issue worth considering is the recommendation made during the focus group discussion. It was implied to make a concept map of the concept animal. However, this could also be done for all concepts relevant for primary science education. It was suggested that through a concept map concepts with relations to other concepts can be visualized. No hierarchical concepts are in it. So the concept animal can be shown with relations to other concepts. When the emphasis is laid on another concept, like ecosystem, the concept animal will lower to the level of the other concepts so to speak. Then the concept ecosystem can be highlighted, for example. Subsequently, the concept map must be covered with different contexts. There are some preconditions, like time availability, a restriction of contexts, and that contexts partly cover one another. This suggestion gives the opportunity to generalize the suggested procedure for other concepts as well. Some of the guidelines found in the study seem to appear as general guidelines, that may be useful to other concepts. It raises the question if the found guidelines 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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