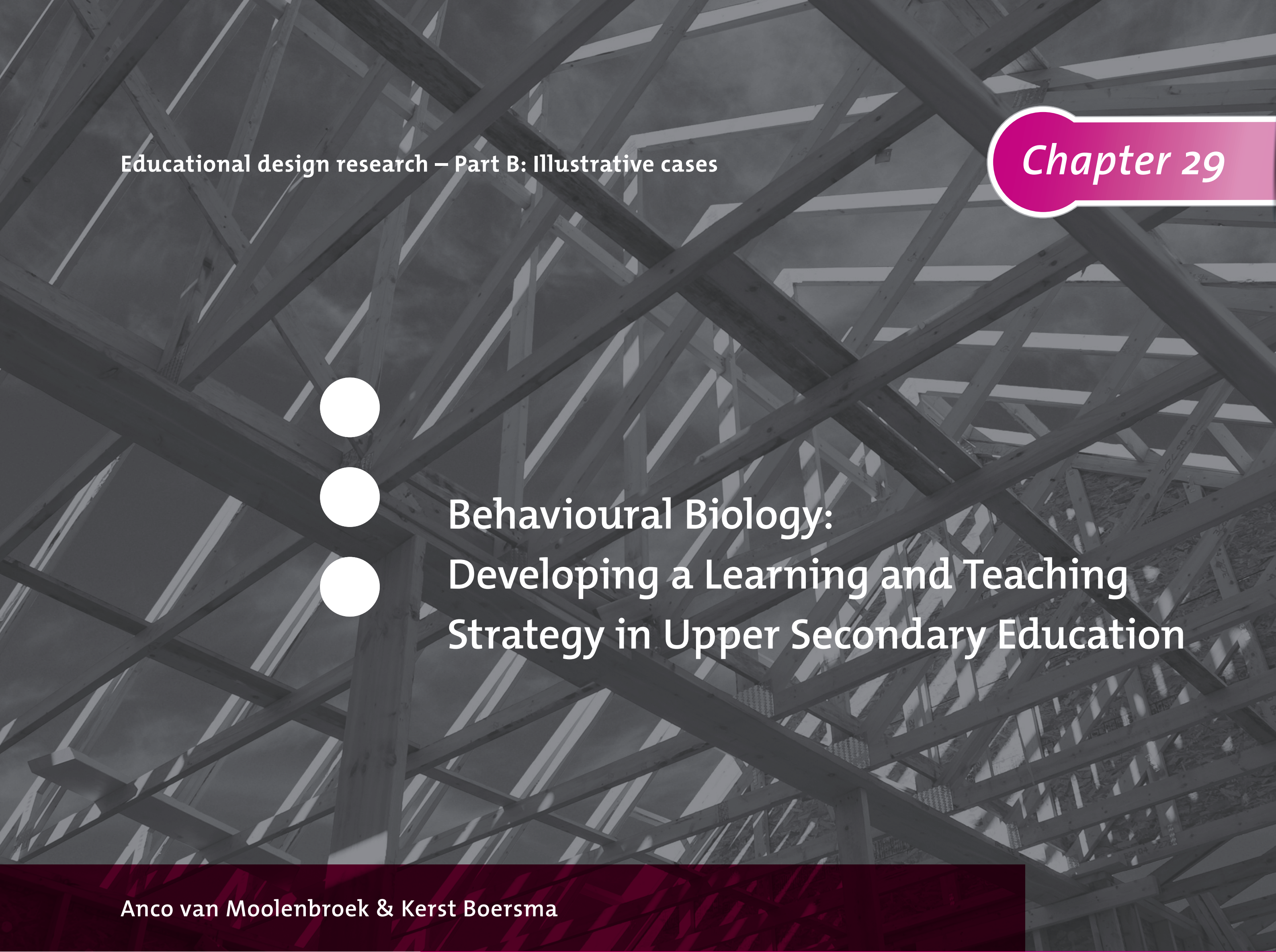

Chapter 29

Behavioural Biology: Developing a Learning and Teaching Strategy in Upper Secondary Education

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29. Behavioural biology: Developing a learning and teaching strategy in upper secondary education

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Abstract

The aim of the study is the development of an adequate learning and teaching (LT-) strategy for behavioural biology that increases students' conceptual development of the subject behaviour. The study is one of a number of design studies conducted in the last decade that contributes to a preliminary design theory for context-based biology education. The design of the study consists of an explorative phase, and two cyclic research phases in which eight case studies were conducted to test the LT-strategy in the classroom. The conceptual framework underlying the study originates from behavioural biology and two pedagogical approaches (the concept-context approach and the problem posing approach). In the study, the concept-context approach and the problem posing approach are integrated in a single pedagogical strategy. Both sources (behavioural biology and pedagogical approaches) resulted in a set of design criteria. The analysis of the data, (e.g. interaction in class discussions and students' concept maps), showed that the LT-strategy structures students' conceptual development. Furthermore, students are able to reason from the perspective of a behavioural biologist. It was concluded that the use of authentic contexts, interactions, and motives stimulates students' motivation, providing for relevance and coherence. An LT-strategy could be constructed with the concept-context approach and the problem posing approach.

1. Introduction

In current upper secondary biology education in the Netherlands, behavioural biology is generally a subject of less curricular importance, and it is isolated from other domains of biology. Furthermore, the most frequently used textbooks present examples of animal behaviour from the 1950's to the 1970's. Tinbergen formulated four questions in order to distinguish the function, development, causes, and evolution of behaviour (Tinbergen, 1963). It was noticed that biology textbooks did not show the dynamic and complex nature of behaviour, lacked references to modern behavioural biology, and did not structure behavioural biology according to the four questions of Tinbergen. From the analysis of the Dutch biology text books it was concluded that the behavioural biology presented to students in upper secondary education is out of date and that students do not have the opportunity to acquire an understanding of current research in behavioural biology. The societal relevance of behavioural biology appears from its contribution to animal welfare, the conservation of species, and the understanding of human nature.

In current biology education, three main problems were recognized, namely an overloaded curriculum, minor relevance to students, and a lack of curricular coherence. These observations coincided with recommendations of the Royal Netherlands Academy of Arts and Sciences (KNAW) to the Minister of Education to adapt the examination programs in upper secondary biology education to the current state of biology in society and research, focussing on students' development of biological key concepts. Following this recommendation, the Minister of

Education established a Board for the Innovation of Biology Education (CVBO) with the task to develop new examination programmes for upper secondary biology education.
The Board elaborated a coherent and actual learning line for biology education, with the conviction that the so-called concept-context approach could provide an important contribution to the solution of the three main problems. (Boersma, van Graft, Harteveld, de Hullu, van den Oever, & van der Zande, 2005). The concept-context approach is an approach for selecting learning goals and organizing knowledge. Contexts have a dual function: relating scientific concepts to contexts and improving the relevance of the science curriculum by selecting contexts that have relevance for the studentsConsequently, it was welcomed that some research studies could be conducted to address these challenges.
The study presented here focuses on the innovation of behavioural biology education, based on the concept-context approach for biology education and it therefore aimed to develop a domain-specific learning and teaching strategy (LT-strategy) for behavioural biology and to provide empirical support for the concept-context approach for biology education. An LT-strategy is a sequence of learning and teaching activities aiming to attain previously defined learning outcomes. An LT-strategy is generally domain-specific.
In the advice of the CVBO to the Minister of Education, including proposals for new examination programs, it was also indicated that the implementation of the new examination programs for upper secondary biology education would require in-service training of biology teachers on the elaboration of the concept-context approach in the biology classroom. It was argued that it would be desirable to support the implementation with outcomes of educational design research. Therefore, a number of design studies conducted in the last decade was summarized and integrated into a preliminary design theory for context-based biology education. It was expected that the design study presented here would contribute to such a design theory. In addition to the actualizing of the behavioural biology education and the development of a domain-specific LT-strategy, its third aim is therefore to contribute to a design theory for context-based biology education.

The primary aim of the study is, however, the development of an LT-strategy for behavioural biology. The research question of the study is as follows:
What are the characteristics of an adequate learning and teaching strategy for behavioural biology in secondary education that increases students' awareness of behaviour?
The design study presented here has been published before as a PhD-thesis (Van Moolenbroek, 2012).

2. Conceptual framework

The conceptual framework underlying the study originates from two sources, behavioural biology and the theory on learning and teaching underpinning the concept-context approach and the problem posing approach. Both sources resulted in a set of design criteria.

Behavioural biology

Today behavioural biology is a broad, integrative academic domain in which physiology, genetics and psychology are integrated with former ethology. This integration with other domains has several implications. First, it implies that behavioural biology does not focus any more at animal behaviour only, but also on human behaviour. Second, it implies that not only the organismal and population level of biological organization are involved, but also the cellular and molecular level. Research on behavioural biology has many practical implications in domains such as animal welfare and human nature. In spite of these two points , the basics for understanding the emergence of behaviour is still found in an early study of Tinbergen (1963), in which four perspectives on behaviour are distinguished: causation, development, function, and evolution. These four perspectives can be considered as the key concepts of behavioural biology.

From these characteristics of current behavioural biology, the following domain-specific design criteria were derived (Van Moolenbroek, 2012):

1. An LT-strategy should include links with other biological disciplines such as physiology, genetics and psychology.
2. Students should be aware that behaviour is emerging from multiple causes, attributed to different levels of biological organization, in the interaction of the organism with its environment, and consequently requires an LT-strategy that includes systems thinking.
3. An LT-strategy should follow the structuring of concepts by the perspectives of causation, development, function and evolution of behaviour.
4. An LT-strategy should pay attention to the social relevance of behaviour biology in order to develop students' understanding of its relevance.

Theory on learning and teaching

The theory selected for the development of design criteria for the didactical component of the LT-strategy is the theory underpinning the concept-context approach, an earlier design study on ecosystems behaviour based on the concept-context approach (Westra, 2008), and studies on the problem posing approach (e.g. Klaassen, 1995; Knippels, 2002).

The design study takes explicitly a learners' point of view. The learning environment, including the teacher, is supposed to structure students' learning processes, and to provide support. That implies that the role of the teacher is conditional, although it is derived from students' supposed learning processes. Therefore, an LT-strategy consists of a sequence of LT-activities that facilitates students' uninterrupted learning.

The concept-context approach for biology education is inspired by cultural-historical activity theory (e.g. Vygotsky, 1978) and situative approaches (e.g. Lave, 1988), and has the following characteristics (Boersma et al., 2005; Boersma, 2011).

To favour students' understanding of the relevance of biology it is recommended to present biological content in context. The understanding of biology's relevance, however, can only be developed if students experience that biological knowledge is used in society. Furthermore, if students experience that biological research has the potential to cope with some of the big issues of the 21st century, such as health, sustainability, food provisions and energy supply. For a better understanding of the relevance of biology, a context is redefined as social practice (van Aalsvoort, 2004). A social practice is defined as a number of participants performing a common, goal-directed activity, by means of tools (such as instruments, symbols, knowledge), according to implicit and explicit rules. The biological knowledge used in a social practice is functional in that specific practice and may differ from the biological knowledge in other social practices. An illustrative example of a concept showing different meanings in different practices is the concept cellular respiration (Wierdsma, 2012).

Considering the large amount of biological terms used in biology education, according to Ausubel's theory (Novak & Gowin, 1984), it is recommended to structure biological knowledge hierarchically, and to focus on students' development of superimposed or key concepts. Since a key concept may structure a large body of (biological) knowledge, it can be expected that it will be used in a diversity of social practices. However, since the meaning of biological knowledge is context-specific it can be expected that a concept will have different meanings in different social practices. Consequently, a student familiar with the meaning of a concept in a first practice has to adapt it when invited to apply it in another practice. This process is called recontextualisation (Van Oers, 1998) and implies a redefinition of the concept 'transfer'.

The problem posing approach, initially developed for physics education (Klaassen, 1995; Lijnse & Klaassen, 2004), is a pedagogical strategy aiming at the development of students' content-specific motives, in such a way that students are aware what they are doing and why, and have the confidence that they can accomplish their aims. Generally, a design is focusing at the interactive development of a central steering question that may be answered by performing one or more tasks. After the performance, the students are invited to reflect on the tasks and evaluate if the question can be answered. If not, a new task and or an additional question is developed; this procedure is continued until the steering question can be answered.
In the study presented here, the concept-context approach and the problem posing approach are integrated in a single pedagogical strategy (Figure 1).

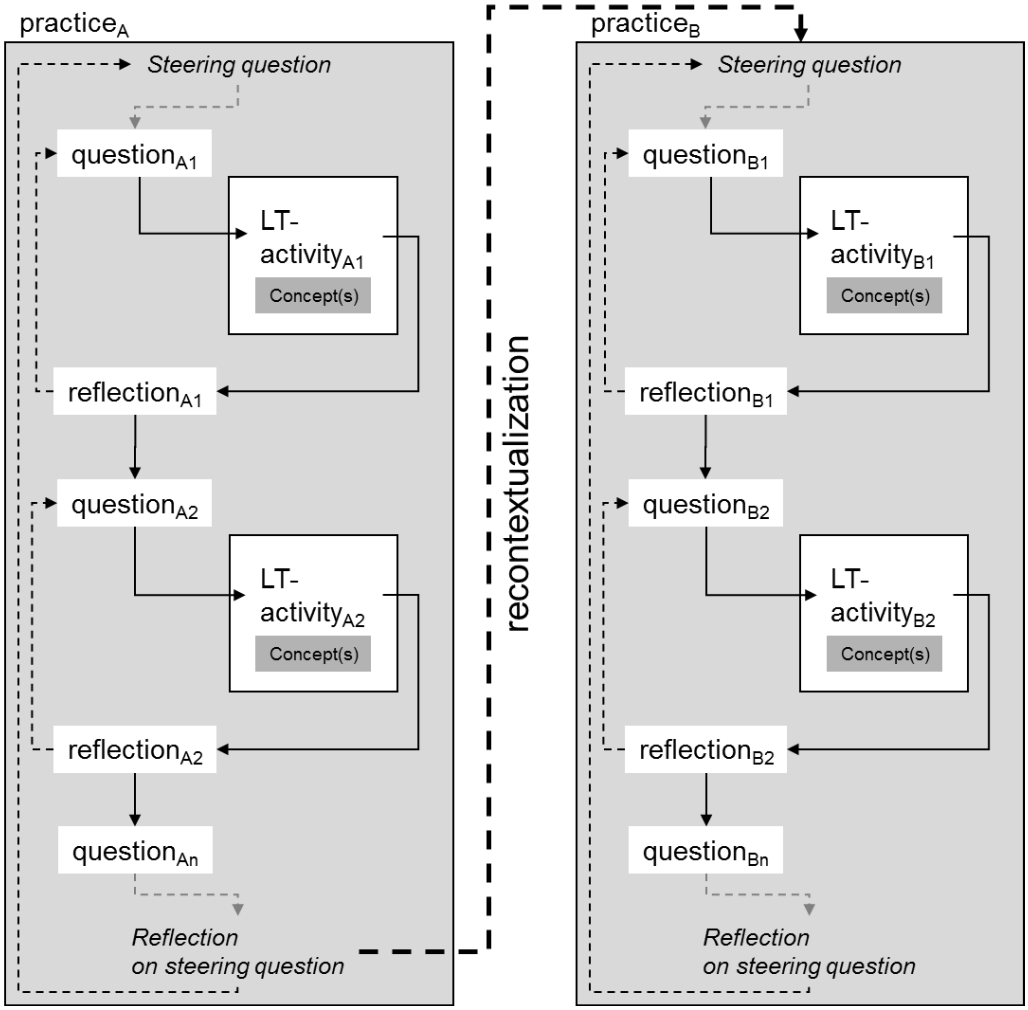

Figure 1: Integration of the concept-context approach and the problem posing approach (Van Moolenbroek, 2012)

Considering the concept context approach and the problem posing approach the following pedagogical design criteria on learning and teaching were articulated:

1. An LT-strategy for behavioural biology should be based on behavioural biology concepts used in authentic social practices. Students should have the opportunity to explore the personal, societal and/or scientific relevance of the selected behavioural biology concepts.

2. Participation in a social practice implies learning as the outcome of interaction between a person and its environment. An LT-strategy for behavioural biology must promote interaction between learners and their learning environment.
3. Learning activities aim to promote the thinking processes of the students. Therefore, an LT-strategy for behavioural biology should evoke motives. The sequence of LT activities should provide a storyline and create opportunities for non-interrupted learning, which supposes a sequence of motives for learning.
4. Recontextualising of earlier acquired concepts should be incorporated explicitly in the LT-strategy. That implies that an LT-strategy should include more than one realistic context.

Considering the design criteria for behavioural biology, the following intended learning outcomes were determined. Students should be able:

a. to explain that behaviour is caused by internal and external factors,
b. to describe that behaviour is the result of the interaction between the organism and its environment,
c. to determine the function of behaviour,
d. to describe the development of behaviour,
e. to recognize the stress mechanism in the behaviour of humans and animals,
f. to carry out a simple behavioural research (only at pre-university level),
g. to discuss applications of behavioural research in vocational and scientific social practices.

3. Design and methodology

Design of the study

The design of the study consisted of an explorative phase, and two cyclic research phases in which eight case studies were conducted (Figure 2).

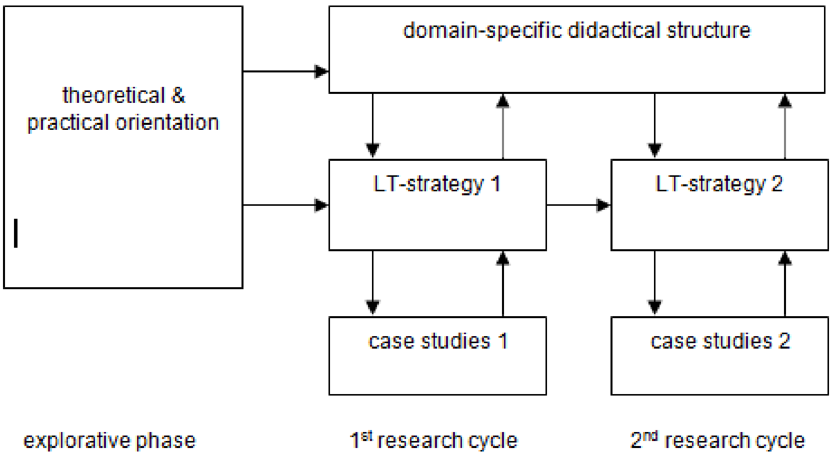

Figure 2: Design of developmental research (after: Boersma, Knippels, & Waarlo, 2005)

In the explorative phase, a literature study was conducted on behavioural biology, on behavioural biology in textbooks, current school practice, student understanding of behaviour, and current ideas on learning and teaching. The research activities resulted in the design criteria presented in the preceding section. In the first research cycle, a design of a preliminary LT-strategy was constructed, taking into account the design criteria. The LT-strategy consists of a sequence of LT-activities and is elaborated into a scenario that describes the LT-activities of the teacher and the students. A scenario hypothesis and theoretically justifies in detail the teaching-learning processes (Lijnse & Klaassen, 2004). Simultaneously and in interaction with the scenario LT-materials were constructed; scenario and LT-materials were finally tested in classroom practice. After data collection and analysis it was decided how the scenario and learning materials had to be adapted (see fig. 3). This procedure was repeated in the second research cycle.

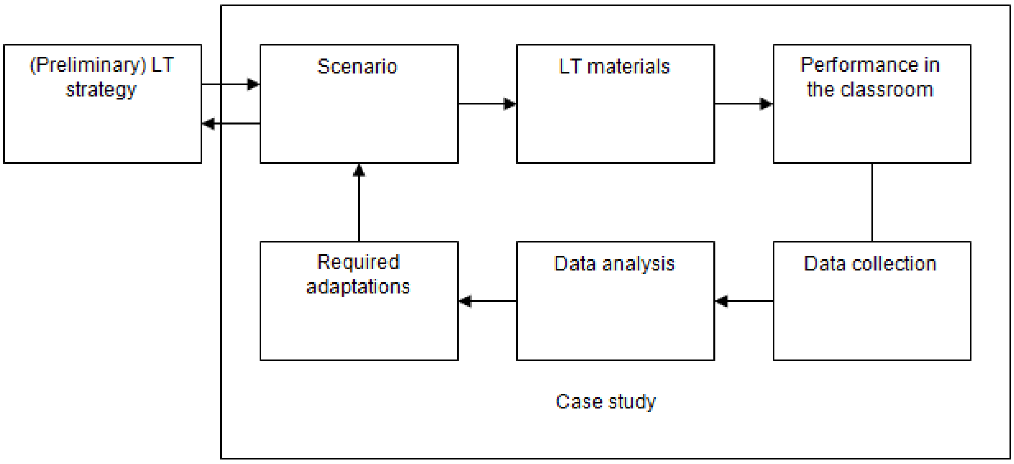

Figure 3: Design of a case study (after: Boersma, Knippel, & Waarlo, 2005)

In this sequence of design and research activities, the scenario fulfills a critical function. It consists of a detailed design of learning and teaching processes, accompanied by a set of argued expectations about the participants' behaviour and learning outcomes, and explains why it should operate according to the expectations.
LT-strategies and scenarios were developed both for general upper secondary (havo) education and for pre-university education (vwo). The difference between the two levels is in particular based on the selection of different social practices. The second practice at havo-level is about designing a welfare friendly pig stable, while the vwo-students have to research the overtraining syndrome.

Data collection and analysis

Table 2 summarizes some characteristics of the participating schools and students.

Table 2: Characteristics of the schools involved in the case studies of the two successive versions of the design. (H = general upper secondary education (havo), V = pre-university education (vwo)

	1st research cycle		2nd research cycle		
Number school	School 1	School 2	School 3	School 2*)	School 4
Grade and level (number of students)	4H (23) 5V (16)	4H (24) 5V (23)	4H (25) 4V (23)	4H (27)	4V (20)
Age of students (years)	H: 15-16 V: 16-17	H: 15-16 V: 16-17	15-16	15-16	15-16
Number of teachers	2	1	2	1	1
Number of lessons	11	10	H: 12 V: 14	12	12
Time-period case study**)	Jan-Feb 2007	Feb-April 2007	April-May 2008	May-June 2008	Sept-Oct 2008

*) School 2 participated in both research cycles, but with different group of students.
**) Cases studies were executed subsequently. Within a research cycle, only minor and mainly textual adaptations of the scenario and learning materials were made.
Table 3 presents an overview of the data collection.

Table 3: Overview of data collection

Data source	Specification
Observations by the designer-researcher	In all lessons, written notes were made. Unexpected situations and remarkable statements of students and teacher were noted that (in)validated the expected activities in the scenario.
Audio recording of classes and groups	In all lessons, audio recorders and video cameras were placed in the classroom. In the case of group work, recorders were placed at the students' tables.
Workbook	In all lessons, the lesson materials consisted of a students' workbook.
List of concepts	Assignment included in the workbook in the second research cycle.
Concept maps	Assignment in the workbook in the second research cycle.
Written test	In the first research cycle.
Essay	In the second research cycle.
Evaluation form	Occurred after the execution of a case study, an evaluation form was filled in by students, containing questions about the motivation of students and valuation of the lesson series.
Reflections with teachers	After each lesson of the second research cycle. Finally, an evaluation interview was taken with all teachers after execution of the scenario.
Observation of a redesigned focus lesson with a small group of students	Between first and second research cycle, pretesting the focus lesson for the second version of the LT-strategy. Observations are used to fine-tune the focus lesson and the teachers' manual.

The hypothetical LT-strategy as described in the scenario guided the selection of data, the interpretation and analysis. Table 4 describes four possibilities that were distinguished in the analysis of the data, to decide for adaptation all LT-activities of the scenario.

Table 4: Adaptation of the LT-activities of the scenario that were considered when the scenario was compared with the performance in the classroom

	Scenario performed as intended	Scenario not performed as intended
Expected learning outcomes are attained	An adaptation of the scenario is not necessary	Additional information about the causes of the deviation is required before it can be decided if the scenario needs adaptation.
Expected learning outcomes are not attained	The scenario (and LT-strategy) should be adapted	Additional information is required about the causes of deviations and deficits; adaptation of the LT-strategy and scenario should be considered.

4. Results

Outline of the LT-strategy

In the explorative phase, the outline of the LT-strategy was adopted from Westra (2008). It consists of three realistic contexts (practices, figure 4). A central steering question is evoked in the focus lesson (figure 4), and each context starts with the development of a steering question. A steering question is derived from the activity of a corresponding authentic practice. The first and second context are aiming at students conceptual development of behavioural biology, whereby the concepts learned in the second context form an extension of the concepts from the first context. The third context aims to test students´ knowledge of behavioural biology.
Each context, including the focus lesson, is built up according to the problem posing approach. A reflection phase follows each LT-activity phase, wherein students reflect on the steering question of the context and the central steering question. After that, a new steering question is evoked, which makes it plausible to change to a new context.

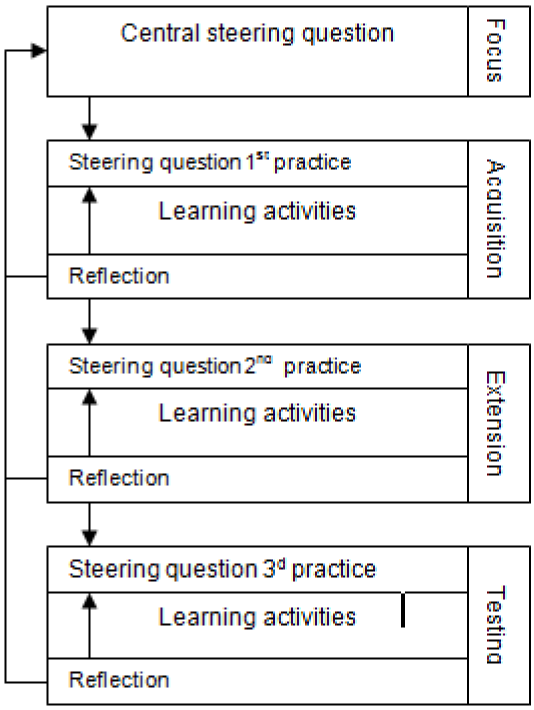

Figure 4: Outline of the LT-strategy (adapted from Westra, 2008)

Which social practices are suitable for learning and teaching behavioural biology? Social practices were selected on the base of the following five criteria. 1) Practices should meet the aims of behavioural biology. 2) Practices should emphasize several levels of biological organization. 3) Practices should elicit motives to increase students' motivation to learn. 4) It should be possible to reduce its complexity. 5) Authentic material of a practice should be available. Applying these criteria, the following social practices were selected (table 5).

Table 5: Selected social practices for havo and vwo

Phase	Havo	Vwo
Acquisition	Caring for your pet	
Extension	Designing a welfare friendly pig stable	Researching the overtraining syndrome of horses
Testing	Dealing with riots during football matches	

Each context has its own steering question, serving as a motive for exploring a new context. A major difficulty in designing a scenario with a non-interrupted storyline was that it seemed not always possible to develop a motive for exploring a new social practice, especially when further explanation was required and the question for explanation was not authentic in the practice the students were dealing with. To solve that difficulty some so-called 'embedded practices' were included. We defined an embedded practice as a (part of a) practice that is necessarily placed into the elaboration of another practice to create a non-interrupted storyline (Van Moolenbroek, 2012). For example, the stress mechanism (The General Adaptation Syndrome) is based on the scientific work of Selye (1978) and used in the first context ('how to care for your pet?') to explain the working of stress in dogs.

The design of the lesson series tested in the first research cycle was considered as a rapid prototype of the LT-strategy. An extensive comparison of the intended with executed scenario of the first version of the design revealed the following four deficiencies:

- A mistake in the design of the focus lesson, including an insufficient explication of the three perspectives on behaviour, resulted in a poorly developed central steering question.
- The needed lesson time did not coincide with the available lesson time.
- A lack of profoundness, particularly at vwo-level, which resulted in a decrease of students' motivation and a superficial conceptualisation of behavioural biology.
- Too few and short reflection phases in the scenario obstructed Recontextualising.

The above-mentioned deficiencies were identified as deficiencies in the scenario and the design of the lesson series. Therefore, four main improvements of the scenario and the design of the lesson series were made in the second research cycle. The focus lesson was renewed; the number of lessons was increased, the General Adaptation Syndrome was added for students of both educational levels, and reflection activities were incorporated more systematically, including the use of concept maps as a reflection tool. The outline of the elaboration of the LT-strategy in a lesson plan of the second research cycle is presented in Table 6.

Table 6: Outline of the lesson plan for learning and teaching behaviour of the second research cycle. (LTA = Learning and teaching activity)

Phase	Lesson	LTA	Description
Focus	1.	1.1 1.2 1.3 1.4	Introduction of the subject by observing unexpected behaviour of a dog. Should serve for the development of a steering question and studying an article about behaviour of wolves that provides for the exploration of the three perspectives (function, causation, and development) on behaviour.
Acquisition	2.	2.1 2.2 2.3	Studying welfare of animals is homework and the 2nd lesson starts with the focus on natural behaviour. The function of behaviour is elaborated in group and class discussion.
	3.	3.1 3.2 3.3	What if natural behaviour cannot be performed? Studying causation of behaviour by looking at stress of dogs and the introduction of the General Adaptation Syndrome. The emphasis is on the normal reaction on stressors (acute stress).
	4.	 4.1 4.2	How to adapt to stressors? Studying adaptation to environmental factors. The development of behaviour is seen in the growing up from juvenile to adult and in the learning of special task for a dog.

Phase	Lesson	LTA	Description		
			Havo	**Vwo**	
	5.	5.1 5.2	Reflection on the first practice by designing a concept map and introduction of the next practice: designing a welfare friendly stable.	Reflection on the first practice by designing a concept map and introduction of the next practice: researching the overtraining syndrome.	5.1 5.2
	6.	6.1 6.2	Discussion of the welfare and stress of farm animals. A part of it is homework A part of it is homework for the next lesson. With the help of an embedded practice, the stress mechanism is studied. The emphasis on the stress reaction is now moved from acute to chronic stress.	After discussing the homework about overtraining in exercise, a behavioural research assignment is prepared by discussing the physiology of the stress mechanism (hormonal cycles). The emphasis on the stress reaction is now moved to chronic stress.	6.1 6.2 6.3
Extension	7.	7.	Working in small groups on designing a welfare friendly stable	Discussion the homework about the stress mechanism and the General Adaption Syndrome Preparing the behavioural research assignment with the Novel Horse Test (NHT)	7.1 7.2
	8.	8.	Working in small groups on designing a welfare friendly	Executing the NHT assignment in small groups	8

Table 6: Outline of the lesson plan for learning and teaching behaviour of the second research cycle. (LTA = Learning and teaching activity)

Phase	Lesson	LTA	Description		
			stable		
	9.		Presentations of the designs of the pig stable	Executing the NHT assignment in small groups	9.
Test	10.	10.1 10.2	Reflection on the practice and introduction of the test practice about dealing with human aggression		
	11.	11.1 11.2	Constructing a concept map about aggression as preparation for writing the essay on the topic ‘how to prevent riots’ Executing the final assignment by watching video about riots		
	12.	12.	Executing the final assignment, writing the essay		

The data collected during the second research cycle show that the scenario is generally executed as intended. However, the data also show that the participating teachers (1) have some difficulties with the understanding of some of the behavioural concepts, (2) take too much time for explanation, and (3) regularly forget to evoke motives for learning. It was concluded that teachers were unfamiliar with the LT-strategy and lacked experience in teaching the concept-context approach and the problem posing approach. Consequently, the teachers' guidance can be improved by focusing more on the behavioural biology concepts and their coherence. Since much emphasis was given to the analysis of the concept maps in LT-activities, we will focus further on their analysis.

Concept maps

It was recorded that adequate reflection time was programmed and that students' conceptual development was effectively stimulated by reflection through the construction of concept maps. In the havo-classes, the concept mapping assignment was too open and more guidance was needed. Vwo-students had difficulties in starting the design of the concept map and in deciding which concepts should be included. Both problems can be solved by adapting the instruction for students. No adaptation of the LT-strategy is required.

Both the technical quality and the domain-specific quality of students’ concept maps were analysed, respectively, in order to determine whether the concept maps were constructed as intended, and to determine the students’ conceptual development. Only 27% of the students' concept maps included linking phrases as a part of the propositions. Furthermore, it was observed that the concept maps showed a large variety in the number of propositions and structure. In general, it was concluded that the technical quality of the students’ concept maps is weak, probably caused by a lack of experience in concept mapping by the teacher and the students. However, considering the domain-specific quality of the concept maps, it appeared that students were able to relate the concepts correctly. The concept maps showed a large diversity in the number of propositions and the individual student elaborated an average of 59% of the concepts included in the reference concept map, including all propositions that students had to acquire. Furthermore, the analysis showed that students have a satisfactory understanding of the behavioural biology concepts, in particular of the concepts stress and stress mechanism. For most behavioural concepts, the amount of correct propositions is as high as 80%.

From these findings, it was concluded that that students’ conceptualisation could increase further when the technical quality of concept maps is improved.

In the third practice (see figure 4), concept mapping is used as a construction tool, preparing students for writing an essay about human aggressive behaviour.
Therefore, here the relationship between the domain-specific quality of the concept map and the essay was investigated.
The analysis showed that the quality of the constructed concept maps is determined by the use of behavioural biology concepts, perspectives, and the use of linking phrases. Furthermore, it showed that the better the domain-specific quality of the concept map, the better the quality of the essay students wrote from a behavioural biology viewpoint. Consequently, it was concluded that students could construct a high quality concept map when they understand the meaning of and relations between its concepts.
The analysis of the essays shows that the participating vwo-students used behavioural biology concepts adequately, while the participating havo-students argued from a practical viewpoint with a minimal use of behavioural biology concepts. Havo-students noted the causes of riots that they could find and formulate a solution. Vwo-students also used resources about aggression in addition to the given resources in the workbook, such as the Wikipedia encyclopaedia. These observations evoked the question if writing an essay is an adequate means for havo-students to recontextualise.

Finally, it was concluded that students' conceptual development results in an understanding of the behavioural biology concepts. Students did not always distinguish the different perspectives explicitly, but did correctly use the behavioural biology concepts. For example, students did not include causation, development, and function of behaviour in a concept map, but were able to use behavioural biology concepts in their essay. The LT-strategy for behavioural biology provides opportunities to recontextualise, although some improvements are desirable. A noticeable observation is that some students recontextualise, while others do not.

Conclusions
The question whether students' awareness of behaviour is evoked by the LT-strategy can be answered positively. Students adequately conceptualized the behavioural biology concepts, and it was concluded that an adequate LT-strategy for behavioural biology could be constructed according to the concept-context approach and the problem posing approach. However, some adaptations to the final LT-strategy are proposed.

- The use of concept mapping as a reflection tool could be improved by a systematic construction of concept maps
- Students evaluated some texts in the workbook as too long. Therefore, length, level, and language in the final version of the texts in the workbook should be adapted.
- The sequence of the steering questions in the (second) practice of the building of a welfare friendly pig stable should be adapted in order to construct a more logical storyline.

Finally, it was concluded that the LT-strategy meets all design criteria, with the exception of the second design criterion indicating that an LT-strategy for behavioural biology should emphasize systems thinking. Systems thinking was only implicitly included. An explicit elaboration of systems thinking in which behaviour is understood as an emerging phenomenon would require a rethinking of the LT-strategy.

5. Reflection
The PhD-study presented provides further empirical support for the concept-context approach. It shows that it is possible to design a feasible and effective LT-strategy based on a sequence of realistic contexts based on authentic social practices, and focussing on students' conceptual development.

The study contributes substantially to a design theory for context-based biology education. Analysis of the domain-specific LT-strategies of a number of completed design studies revealed that a small number of didactical structures are applied in different combinations in each of these studies (Boersma, 2011; Boersma & Waarlo, 2009). Two of these structures are characteristic for the concept-context approach: contextual transposition (i.e. educational adaptation of an authentic social practice to a realistic context) and recontextualising. A preliminary design theory for curriculum developers was constructed (Boersma, 2011), including the results of completed PhD studies and some studies in progress. In the LT-strategy for behavioural biology, three of the five of these didactical structures are integrated: the problem posing approach, contextual transposition and recontextualisation. The so-called yoyo-strategy (Knippels, 2002), focusing on sequencing levels of biological organization, was applied only implicitly.
In particular, the adaptation of the design of the focus lesson confirmed experiences from earlier studies that an adequate design is conditional for uninterrupted LT-processes and the attainability of the intended learning outcomes. Such findings also indicate, however, that an adequate design cannot guarantee that the intended learning outcomes are acquired. The ultimate success of a design theory is determined by how it is elaborated in a scenario and how teachers and students put it in practice.

Key source

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