



## Students' conceptions about animal ethics: the benefit of moral metaphors for fostering decision-making competence

Nadine Tramowsky, Denis Messig & Jorge Groß

To cite this article: Nadine Tramowsky, Denis Messig & Jorge Groß (2022) Students' conceptions about animal ethics: the benefit of moral metaphors for fostering decision-making competence, International Journal of Science Education, 44:3, 355-378, DOI: [10.1080/09500693.2022.2028924](https://doi.org/10.1080/09500693.2022.2028924)

To link to this article: <https://doi.org/10.1080/09500693.2022.2028924>



© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 12 Mar 2022.



Submit your article to this journal [↗](#)



Article views: 1533






View related articles [↗](#)



View Crossmark data [↗](#)

# Students' conceptions about animal ethics: the benefit of moral metaphors for fostering decision-making competence

Nadine Tramowsky <sup>a</sup>, Denis Messig <sup>b</sup> and Jorge Groß <sup>b</sup>

<sup>a</sup>Department of Biology and its Didactics, University of Education Freiburg, Freiburg, Germany; <sup>b</sup>Department of Science Education, University of Bamberg, Bamberg, Germany

## ABSTRACT

The analysis of students' conceptions is a crucial element in modern science education research. Based on a large number of studies, we know that learning environments should build upon students' existing knowledge to initiate conceptual change towards an adequate scientific understanding. This also holds true when it comes to moral reasoning. In this case, the implementation of educational standards, such as decision-making competence, strongly relies on students' conceptions about ethical issues. In this study the Conceptual Metaphor Theory is used empirically in order to analyse students' language in regard to conceptual metaphors. To date, little educational research exists on the effects of moral metaphors in science education. For this reason, we conducted a two-part qualitative interview study ( $n = 9 + 6$  and 6) in order to identify German high-school students' moral conceptions about animal ethics. The conceptions were identified and analysed by means of qualitative content analysis. A key finding can be seen in the underlying embodied conceptions and image schemas that are in particular linked to human well-being. Apparently, students use these metaphorical thinking patterns and are therefore capable of conceiving abstract conceptions about animal ethics. As a consequence, we propose an alternative approach in order to foster decision-making competence.

## ARTICLE HISTORY



Received 21 June 2020  
Accepted 10 January 2022

## KEYWORDS

Animal ethics; decision-making competence; students' moral conceptions; socio-scientific issues (SSIs); Conceptual Metaphor Theory

## Introduction

Morality includes individual conceptions and beliefs, according to which, people value actions as morally good or evil. According to moral scepticism, no valid morally good or bad exists and the the discussions on this topic are quite controversial. However, humans are able to make moral statements, act morally and express values. The rationalistic approaches according to Kohlberg (1976) and Piaget (1997) assume that moral thinking develops progressively and irreversibly in stages through rational thinking and empathy. Unlike Piaget and Kohlberg, Haidt (2012) challenges the purely

**CONTACT** Nadine Tramowsky  [nadine.tramowsky@ph-freiburg.de](mailto:nadine.tramowsky@ph-freiburg.de)  Department of Biology and its Didactics, University of Education Freiburg, Kunzenweg 21, Freiburg 79117, Germany

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

rationalistic traditional model of moral judgement. From his intuitionist perspective, moral judgements are the result of a quick and automatic assessment; an intuition. Our approach aims at clarifying the genesis and the resulting consequences of these moral conceptions from a perspective of understanding. Thus, we follow a different path: From a cognitive-linguistic perspective, morality includes abstract conceptions and can therefore be understood in a metaphorical form. Based on this approach, we shall show that moral conceptions are structured by metaphors.

In 1980, George Lakoff und Mark Johnson published their views on the underlying processes of abstract thinking. This approach has become one of the most accepted theories in the field of cognitive linguistics. The Conceptual Metaphor Theory (hereinafter referred to as CMT) was one of the first theories to propose a connection between metaphors in language and cognition. Lakoff and Johnson (1980) argued that individuals conceive abstract conceptions on the basis of embodied conceptions. Consequently, human thinking is based on experience and, due to neuronal networking, is predominantly structured in a metaphorical way (Gallese & Lakoff, 2005). Conceptual metaphors thus facilitate the understanding of abstract ideas by neuronal mapping.

Not only did Lakoff and Johnson's theory influence the field of neurobiology, but especially in policy making, the importance of language with its associations and connotations has also been analysed and used for political campaigns, elections and parliamentary discourse respectively (Lakoff, 2002). Besides this, the CMT has also tremendously influenced other disciplines such as philosophy and education, e.g. Niebert et al. (2012). According to Johnson's (2008) theory of experientialism, philosophical reflections on whether a true nature of reality exists or not is just one example. Because conceptual metaphors are a crucial part of human thought and moral reasoning, it is of utmost importance to understand specific correlations between metaphoric thinking and learning processes of any kind. Particularly in the field of science education, research on decision-making competence is gaining increasing importance. Apart from that, a large amount of international research has been carried-out on socio-scientific issues (SSIs) (Lee & Grace, 2012). SSIs are defined as authentic problems, such as the issue of sustainable development (Bögeholz et al., 2017) or climate change (Lombardi et al., 2016), and thus provide suitable topics for argumentation, moral reasoning and multi-perspective decision-making (Ceyhan et al., 2021; Höttecke et al., 2010). Animal ethics, such as meat consumption is a common SSI that encourages students to think from different perspectives (Jiménez-Aleixandre & Brocos, 2017). It combines different fields, such as environment, science, politics, sociology as well as culture, economy, morals and ethics (Chang Rundgren & Rundgren, 2010). With the aid of SSIs, teachers can assess and reflect on moral arguments in order to promote decision-making competences (Boerwinkel & Waarlo, 2010). But enhancing decision-making competences is still quite a challenge. Taking students' perspectives into account and creating learning environments that can trigger conceptual change (Duit & Treagust, 2003) belong to the most important skills science educators should possess (Driver, 1989). Correspondingly, empirical research in science education addresses the identification of students' conceptions in a diverse range of biological issues – for example, microcosm (Niebert & Gropengießer, 2015), climate change (Niebert & Gropengießer, 2013), and evolution (Zabel & Gropengießer, 2015). In contrast to similar studies on students' conceptions, these papers make use of the CMT by focusing on the genesis of students' conceptions

and exploring strategies for teaching scientific issues more effectively and evolving theory-based learning environments. However, as far as decision-making competence and SSIs (Morin et al., 2014) are concerned, only a small amount of research exists that focuses on the analysis of students' moral conceptions and their deeper understanding. Animal ethics issues such as welfare are becoming increasingly important in Europe from a social, political, ethical and scientific viewpoint (Mazas et al., 2013). In general, Biology curricula are heavily weighted towards humans, and animal ethics issues play a subordinate role in German biology classes and teacher training courses (Binngießer et al., 2013). Indeed, studies on the genesis of students' conceptions in respect to morality and animal ethics are hitherto entirely lacking. Reiss (2017) provided a coherent framework with which science educators can assess how animal ethics should be taught: In review, students gain ethical sensitivity and ethical knowledge and possibly gain skills in implementing normatively correct choices. As closely related research has revealed, a cognitive-linguistic approach towards animal ethics and decision-making processes could lead to feasible conclusions about competence-oriented teaching and fruitful learning environments.

For these reasons, a qualitative interview study should aim at the identification and analyzation of high school students' moral conceptions about animal ethics using the CMT (Lakoff & Johnson, 1999). This will make it possible to derive conclusions about the genesis of moral conceptions in respect to animal ethics in order to develop a diagnostic tool. The results can give evidence about learning barriers and potentials that are capable of fostering decision-making competences. Based on these theoretical and evidenced frameworks, our main research questions are:

- Which moral conceptions and moral metaphors can be found in students' decisions about the animal-human relationship and livestock farming and which embodied conceptions and metaphors are fundamental for inducing such decisions? (RQ1)
- Which theoretical conditions are significant for the diagnosis of moral conceptions? (RQ2)
- Which implications can be derived from the results of promoting decision-making competences? (RQ3)

## **Theoretical assumptions**

### ***Embodied conceptions***

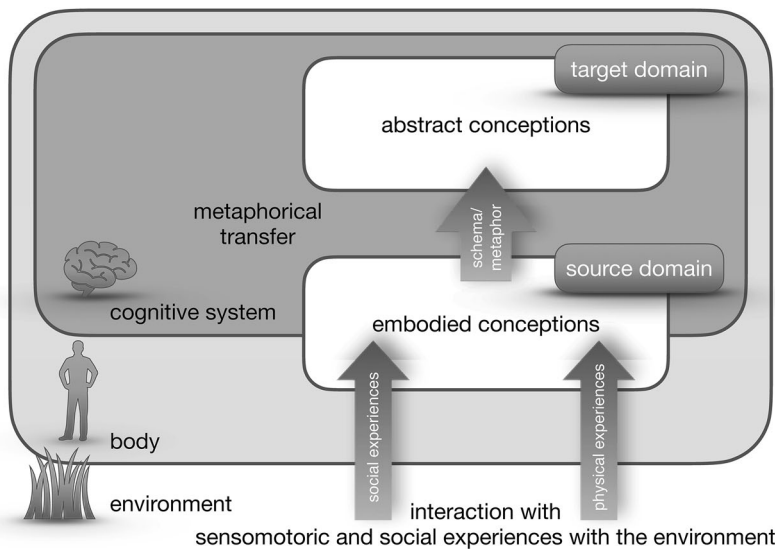
Our understanding of learning is based on the paradigm of a moderate constructivism and the revised conceptual change approach (Duit & Treagust, 2003). Subsequently, students are seen as self-controlled, social and actively constructing subjects with prior knowledge (Phillips, 2000). Studies show that newly derived conceptions can be either favourable or obstructive for learning and cognition (Duit & Treagust, 1998). For a deeper understanding of moral reasoning, we have used Lakoff and Johnson's Conceptual Metaphor Theory (2003) to discern how students' conceptions develop.

According to the CMT, every human being recurrently interacts with his/her environment in physical and social ways. Neurological, psychological and linguistic evidence suggests that bodily interactions result in embodied thinking patterns in the human

neuronal circuitry (Gallese & Lakoff, 2005). For abstract cognition, among the most important embodied patterns are so called image schemata, which form when recurring interactions with consistent structures occur (Lakoff & Johnson, 2003). For example, when people are sad, they literally make themselves smaller or walk with a stoop instead of standing erect and upright. Thus, the Up–Down-Schema is formed by experiences.

If human cognition was merely based on our sensorimotor experiences, how could abstract reasoning ultimately be possible? The CMT figures that embodied conceptions in a source domain (based on sensorimotor experiences) are metaphorically mapped onto specific target domains, which thus enables us to conceptualise abstract ideas. Imaging methods have demonstrated this neuronal process called cross-domain mapping (Rohrer, 2005). It explains how image schemata are used to facilitate abstract reasoning. The trajectory in this process is called a conceptual metaphor. In this context, a conceptual metaphor is not seen as a stylistic device but rather as the result of a neuronal construction to express one idea in terms of another. This mechanism can be observed in statements such as ‘She deserves a higher benefit’. Although benefits – physically seen – cannot be higher or lower, people are capable of conceiving the idea because they have an embodied conception of what is low and high in a physical manner (source domain), which they use for conceiving abstract conceptions (target domain).

For our research project, it seems to be important that if conceiving abstract conceptions is based on embodied conceptions (Flanagan, 1991), then abstract reasoning associated with morality and ethics will also be inevitably intertwined with embodied conceptions (Churchland, 1995) (see Figure 1). In turn, it becomes possible to draw conclusions on the genesis of students’ conceptions about abstract scientific phenomena (Gropengießer, 1998). By using the CMT as an analytical approach, interview transcripts



**Figure 1.** Genesis of abstract conceptions resulting from sensorimotor experiences and embodied conceptions based on the Conceptual Metaphor Theory (CMT).

can be analysed from a language point of view and thus can help to answer questions about the conceptions' source domain and the underlying image schemata, as well as conceptual metaphors. These deductions can help to identify implications suitable for fostering decision-making competences.

### ***Embodied conceptions and moral metaphors***

According to the CMT, conceptual metaphors help individuals to grasp the world around them. With regard to moral reasoning in a political discourse, the CMT proposes that different political ideologies are constructed on the basis of different metaphorical models (Lakoff, 2002). For example, Lakoff argues that members of the US-American Republican and Democratic parties consider the nation as 'a family', the government as 'a parent', and citizens as 'children'. In contrast, Republicans often follow a strict parent model, whereas Democrats rather feel aligned towards a nurturant parent model (Lakoff & Johnson, 1999). Strict parents are characterised by self-discipline and self-reliance and, subsequently, conservative governments focus on protection. On the other hand, nurturing parents emphasise empathy and responsibility and focus on promoting fairness and caring for individuals. According to Lakoff, these two metaphorical models explain why Republicans and Democrats favour different political policies (Lakoff, 2002).

For our part, we assume that conceptual metaphors are also one of the most fundamental forms of moral reasoning (Bialostok, 2014) and decision-making processes in education. Human well-being is essential for moral reasoning (Lakoff & Johnson, 1999). In particular, cross-cultural physical and social experiences are important for increasing or decreasing human well-being. Recurring experiences with feelings of well-being such as health and disease, freedom and pressure or nurturance and severity can provide a basis for the embodiment of conceptions of well-being in the source domain (Baumeister & Exline, 2000). These embodied conceptions can be mapped imaginatively with conceptual metaphors on abstract target domains; for example, in order to understand moral politics (Wehling, 2013) and to categorise good and evil, as well as right and wrong. As a result, moral reasoning seems to be based on embodiment and moral metaphors. The assumption that metaphors provide an approach towards understanding moral thoughts and influencing our actions has already been published in various research papers, such as Zhong and Liljenquist (2006). As an example, in order to understand the categories of good and evil, human beings often apply the Up-Down Schema (Lakoff, 1987). This embodied conception is used metaphorically to reflect on supernatural and religious conceptions; for instance, God Is Up and Devil Is Down and Up Is Good and Down Is Bad (Meier et al., 2007). Moral metaphors provide metaphorical mappings that link source domains with target domains. For Lakoff and Johnson (1999), the body serves as a source domain to understand morality, based on the embodied conception of well-being, and they described a set of categories of moral metaphors used in the western world (1999, pp. 290–334).

As an example, the metaphor of moral order is based on experiences with regimes and authorities: God is 'naturally' more powerful than humans. Humans are more powerful than animals, adults are more powerful than children and men are more powerful than women. This 'natural' order can become a corresponding moral order (see Lakoff &

Johnson, 1999, pp. 298–304). Other metaphors form a basis for moral empathy and nurturance. For instance, the community is understood metaphorically as the family, the moral agents as the nurturing parents; the humans needing help as children, moral actions as nurturing acts, and the well-being of others as one's own well-being (see *ibid.*, pp. 309–310). Another example demonstrates that economic concepts are applied to moral problems. Moral actions can also be understood as an accounting process to balance moral accounts. It is moral to pay debts and immoral not to do so. Fairness is an imaginative process of balancing moral accounts; fair treatment and distribution are moral actions, whereas unfair treatment and distribution are immoral actions (see *ibid.*, pp. 292–298). Here, the experience with justice is transferred to other moral areas. This relates to the equitable distribution of objects or goods (e.g. smartphones, money, a pretty pebble found on the beach) or immaterial objects (e.g. career prospects, participation, responsibility or power). The moral in this case is the equitable distribution. But what exactly is meant by simple distribution is a subject of dispute (*ibid.*). Other metaphors can structure decisions by establishing freedom as moral, and restrictions as immoral (*ibid.*, p. 304). And other metaphors reveal that so-called moral people are described as healthy and pure ('you have a clean vest') and immoral people as sick, infectious and unclean. Each object has a moral essence that establishes moral behaviour.

Moreover, embodied conceptions of well-being are used metaphorically in decision-making processes (Brugman et al., 2019). For our research, we therefore created a design that aims at students' moral conceptions used during in decision-making processes in the field of animal ethics in science education. The study focuses on the genesis of moral conceptions and its significance for enhancing decision-making processes in science classes. The identification of learning potentials and means of improving decision-making competences also belong to the scope of research.

## Methods

### *Model of Educational Reconstruction*

The Model of Educational Reconstruction (hereinafter referred to as MER) was developed as a theoretical framework for research and development in science education (Duit et al., 2012). Its main intention is to identify and analyse both students' as well as scientists' conceptions in order to draw conclusions about improving learning processes and to optimise skills and competences. In this study, the MER is used to foster decision-making competence. Thus, the following research tasks were performed:

- content-based identification and analysis of students' perspectives to understand the genesis of students' moral conceptions (RQ1, 2), and
- development of a diagnostic tool to construct learning environments based on identified learning potentials (RQ3).

The MER consisted originally of three tasks, all of which we have covered. However, we decided not to include the task 'clarification of scientific content' explicitly in this paper, because we wish to focus on student conceptions and the development of learning environments. In addition, especially in the case of moral questions (also because of the

absolutely necessary multi-perspectivity), the clarification of the scientific background represents an extensive task that would fill a separate paper. Nevertheless, these results find their way into the paper implicitly, since the technical concepts were used in the interpretation of the students' statements. The findings from the 'clarification of scientific content' have been published *monographically* (see Tramowsky, 2019).

### **Individual and group discussions**

This paper focuses on the identification of students' moral conceptions and metaphors in the field of animal ethics. In order to encourage discussion and reflection processes with respect to morality and the structure of moral conceptions, we conducted a two-part qualitative interview study. On this basis, high-school students' moral conceptions and moral metaphors relating to animal ethics were identified. This led to the development of a tool for analysing moral metaphors.

In cooperation with science teachers, we recruited participants from a secondary school in Bavaria, Germany. We intentionally addressed students at the end of secondary school to ensure that they were capable of making self-determined decisions (Piaget, 1997). As the interviews were conducted at our university lab, parental as well as school administration permissions were required and obtained. Involved teachers, students and parents/guardians were informed about the aim of the study, data recording, storage and protection as well as place and time of the interviews. Participation was always voluntary. Additionally, they were informed that the study focuses on spontaneous and authentic statements, rather than those induced by predefined or given situations. The topic of study remained unknown to the participants. During the study, the students were asked specific questions about different types of livestock farming, animal slaughter, suffering and compassion and the use of animals. Furthermore, we questioned about personal experience, values, and attitudes as well as ratings and decisions (for example, 'How do you rate mass livestock-farming?'). The revised interview guideline of the study was used to identify and interpret the structuring of the moral conceptions. All personalised data was anonymized.

The interview guideline was developed on the basis of theory and formed the structure for the nature and content of the personal interview. The interview guideline has a structuring function and contains (1) questions on animal husbandry and the assessment of animal husbandry systems (e.g. 'Where does the meat you eat come from?'), (2) questions on meat consumption and the assessment of meat consumption (e.g. 'What do you look for when you buy and consume meat?') and (3) questions on your own family situation (e.g. 'Who cooks and chooses the meat at home and why is that?'). In the in-depth questions, care was taken to use simple, clear and concrete wording and to differentiate. The guideline also provided sufficient openness to be able to react flexibly to the answers of the interviewees. During the creation of the guideline, repetitions in the form of questions and summaries were built in for testing reliability by means of internal triangulation. These repetitions were formulated differently, but were basically intended to capture similar statements (e.g. 'Summarise again. How do you judge intensive animal husbandry?'). The theory-based interview guideline was formally checked and redesigned with aid of a mock interview. In the first part of our study, nine students in groups of three (5 m/4f), aged 15 years on average, were questioned about the aforementioned



ethical issues. A structured guideline throughout an initial individual interview followed by a group discussion (20–30 minutes long) was used (based on Bortz & Döring, 2006). This procedure intended to identify and analyse students' conceptions about animal ethics and moral metaphors. For saturation, we additionally interviewed six students (3 m/3f), aged 11 years on average, in two group discussions in order to analyse further moral conceptions.

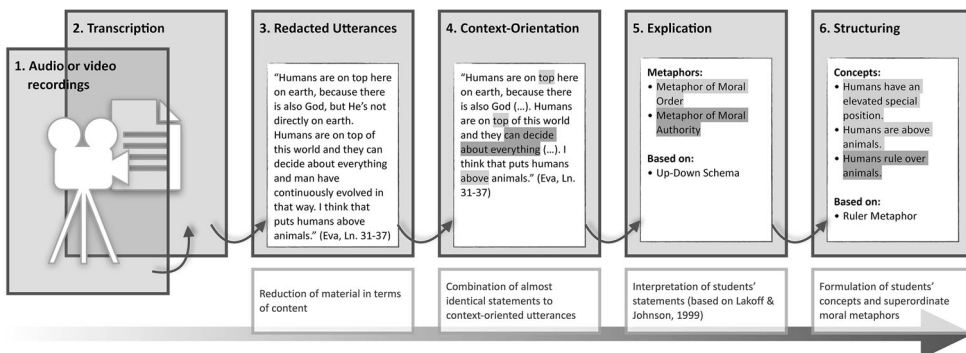
Another important aim of our research is the development of a diagnostic tool for the construction of learning environments based on the identified conceptions. Therefore, in part two, we questioned a further six students (2 m/4f), aged 15 years on average, to analyse their moral conceptions. We proceeded as in part one.

The children lived in a small town in Bavaria (Bamberg) or in the surrounding district. Both the county and the town are rather rural and mainly Catholic. Two groups with different students were used. Basically, the same questions were posed in both groups. However, since we may have possibly influenced the children with our questions, we carefully revised the interview guideline after the first round (see internal triangulation). The students in the first group were in grade 9 and took the same biology course. The students in the other group were from grades 9 and 5. In doing so, we hoped to receive more information about the connection between age and metaphorical judgment. This data has not yet been analysed.

### Qualitative content analysis

The collected data was analysed in accordance with Qualitative Content Analysis (Mayring, 2004) in the following manner (see Figure 2): (1) The statements and actions of the students were documented by means of audio and video recordings. (2) The statements were transcribed into a legible form with the help of transcription rules. (3) The material was reduced in its content (redacted utterances) leading to more syntactic and grammatically appropriate statements. (4) Data evaluation took place (context-oriented utterances). Taking our research questions into account, we

Steps of Qualitative Content Analysis



**Figure 2.** Methodical approach to editing and analyzing students' conceptions and deriving superordinate moral metaphors. White boxes showing an example of the Ruler Metaphor illustrate important steps of Qualitative Content Analysis.

rearranged the statements to create sections with coherent content. To achieve this, we summarised context-related utterances with the help of a detailed category system representing the scientific and everyday conceptions (result of the clarification of scientific content). Having Lakoff and Johnson's (1999) twenty theory-based general moral metaphors in mind, a category coding scheme was developed. With the aid of selective coding using the software MAXQDA, the edited statements were specifically analysed to establish whether they contained the theory-based general moral metaphors. In a next step, these statements were arranged thematically; para-conceptions were examined and bundled into coherent statements. 5) With the aid of a cognitive linguistic theoretical approach, we explicated the statements according to the CMT: According to the statements' semantic structure, moral conceptions were defined and described. Thus, image-schema- and content-related statements were joined to form specific moral conceptions and moral metaphors. Thereafter, we were able to draw conclusions about the genesis of the identified moral conceptions and moral metaphors. Here, the interpretation of the identified metaphors was seen as a chance to improve the understanding of learners' moral thinking patterns. Following the rules of qualitative content analysis, the identified moral conceptions were sequenced, explained and contextualised by means of anchor examples. We refer herein to the line numbers (referred to as Ln.) of the respective transcripts. 6) In a final step, we summarised, listed and compared the identified moral conceptions and moral metaphors. Thus, the twenty moral metaphors described by Lakoff and Johnson (1999) were sorted into five superordinate moral metaphors. The moral metaphors were assigned to superordinate moral metaphors on the basis of similarity of content and theoretical connection. For example, the Ruler Metaphor was allocated to the Up–Down Schema (Lakoff, 1987) and the Empathy Metaphor was assigned to the Person Schema (Lakoff & Johnson, 2003). In this manner, these five superordinate moral metaphors were derived by categorising the theory-based moral metaphors and the empirically identified moral conceptions of this study.

During the entire data processing, it was monitored whether the utterances were authentic or whether they were confounding variables. This procedure was supported by internal triangulation. A repetitive methodology in form of questioning, task assigning and recapping in interviews and group discussions was used to control the reliability and validity.

For this article, relevant German statements were translated into English by three independent researchers and one native speaker. We are aware that translation is always subject to interpretation. However, Lakoff and Johnson point to the cross-cultural spread of moral metaphors, which can be seen as a particularly large part of the Western moral tradition (1999, pp. 311–313).

## Data results

### *Moral conceptions and moral metaphors in students' decisions about the animal-human relationship and livestock farming (RQ1)*

Our first research question focused on the identification of moral conceptions and metaphors which can be derived from the conducted interviews and group discussions. In consistence with other research on the conceptualisation of animals (Gebhard, 2013),

results of the qualitative content analysis confirm the idea that students often use metaphorical conceptions to conceptualise the nature of animals, as the following examples show. For further examples and details see Table 1. In part one, Eva (15 years old) was asked to justify her meat consumption. Her reply was as follows:

Humans are on TOP here on earth, because there is also God, but He's not directly on earth. Humans are on TOP of this world and they can decide about everything and man have continuously evolved in that way. I think that puts humans ABOVE animals. [...] Humans keeps animals in order to eat them and then he is, so to speak, the RULER OVER THE ANIMALS. (Eva, Ln. 31–45)

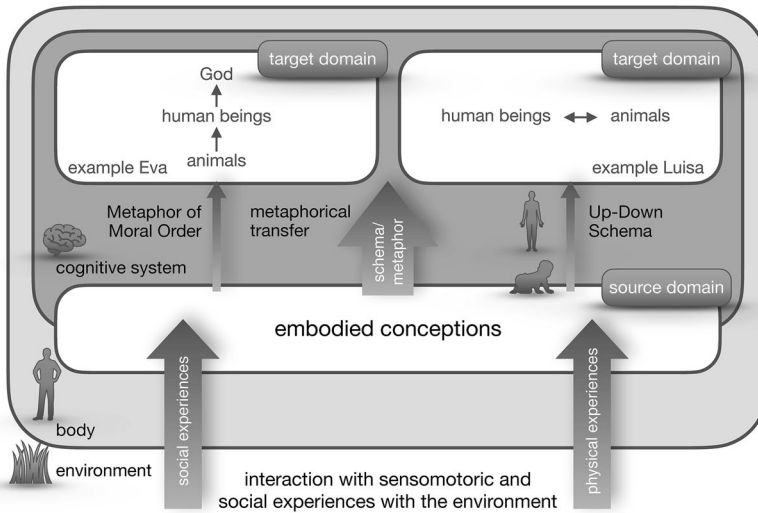
**Table 1.** Examples of students' statements with their corresponding moral conceptions, superordinate moral metaphors and occurrence about animal-human relationships and livestock farming.

Anchor example	Moral conception	Superordinate moral metaphor	Number of students (N = 21)
Students' Statements about the Animal-Human Relationship			
'Humans are on top here on earth, because there is also God, but He's not directly on earth. Humans are on top of this world, and they can decide about everything and man have continuously evolved in that way. I think that puts humans above animals' (Eva, Ln. 31–37).	Humans have an elevated special position.	Ruler Metaphor	n = 10
'Humans have placed themselves above the other animals, because he has developed more abilities through his brain [...] I don't know if there is anyone else who is above humans, but maybe among religious people, they say God' (Milan, Ln. 25–30).	Humans are above animals.		n = 10
'I think that humans are actually some kind of rulers. [...] Humans have simply placed themselves above everything and we can actually only do that by evolution' (Paul, Ln. 12–17).	Humans rule over animals.		n = 13
'Some people think that animals are subordinate to people, and we have the right to treat animals like this [...] that they are not worth as much as people. [...] In my opinion, animals should have equal rights' (Luisa, Ln. 74–78, 96–98).	Animals and humans are equal.		n = 6
Students' Statements about Livestock Farming			
'I think that animals are also living things [...] and we can also feed ourselves with vegetarian products. [...]' (Luisa, Ln. 96–98).	Animals are living individuals.	Empathy Metaphor	n = 17
'If you slip into the role of a pig, then you experience everything that happened' (Peter, Ln. 481).	Animals are persons.		n = 16
'The animal feels bad because I would also feel bad if I had to be locked up in such a small space with lots of others. That is not fair to animals because we would not treat ourselves like that' (Nora, Ln. 98–111).	Animal-friendly livestock farming means human well-being.		n = 15
'[...] Because animals also have feelings, just like us humans. [...] Animals can suffer when they are in cramped cages [...] You know that yourself, it burns even when you only have a small scratch [...] It's like us, we also go to the doctor so that we get help and don't have to suffer pain. With animals, this is usually ignored' (Lisa, Ln. 18–31).	Animal-friendly livestock farming consider human emotions.		n = 12

In accordance with our research goal, we focused on the underlying embodied moral conceptions and moral metaphors. Eva uses terms such as ‘top’ and ‘above’, which indicate the use of the Ruler Metaphor as well as an underlying kinesthetic image schema, such as the Up–Down Schema. Interestingly, Eva often used similar expressions to describe and explain her notion of animal-human relationships as hierarchical (HUMANS HAVE AN ELEVATED SPECIAL POSITION and HUMANS ARE ABOVE ANIMALS). In fact, we found references to hierarchical orders between humans and animals throughout almost all of our interviews (see Table 1). Terms such as TOP and ABOVE indicate the important role of physical experiences; UP and DOWN when it comes to statements about value. Other participants shared this moral conception called HUMANS RULE OVER ANIMALS. It seems that students such as Eva transfer this experiential knowledge to the topic of the animal-human relationship and moral conceptions of the treatment of animals. Several of the interviewed students shared the common conception: HUMANS RULE OVER ANIMALS. According to Lakoff and Johnson (1999), moral conceptions have their origin in embodied experience. The human body is perceived and conceived with the help of the Up–Down Schema (Lakoff, 1987, pp. 275–278). Because this embodied structure is a crucial part of the Metaphors of Moral Authority and Moral Order, it seems that students used it as a spatial arrangement to conceptualise the relationship between humans and animals: The embodied image schema UP and DOWN (source domain) is metaphorically transferred to abstract animal ethical issues (target domain). Thus, moral conceptions are likely to derive from image schemas linked with the human well-being. UP is experienced as something good and valuable, whereas DOWN is seen as something bad and invaluable. Thus, our research confirms existing studies that students associate things such as God, power and the morally good with UP (Meier et al., 2007). Based on hierarchical conceptions, our results reveal that students are likely to understand the treatment of animals either in a conservative and therefore authoritarian, or in a progressive and nurturing way. This bias can also be observed in examples such as Luisa (14 years old). Compared to Eva, she argues quite differently in respect to animal-human relationships:

Some people think that animals are SUBORDINATE to people and we have the RIGHT to treat animals like this (...) that they are not WORTH as much as people. (...) I think that animals are also living things (...) and we can also feed ourselves with vegetarian products. In my opinion, animals should have EQUAL RIGHTS. (Luisa, Ln. 74–78, 96–98)

The analysis of this statement reveals that Luisa uses a moral conception of equality (ANIMALS AND HUMANS ARE EQUAL), expressing the parity between humans and animals. In contrast to Eva, Luisa uses the concept of morality in a progressive form and argues from a different perspective. It seems that Eva and Luisa conceptualise the relationship between humans and animals on the basis of the Metaphor of Moral Order (Lakoff & Johnson, 1999). As both statements indicate, Luisa has the conception that describes the equality between humans and animals (progressive value orientation), whereas Eva uses a more conservatively valued orientation in which people are worth more than animals. In contrast to Eva, Luisa does not understand the animal-human relationship as superior or inferior but as on a par (see Figure 3). When analytically reviewing all interviews, another important difference between Eva’s and Luisa’s method of conceptualising human-animal relationships emerges: Eva’s statements only



**Figure 3.** Genesis of differently structured abstract conceptions based on metaphorical transfer in the context of human-animal relationships.

allude to a hierarchical perspective based on social conditions. In contrast, Luisa also describes top-down differences between humans and animals, which she morally rejects. Instead, she proceeds by referring to an alternative conception in which equality and parity are crucial arguments describing a state that should be achieved. Particularly in group interviews, we encountered that our participants often juxtaposed the two aspects of how things are and how they should be.

Besides human-animal relationships, one SSI of the conducted study consisted of the topic of livestock farming. The following statement represents a typical answer on this subject. After being asked about her opinion on livestock farming, Nora (15-years-old) expressed her views as follows:

The animal feels bad because I WOULD ALSO FEEL BAD if I had to be locked up in such a SMALL SPACE with lots of others. That is NOT FAIR to animals because we would not TREAT OURSELVES like that. (Nora, Ln. 98–111)

The analysis suggests that Nora argued by showing compassion. In doing so, she created an analogy between the animal's and her own discomfort. Statements such as Nora's were found very often throughout the conducted interviews and group discussions. The animals were described as living individuals with human emotions also in pursuit of freedom and independence. Furthermore, other students linked animal-friendly livestock farming with animal well-being, which they equated with human well-being (ANIMAL-FRIENDLY LIVESTOCK FARMING MEANS HUMAN WELL-BEING). Further data confirms that most participants spoke similarly of animals as if they were speaking of humans; about animal feelings analogous to human feelings and emotions (ANIMAL-FRIENDLY LIVESTOCK FARMING CONSIDERS HUMAN EMOTIONS) and about animal well-being similarly to their own well-being. Based on our research, it can be determined that students often refer to their own well-being when making decisions about livestock farming. Again, the conceptual metaphor theory provides a suitable explanation for this phenomenon:

It seems that experiences gained about human feelings play an important role when it comes to moral judgments. Moreover, students tend to transfer experiential knowledge about nurturance to the topic of animal well-being and livestock farming. In science education research, it is known that students use such analogies in order to conceive abstract biological phenomena (e.g. Driver, 1989). It seems that students such as Nora are relying on analogies in this case. However, according to Lakoff and Johnson (2003), an analogy is considered as the product of a metaphor. By linking the source and the target domain, a similarity is thereby established. Analogies are thus perceptions of similarity. This means that they are the direct result of a metaphorical projection. According to Lakoff and Johnson (1999), moral nurturance requires empathy (for animals) and help for those in need (Bialostok, 2014). It seems that in this case, moral conceptions have their origin in the embodied experience of one's own well-being.

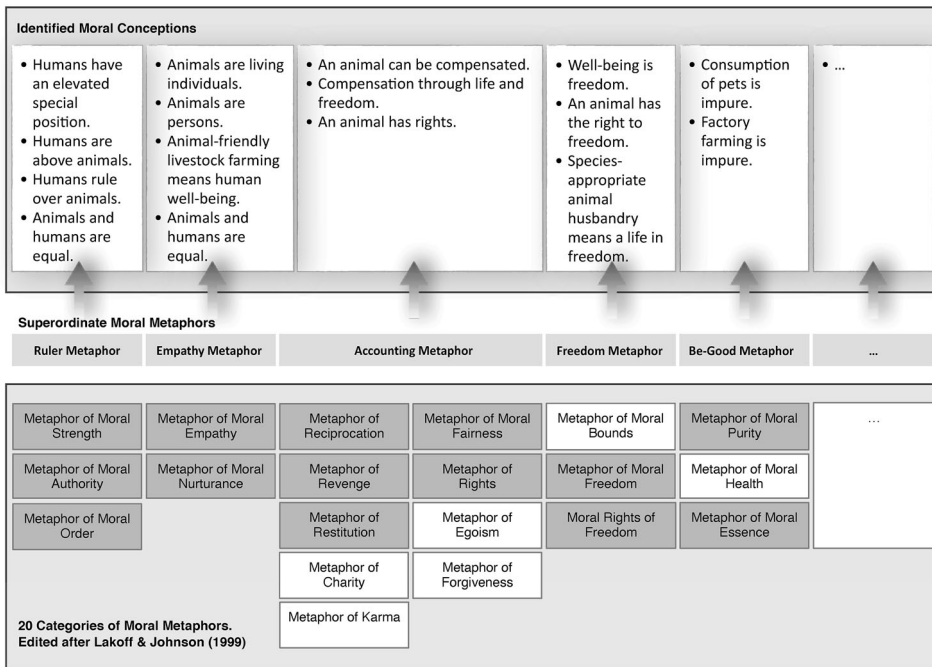
Consequently, morality is perceived and conceived with the help of metaphors such as Metaphors of Moral Nurturance and Empathy (Lakoff & Johnson, 1999). These metaphors are connected with the Person Schema (Lakoff & Johnson, 2003). In our study, embodied conceptions about well-being (source domain) were metaphorically transferred to the abstract biological phenomenon of animal well-being (target domain).

As our data shows, when using the Metaphor of Moral Empathy (Lakoff & Johnson, 1999) for their judgments, the participants often empathise with an individual animal: 'If YOU SLIP INTO the role of A PIG, then YOU EXPERIENCE everything that happened' (Peter, Ln. 481). In addition, few of the interviewed students described animals as living individuals (ANIMALS ARE LIVING INDIVIDUALS) or used anthropomorphic conceptions (ANIMALS ARE PERSONS) when they imagined an individual animal, for example a pet or a wild animal. In summary, our results indicate that students' moral conceptions often attribute human characteristics to animals.

### **Educational moral metaphors system (RQ2)**

According to the identified moral conceptions and their theoretical analysis, our data also shows that 14 of 20 categories of moral metaphors (Lakoff & Johnson, 1999) were used by the participants (see Figure 4): Moral Authority, Moral Order, Moral Empathy, Moral Nurturance, Restitution, Moral Fairness, Rights, Moral Freedom, Moral Rights of Freedom, Moral Purity and Moral Essence. The metaphors identified from the data formed a mentally coherent framework of conceptions. In order to apply this to educational processes, matching metaphors were merged to create superordinate moral metaphors. Figure 4 graphically illustrates this coherent process by presenting identified moral metaphors and moral conceptions allocated with the respective superordinate moral metaphor. In this manner, the following superordinate moral metaphors were determined:

- The metaphors of strength, authority and order are a combination that cannot be considered separately and build on each other. Moral strength establishes moral order, which in turn establishes moral authority. Of the three metaphors in this group, two were used by the students to speak about meat consumption and animal husbandry. Because of the connections, all three metaphors are combined into the overarching *Ruler Metaphor* in the rest of this paper.



**Figure 4.** The system of moral metaphors based on embodied conceptions of well-being. Lower grey boxes illustrate moral metaphors used by students. Corresponding metaphors were merged to create superordinate moral metaphors (middle grey boxes). White boxes show identified moral conceptions based on their superordinate moral metaphors. The empty column stands for possible further categories which have not yet been covered.

- The metaphors of empathy and moral nurturance expressed by the students are not always distinguishable from each other, but form an interconnected framework of ideas. Empathy and compassion form the basis for moral care. The two metaphors were used by all students to assess animal husbandry. With the help of personifications, pupils metaphorically understand the nature of other species. Because of the similarities and connections, the two metaphors and the analogies found will be combined into the overarching *Empathy Metaphor* in the remainder of this paper.
- The metaphors of moral balance (code 1–9) used by the pupils cannot always be clearly distinguished from each other, but form an interconnected framework of ideas. The metaphor of moral rights ascribes rights to animals that are to be respected on the basis of one’s own experience. The metaphor of fairness is a method of diagnosing justice and injustice in terms of disregard for moral rights. According to this conception, the metaphor of moral compensation is a way of rebalancing the moral account that has fallen into imbalance, thus restoring morality. Of the nine metaphors in the moral account, five were used by the students to speak about justice. In the remainder of this paper, due to the similarities and interconnections, all nine metaphors of the moral balance will be combined into one overarching *Accounting Metaphor*.
- Pupils use a direct understanding in the literal sense as well as anthropomorphisms, which can differ in principle from professionally oriented conceptions when assessing different types of attitudes. Of the three metaphors of freedom (see Figure 4), two were

used by the students when assessing forms of attitude. The metaphors and analogies of freedom and the right to freedom they voiced are related to each other in terms of content, and are summarised in the further course of this work with the metaphor of moral boundaries to form the overarching Freedom Metaphor.

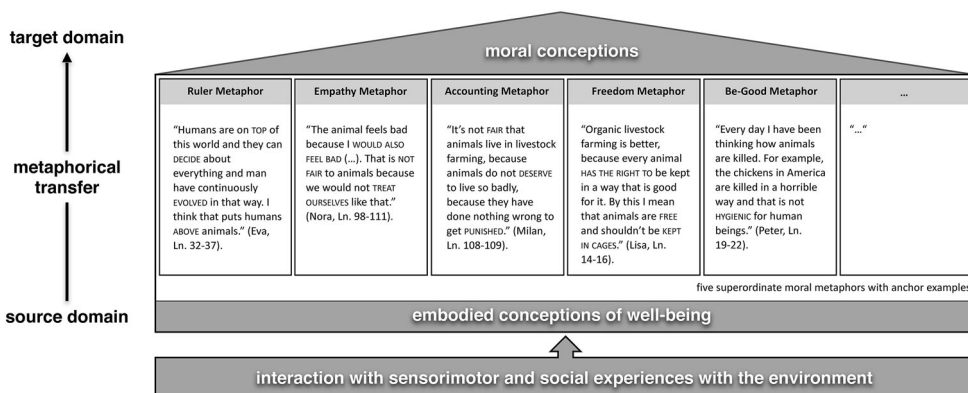
- The *Be-Good Metaphor* pertains to the value and character of a being with all its virtues and vices in its perfection, and forms a roof for the metaphors of moral purity and health. The metaphors of moral purity and health concern human behaviour towards animals, which is to be respected on the basis of one's own experience. Two out of three metaphors were used by three students to speak about human behaviour towards animals. Because of the similarities and connections, the three metaphors will be combined into one overarching *Be-Good Metaphor* in the remainder of this paper. The Be-Good metaphor has rarely been used to judge animal ethics issues to date, therefore, this has not been elaborated on here.

For anchor models see Figure 5, where anchor examples are assigned to each superordinate moral metaphor.

The metaphors were used in different contexts. The analysis of our data revealed that the superordinate moral metaphors 'Ruler Metaphor' and 'Empathy Metaphor' were identified above average in comparison to all the others. The empathy and ruler metaphors seem to have had an overarching meaning in our context, as they were usually also linked to the freedom and accounting metaphors. Consequently, we concluded that they play a predominant role when it comes to conceptualising moral reasoning in our study. Moreover, both may play an important role for fostering decision-making competences (RQ3). Hereinafter, the results in respect to these two superordinate moral metaphors will be explained in greater detail.

### Ruler metaphor

The analysis of the statements of Eva, Milan and Paul (see Table 1), leads to evidence that different moral metaphors can be found in all of our students' statements (see Figure 4).



**Figure 5.** The Educational System of Moral Metaphors: Moral conceptions rely on superordinate moral metaphors, which are based on embodied conceptions. White boxes show anchor examples for each identified moral metaphor. The empty column stands for possible further metaphors which have not yet been covered.



The Metaphors of Moral Strength, Moral Order and Moral Authority represent a combination that cannot be divided. We were able to identify this connection, which was theoretically presented by Lakoff and Johnson (1999) from our own data. In this connection, the Metaphor of Moral Strength is the foundation for the Metaphor of Moral Order and this in turn, can be regarded as the foundation for the Metaphor of Moral Authority. The following example illustrates this:

Humans are on TOP here on earth, because there is also God, but He's not directly on earth. Humans are on TOP of this world, and they CAN DECIDE ABOUT EVERYTHING and man have continuously evolved in that way. I think that puts humans ABOVE animals. [...] Humans keeps animals in order to eat them and then he is, so to speak, the RULER OVER THE ANIMALS. (Eva, Ln. 31–45)

Eva uses terms such as 'can decide about everything', which indicate the use of the Metaphor of Moral Strength, 'top' and 'above', the use of the Metaphor of Moral Order, and 'ruler over the animals', the Metaphor of Moral Authority. Due to the interdependencies, all three moral metaphors were combined in the further course of this work to form the superordinate moral metaphor Ruler Metaphor. Thus, the Ruler Metaphor is based on experiences with regimes and authorities: God is for Eva 'naturally' more powerful than humans, humans are more powerful than animals, adults are more powerful than children, and men are more powerful than women. This 'natural' order can become a corresponding moral order (see Lakoff & Johnson, 1999, pp. 298–304). Based on this order, humans therefore have moral authority over animals. Eva feels that this power imbalance is metaphorically similar to parental authority, where farmers (like parents) have the welfare of animals (like children) in mind and know what is best for them. Even though she derives ethical problems from husbandry conditions by using the metaphor of moral strength, it emerges from her statement that humans must have the authority to do this.

### *Empathy metaphor*

The analysis of statements from Nora, Peter or Lisa (see Table 1) reveals a different case of using moral metaphors interdependently (see Figure 4). Here, the moral metaphors of Moral Empathy and Moral Nurturance were expressed by these students during the interview und group discussions. The following example illustrates this:

The animal feels bad because I WOULD ALSO FEEL BAD if I had to be locked up in such a SMALL SPACE with lots of others. That is NOT FAIR to animals because we would not TREAT OURSELVES like that. (Nora, Ln. 98–111)

In general, both moral metaphors were used regularly by our students, such as Nora to assess livestock farming. Nora uses terms such as 'I would also feel bad', which indicates the use of the Metaphor of Empathy and 'would not TREAT OURSELVES like that' indicating the use of the Metaphor of Nurturance. The two moral metaphors also form a mentally coherent framework of conceptions: The Metaphor of Moral Empathy provides the basis for Moral Nurturing. This means a community is understood metaphorically as a family, its moral agents as nurturing parents. Residents needing help are conceptualised as children, moral actions as nurturing acts and the well-being of others as one's own well-being (see Lakoff & Johnson, 1999, pp. 309–310). With these theoretical and

empirical considerations, both moral metaphors were combined to form the superordinate moral metaphor called Empathy Metaphor.

The process of merging moral metaphors with the help of identified moral conceptions in order to derive superordinate moral metaphors was carried out similarly for the development of the Accounting Metaphor, the Freedom Metaphor and the Be-Good Metaphor.

## Discussion

### *Genesis of moral conceptions*

Our assumptions that students' conceptions in moral evaluations are metaphorically structured and the CMT is suitable for a deeper analysis were affirmed. In this study on students' perspectives, pupils' conceptions were comprehensively analysed using the framework of the MER. From the respective findings, we can state that students often use metaphorical conceptions when they make decisions about animal ethics. As the results show, identified moral conceptions are likely to derive from embodied experience combined with our individual sense of well-being (RQ1). Thus, they are often based on the Ruler Metaphor and the Empathy Metaphor, structured by the Up-Down Schema (Lakoff, 1987), the Person Schema (Lakoff & Johnson, 2003) and the Part-Whole Schema (Lakoff, 1987). This leads to the observed fact that animal-human relationships and livestock farming are conceptualised on the basis of associated embodied conceptions. Based on theoretical conclusions and empirical results, the Educational Moral Metaphors System was developed (RQ2). We can therefore conclude that Lakoff and Johnson's theory is also suitable for educational purposes, to facilitate the development of strategies for teaching scientific issues more effectively and evolving theory-based learning environments.

The results from RQ1 and RQ2 indicate that the transfer of embodied conceptions to questions of morality is widespread among students. But which implications for fostering decision-making competences in science education can be derived from this observation?

### *Moral metaphors as a precondition: environments and implications for fostering decision-making competences (RQ3)*

In order to give students the opportunity to reflect on their own moral conceptions and to expand them for the benefit of other perspectives, one should understand their thinking patterns and get to know alternative metaphors for judging SSI issues. A critical reflection of one's own perception could be suitable to form multi-perspective conceptions and, thereby enhance decision-making competences (Gropengießer & Groß, 2019). Below, three learning environments based on the Ruler and Empathy Metaphor to foster decision-making competences will be discussed.

### *Enhancing decision-making competences in respect to expanding existing image schemas on hierarchical orders*

The identified conceptions on the human-animal relationship indicate that many students regard humans as superior and more valuable than other organisms. Thus, a

change in perspective can be beneficial: Instead of regarding the animal-human relationship as a hierarchical order, a different perspective based on the equality conception (progressive value orientation) can be constructed. In order to critically reflect on hierarchical orders between humans and other animals, students should reflect upon and get to know their own thought structures, in order to expand them in favour of different and alternative conceptions. At this point, the Up–Down Schema (Lakoff, 1987) can be integrated in the following learning environment: Students receive images of people and animals with the task of arranging them according to their metaphorical conceptions (predominantly in hierarchical order). Subsequently, they are asked to explain their decisions and discuss alternative arrangements (e.g. equivalent order). In this way, different manifestations of the Ruler Metaphor can be explicitly addressed, thereby achieving the enhancement of decision-making competences in form of a multiperspective approach.

At this point it should be mentioned that neither do we raise questions on something being morally good or bad, nor do we wish to evaluate the participants' statements and moral standpoints as ideal or less ideal. Instead, we are concerned with enhancing decision-making competencies more precisely with the ability to think and judge from multiple perspectives. For this purpose it is important for us to take the genesis of moral conceptions into account for our analysis. Thus, identified metaphors can lead to conclusions about advantages and disadvantages in the context of evaluation competencies. For example: The relationship between humans and animals is something abstract and conceived as metaphorical. We recognise that a power imbalance between animals and humans exists and make statements in a sense of 'animals are subordinate to humans' to illustrate this phenomenon. This is justified. However, students should be aware that humans and animals can also be thought of on the same level. These conceptions are partly responsible for our moral judgement. For Charles Darwin, the founder of the scientific theory of evolution, no species stands 'higher' than another (Reiss & Harms, 2019). Biologically, all living organisms are equal because they have all equally undergone evolution until the present day. Through hierarchical metaphors, we tend to understand only one side of the human-animal relationship. We should not simply accept the hierarchical view and therefore constantly question our thoughts, statements and actions (Tramowsky & Groß, 2018). Unreflective or abusive use of metaphors can also reinforce discrimination between humans (e.g. slavery, racism, sexism). Multiperspective thinking means, in the sense of evaluation competence, to recognise these different perspectives and to be able to reflect on them.

### *Enhancing decision-making competences by means of creating new experiences with animal well-being*

Also, the conception that ANIMALS ARE PERSONS is common within the mindsets of pupils and is particularly evident in statements on the assessment of animal well-being. Anthropomorphic conceptions constitute a learning opportunity because students can thereby empathise with animals and feel compassion. Nevertheless, a different perspective must be considered to evoke a more reflected opinion: Instead of conceiving animals as human beings, the conception of animal well-being should also be developed. Based on this idea, students should understand that animals have individual and species-specific requirements that may differ from human needs. At this stage, the Person Schema (Lakoff & Johnson, 2003) can be used to create experiences during a particular teaching unit.

Furthermore, visiting livestock farms may also help to gain experiences about the well-being of individual animals. With these experiences in addition to existing metaphorical thinking patterns, scientific conceptions about the needs and behaviour of animals can be used to initiate evaluation processes.

### ***Enhancing decision-making competences with a view to modifying an existing image schema about animal well-being with respect to creating new experiences***

The conception: ANIMALS ARE PRODUCTS / INDUSTRIAL MERCHANDISE differs from the conception: ANIMALS ARE PERSONS in the respect that the focus does not lie on a single individual, but rather on a group of animals. In this sense, our analysis has shown that the participants' comments on animal well-being were less associated with such objectifications. Thus, the Part-Whole Schema should have a significant function (Lakoff, 1987) for designing fruitful learning environments. The reason for this can be seen, once again, in underlying embodied conceptions: Students conceive groups of animals as a singular entity, and as a result, the animals' individuality fades and even disappears. For the evaluation of animal well-being, it is important to focus on individuals being a part of the entire group. With a schematic representation of a whole group, which in turn consists of many individual animals, the schema can be visualised and thus reflected upon.

### ***Enhancing decision-making competences for teachers by using moral metaphors and image schemas for conceptual change***

The examples I-III indicate that SSIs and their moral conceptions are often evaluated from just a single perspective. However, open-minded and thoroughly-reflected moral reasoning as well as multi-perspective conceptions are important attributes of decision-making competence and SSIs (Höttecke et al., 2010; Lombardi et al., 2016). Based on the CMT and the Educational Moral Metaphors System, this study aims at the development of fruitful teaching environments. However, embodied conceptions students have about morals cannot easily be erased or changed. We rather hope to expand and evaluate moral conceptions and trigger learning processes towards developing adequate scientific conceptions. Therefore, we focus on the implementation of multi-perspective learning environments in science education classes in order to give students the opportunity to occupy themselves with alternative perspectives. Based on our results, we were able to derive school-related implications for fostering decision-making competences from the reflection on metaphoric conceptions and multi-perspective assessments and evaluations (RQ3).

### ***Limitations of the study***

Using a content-based analytical approach, it seems possible to turn implicit, into explicit moral conceptions. The challenge is to reflect and expand the student's individual perspective and to take embodied conceptions into account. This paper does not clarify whether and how the learning environments will function in accordance with our assumptions. For the subsequent research work, room exists for further detailed specification of the cases investigated (e.g. which concrete ways of thinking and learning result from the learning environments?). By using qualitative teaching experiments (Komorek & Duit, 2004), it would be possible to create concept maps illustrating the conceptions,

metaphors and assigned image schemas students have before and during being confronted with the learning environments. Thus, it would be possible to reconstruct learning pathways by linking identified conceptions according to the conceptual changes the students underwent (Duit & Treagust, 2003). Quantitative studies could also be used to determine whether an effect correlates with the learning programme, the discussion, the initial question or with a combination of several factors. However, based on this study's methodology, no evidence can be provided with regard to the distribution of the conceptions among the students. Therefore, further research using quantitative methods would be desirable.

Qualitative content analysis always builds on a high level of expertise in respect to interpreting the data collected. To meet high quality standards the recorded data was analysed by independent researchers. This method of interpersonal consensus-building was conducted by researchers and members of the Department of Science Education as well as professors of the Department of Systematic Theology and Ethics and of the Department of Philosophy at the University of Bamberg, and can be seen as one measure towards an appropriate level of argumentative validation. This procedure was complemented by internal triangulation. Content-oriented repetitions by means of questions, tasks and other assignments led to the possibility of reviewing the collected data in form of reliability and validity. In addition, internal validation measures for the entire data set took place in form of lectures and discussions within the Department of Science Education as well as in international discourse. However, qualitative content analysis remains a method of subjective interpretation. By applying the aforementioned rules and theoretical principles, which have been approved and refined by a broad variety of former qualitative studies, we have tried to interpret our data in the most transparent and comprehensible manner possible.

In our study, we have described individual cases. The identified moral conceptions are subjective phenomena, since it is always individuals who develop subjective conceptions in social contexts and express them verbally. This limits the generalisation of the results. The present research results are of educational interest insofar as they go beyond individual cases, since they deal with typical and exemplary generalisable aspects of moral conceptions. For this purpose, individual moral conceptions were bundled into superordinate moral metaphors, which can be generalised to the extent that they can be regarded as typical representatives of a class of similar cases and in this respect, can represent usable recurring learning presuppositions. For example, hierarchical conceptions that we identified in the context of human-animal relationships may also be found in similar ethical contexts. Unreflective or abusive use of metaphors can also reinforce discrimination between humans.

## Conclusion

As a consequence of our studies, educational recommendations for biology lessons can be derived. In principle, teachers can make three offers to their students:

- Firstly, they can create new experiences. For example, one can open up a whole new world by visiting livestock farms.

- Secondly, it can be helpful to characterise the conceptions that scientists contribute to these experiences. This can be done with the aid of interviews but also by interpreting the scientific content (Gropengießer & Groß, 2019).
- Thirdly, it can be particularly helpful for understanding biological phenomenon when the used metaphors are dissociated from their unquestioned familiarity and considered consciously (Niebert & Gropengießer, 2013). For this purpose, the metaphorically used image schemas are drawn-up and processed physically.

In particular, the third offer – the reflected handling of metaphors and their image schemata – presents a challenge for science education. In order to explore the relationship between experiences, language and thinking for biology lessons, selected topics of biology education must be systematically examined in respect to the metaphors and utilised image schemas. In the framework of the conceptual metaphor theory, the understanding processes can be made accessible with the method of metaphor analysis. The search for the source region leads the metaphor analysis to the respective embodied image schema, and its structures are transferred to the target domain. This applies to both the analysis of the student's conceptions and the scientific conceptions.

The comparison of the initial learning situation with the objective of a correct presentation provides information about the learning needs. There appear to be four possibilities (based on Gropengießer & Groß, 2019):

- keep an existing image schema, and modify it in respect to creating new experiences;
- let students reflect on existing image schemas and conceptions in order to achieve a meta-understanding;
- expand existing image schemas, or
- sometimes even discard these, when they clearly constitute an obstacle for learning.

Even if learning needs can be clearly specified and named, learning offers are dependent on creative ideas. We have developed empirical evidence for such ideas, which can now be piloted in a methodologically controlled approach with respect to their benefits for fostering decision making competence.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## ORCID

Nadine Tramowsky  <http://orcid.org/0000-0003-1174-506X>

Denis Messig  <http://orcid.org/0000-0001-6508-7504>

Jorge Groß  <http://orcid.org/0000-0002-3525-9448>

## References

Baumeister, R., & Exline, J. (2000). Self-control, morality, and human strength. *Journal of Social and Clinical Psychology*, 19(1), 29–42. <https://doi.org/10.1521/jscp.2000.19.1.29>

- Bialostok, S. M. (2014). Metaphors that teachers live by: A cultural model of literacy in the era of new literacies. *Language and Education*, 28(6), 501–520. <https://doi.org/10.1080/09500782.2014.905591>
- Binngießler, J., Wilhelm, C., & Randler, C. (2013). Attitudes toward animals among German children and adolescents. *Anthrozoös*, 26(3), 325–339. <https://doi.org/10.2752/175303713X13697429463475>
- Boerwinkel, D. J., & Waarlo, A. J. (2010). Genomics education for decision-making: Proceedings of the second invitational workshop on genomics education. In D. J. Boerwinkel & A. J. Waarlo (Eds.), *Genomics education for decision-making: Proceedings of the second invitational workshop on genomics education* (pp. 15–27). CD-β Press.
- Bögeholz, S., Eggert, S., Ziese, C., & Hasselhorn, M. (2017). Modeling and fostering decision-making competencies regarding challenging issues of sustainable development. In D. Leutner, J. Fleischer, J. Grünkorn, & E. Klieme (Eds.), *Methodology of educational measurement and assessment. Competence assessment in education: Research, models and instruments* (pp. 263–284). Springer.
- Bortz, J., & Döring, N. (2006). *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler* [Research methods and evaluation for human and social scientists]. Springer.
- Brugman, B., Burgers, C., & Vis, B. (2019). Metaphorical framing in political discourse through words vs. concepts: A meta-analysis. *Language and Cognition*, 11(1), 41–65. <https://doi.org/10.1017/langcog.2019.5>
- Ceyhan, G., Lombardi, D., & Saribas, D. (2021). Probing into pre-service science teachers' practices of scientific evaluation and decision-making on socio-scientific issues. *Journal of Science Teacher Education*, 32(8), 865–889. <https://doi.org/10.1080/1046560X.2021.1894762>
- Chang Rundgren, S. N., & Rundgren, C. J. (2010). SEE-SEP: From a separate to a holistic view of socioscientific issues. *Asia-Pacific Forum on Science Learning and Teaching*, 11(1), 1–24.
- Churchland, P. M. (1995). *The engine of reason, the seat of the soul: A philosophical journey into the brain*. MIT Press.
- Driver, R. (1989). Changing conceptions. In P. Aidey (Ed.), *Adolescent development and school science* (pp. 79–99). Falmer Press.
- Duit, R., Gropengießer, H., Kattmann, U., Komorek, M., & Parchmann, I. (2012). The model of educational reconstruction – A framework for improving teaching and learning science. In D. Jorde, J. Dillon (Eds.), *Science education research and practice in Europe. Cultural Perspectives in Science Education*, SensePublishers (pp. 13–37). [https://doi.org/10.1007/978-94-6091-900-8\\_2](https://doi.org/10.1007/978-94-6091-900-8_2)
- Duit, R., & Treagust, D. F. (1998). Learning in science— From behaviourism towards social constructivism and beyond. In In: Fraser, B.J. and Tobin, K. G. (Eds.), *International handbook of science education*, Kluwer Academic Publishers (pp. 3–25). [https://doi.org/10.1007/978-94-011-4940-2\\_1](https://doi.org/10.1007/978-94-011-4940-2_1)
- Duit, R., & Treagust, D. F. (2003). Conceptual change: A powerful framework for improving science teaching and learning. *International Journal of Science Education*, 25(6), 671–688. <https://doi.org/10.1080/09500690305016>
- Flanagan, O. J. (1991). *Varieties of moral personality: Ethics and psychological realism*. Harvard University Press.
- Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive Neuropsychology*, 22(3-4), 455–479. <https://doi.org/10.1080/02643290442000310>
- Gebhard, U. (2013). *Kind und Natur: Die Bedeutung der Natur für die psychische Entwicklung* [The child and nature: The significance of nature for psychological development]. Springer VS.
- Gropengießer, H. (1998). *What language reveals about our conceptions: A case study on seeing*. In M. Komorek, Behrendt, H., Dahncke, H., Duit, R., Graeber, W., Kross, A. (Eds.), *Research in Science Education - Past, Present, and Future*. (Vol. 1, pp. 140–142)
- Gropengießer, H., & Groß, J. (2019). Lernstrategien für das Verstehen biologischer Phänomene: Die Rolle der verkörperten Schemata und Metaphern in der Vermittlung [Learning strategies

- for the understanding of biological phenomena: The role of embodied schemata and metaphors in mediation]. In J. Groß, M. Hammann, P. Schmiemann, & J. Zabel (Eds.), *Biologiedidaktische Forschung: Erträge für die Praxis* [Biology education research: Profits for the practice] (pp. 59–76). Springer Spektrum.
- Haidt, J. (2012). *The righteous mind*. Pantheon.
- Höttecke, D., Hössle, C., Eilks, I., Menthe, J., Mrochen, M., Oelgeklaus, H., & Feierabend, T. (2010). Judgment and decision-making about socio-scientific issues: One basis for a cross-faculty approach for learning about climate change. In I. Eilks & B. Ralle (Eds.), *Contemporary science education: Implications from science education research about orientations, strategies and assessment* (pp. 179–192). Shaker.
- Jiménez-Aleixandre, M. P., & Brocos, P. (2017). Processes of negotiation in socio-scientific argumentation about vegetarianism in teacher education. In Arcidiacono F., Bova A. (Eds) *Interpersonal Argumentation in Educational and Professional Contexts*. Springer (pp. 117–139). [https://doi.org/10.1007/978-3-319-59084-4\\_6](https://doi.org/10.1007/978-3-319-59084-4_6)
- Johnson, M. (2008). Philosophy's debt to metaphor. In R. Gibbs, Jr. (Eds.), *The cambridge handbook of metaphor and thought*. Cambridge University Press (pp. 39–52). <https://doi.org/10.1017/cbo9780511816802.004>
- Kohlberg, L. (1976). Moral stages and moralization: The cognitive-developmental approach. In T. Lickona (Ed.), *Moral development and behavior: Theory, research, and social issues* (pp. 31–53). Holt, Rinehart, & Winston.
- Komorek, M., & Duit, R. (2004). The teaching experiment as a powerful method to develop and evaluate teaching and learning sequences in the domain of non-linear systems. *International Journal of Science Education*, 26(5), 619–633. <https://doi.org/10.1080/09500690310001614717>
- Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. University of Chicago Press.
- Lakoff, G. (2002). *Moral politics: How liberals and conservatives think*. Chicago University Press.
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. University of Chicago Press.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. Basic Books.
- Lakoff, G., & Johnson, M. (2003). *Metaphors we live by*. University of Chicago Press.
- Lee, Y. C., & Grace, M. (2012). Students' reasoning and decision making about a socioscientific issue: A cross-context comparison. *Science Education*, 96(5), 787–807. <https://doi.org/10.1002/sce.21021>
- Lombardi, D., Brandt, C. B., Bickel, E. S., & Burg, C. (2016). Students' evaluations about climate change. *International Journal of Science Education*, 38(8), 1392–1414. <https://doi.org/10.1080/09500693.2016.1193912>
- Mayring, P. (2004). Qualitative content analysis. In U. Flick, E. von Kardoff, & I. Steinke (Eds.), *A companion to qualitative research* (pp. 266–269). Sage Publications.
- Mazas, B., Fernández Manzanal, R., Zarza, F. J., & Adolfo María, G. (2013). Development and validation of a scale to assess students' attitude towards animal welfare. *International Journal of Science Education*, 35(11), 1775–1799. <https://doi.org/10.1080/09500693.2013.810354>
- Meier, D. P., Hauser, D. J., Robinson, M. D., Friesen, C. K., & Schjeldahl, K. (2007). What's "up" with God?: Vertical space as a representation of the divine. *Journal of Personality and Social Psychology*, 93(5), 699–710. <https://doi.org/10.1037/0022-3514.93.5.699>
- Morin, O., Simonneaux, L., Simonneaux, J., Tytler, R., & Barraza, L. (2014). Developing and using an S3R model to analyse reasoning in web-based cross-national exchanges on sustainability. *Science Education*, 98(3), 517–542. <https://doi.org/10.1002/sce.21113>
- Niebert, K., & Gropengießer, H. (2013). Understanding and communicating climate change in metaphors. *Environmental Education Research*, 19(3), 282–302. <https://doi.org/10.1080/13504622.2012.690855>
- Niebert, K., & Gropengießer, H. (2015). Understanding Starts in the Mesocosm: Conceptual metaphor as a framework for external representations in science teaching. *International Journal of Science Education*, 37(5-6), 903–933. <https://doi.org/10.1080/09500693.2015.1025310>



- Niebert, K., Marsch, S., & Treagust, D. (2012). Understanding needs embodiment: A theory-guided reanalysis of the role of metaphors and analogies in understanding science. *Science Education*, 96(5), 849–877. <https://doi.org/10.1002/sce.21026>
- Phillips, D. C. (2000). *Constructivism in education: Opinions and second opinions on controversial issues*. University of Chicago Press.
- Piaget, J. (1997). *The moral judgement of the child*. Simon and Schuster.
- Reiss, M. (2017). A framework within which to determine how we should use animals in science education. In M. P. Mueller, D. J. Tippins, & A. J. Stewart (Eds.), *Animals and Science education* (pp. 243–259). Springer.
- Reiss, M., & Harms, U. (Eds.). (2019). *Evolution education Re-considered: Understanding what works* (pp. 285–306). Springer Nature.
- Rohrer, T. (2005). Image schemata in the brain. In B. Grady & J. Hampe (Eds.), *From perception to meaning: Image schemas in cognitive linguistics* (pp. 165–196). Mouton de Gruyter.
- Tramowsky, N. (2019). *Moralvorstellungen zum Umgang mit Tieren. Die Entwicklung didaktisch rekonstruierter Lernangebote unter Anwendung der Metapherntheorie* [Moral conceptions about the handling of animals. The development of educationally reconstructed learning approaches using the Conceptual Metaphor Theory]. Carl-Auer-Systeme.
- Tramowsky, N., & Groß, J. (2018). Conceptions in the flesh: The educational moral metaphors system, using the example of meat consumption. In N. Gericke & M. Grace (Eds.), *Challenges in biology education research* (pp. 73–90). University Printing Office.
- Wehling, E. (2013). *Nation under joint custody: How conflicting family models divide US politics* [Doctoral dissertation, University of California at Berkeley]. University of California. Retrieved June 22, 2020, from [https://digitalassets.lib.berkeley.edu/etd/ucb/text/Wehling\\_berkeley\\_0028E\\_13309.pdf](https://digitalassets.lib.berkeley.edu/etd/ucb/text/Wehling_berkeley_0028E_13309.pdf)
- Zabel, J., & Gropengießer, H. (2015). What can narrative contribute to students' understanding of scientific concepts, e.g. evolution theory? *Journal of the European Teacher Education Network*, Vol.10, 136–146 URL: <https://jeten-online.org/index.php/jeten/article/view/74> .
- Zhong, C. B., & Liljenquist, K. (2006). Washing away your sins: Threatened morality and physical cleansing. *Science*, 313(8), 1451–1452.