Green classroom at the wildlife park:

Aspects of environmental, instructional and conceptual education of primary school children concerning the European wildcat.

Dissertation zur Erlangung des

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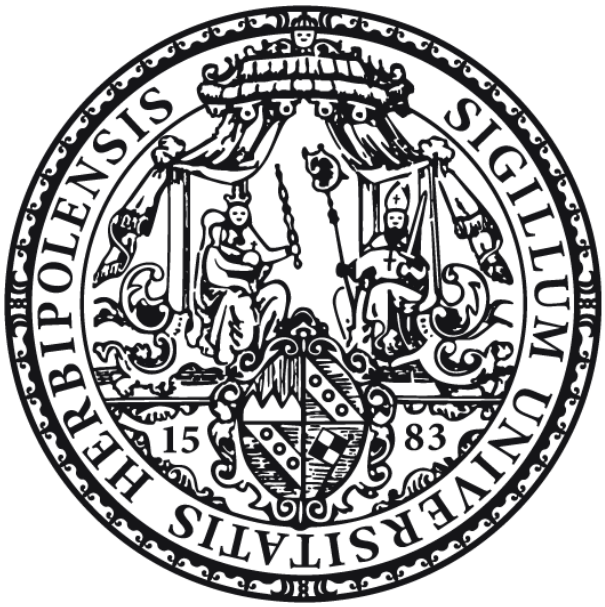

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Eingereicht am: ……..……..

<u>Mitglieder der Promotionskommission:</u>

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Content

Summary

To foster sustainable environmentally friendly behavior in children it is important to provide an effective form of environmental education. In this context we studied three important factors: Attitude towards nature, environmental knowledge and advanced expert knowledge.

Concerning attitude towards nature our first question was: “Is it possible to affect primary school children’s environmental values during a one-day visit at a wildlife park?” As a control, the program was also conducted in schools, leading to two different learning settings- wildlife park and school.

Regarding environmental knowledge, in our second question we wanted to know, if our modified teaching approach “guided learning at workstations” (G) combining instructional and constructivist elements would lead to good cognitive learning results of primary school children. Additionally, we compared it to a stronger teacher-centered (T) as well as to a stronger student-centered (S) approach.

The third question we asked was “Is it possible to convey fascinating expert knowledge on a more advanced subject to primary school children using conceptual change theory?” After gathering primary school children’s preconceptions, we defined different groups due to the heterogeneity of their pre-existing conceptions and the change in conceptions. Based on this research we designed a program along with an instrument to measure the impact of the conceptual change teaching method.

After years of building a strong cooperation between the section Didactics of Biology at the Julius-Maximilians University Würzburg, the nearby schools and the wildlife park “Wild-Park Klaushof” near Bad Kissingen in northern Bavaria it was time to evaluate the environmental education programs prepared and applied by undergraduate university students. As a model species we chose the European wildcat (*Felis silvestris silvestris*) which represents endangered wildlife in Europe and the need for human interaction for the sake of preserving a species by restoring or recreating the habitat conditions needed while maintaining current infrastructure. Drawing from our own as well as teachers’ and university students’ experiences, we built, implemented and evaluated a hands-on program following several workstations between the wildcat enclosure and the wildlife park’s green classroom.

The content of our intervention was presented as a problem-oriented lesson, where children were confronted with the need for human interaction in order to preserve the European wildcat. Not only on a theoretical basis, but very specific to their hometowns they were told where and when nature conservation groups met or where to donate money.

692 Bavarian third grade primary school children in 35 classes participated in the one-day intervention that took place between the months of april, 2014 and november, 2015 in the wildlife park or in their respective classrooms. The ages varied between 8 and 11 years with the mean age being 8.88 ± 0.56 years old. 48.6 % of them were boys, 51.4 % were girls.

(1) To measure primary school children's environmental attitudes a questionnaire on two major environmental values- preservation and utilization of nature- was administered in a pre, post- and retention test design. It was possible to affect primary school children's environmental preservation values during our one-day program. This result could be found not only at the wildlife park but unexpectedly also in school, where we educated classes for control purposes. We also found this impact consistent in all used teaching approaches and were surprised to see the preservation values change in a way we did not expect from higher tendency towards preservation of nature to a lower one.

We presume that children of this age group reflected on the contents of our intervention. This had an influence on their own values towards preservation which led to a more realistic marking behavior in the questionnaire. We therefore conclude that it is possible to affect primary school children's environmental values with a one-day program on environmental content.

(2) We were interested in conveying environmental knowledge about the European wildcat; its morphology, ecology and behavior. We designed and applied a knowledge questionnaire also in a pre-, post- and retention test design, to find out, whether different forms of instruction made a difference in learning success of primary school children.

We used two approaches with a teacher in the role of a didactic leader- our modified guided approach (G) as well as a stronger teacher-centered one (T) with a higher focus on instruction. The third approach was presented as a strong student-centered learning at workstations (S) without a didactic leader we also called "free learning at workstations".

Overall, all children's knowledge scores changed significantly from pre- to post-test and from pre- to retention test, indicating learning success. Differences could only be found between the posttest values of both approaches with a didactic leader (G, T) in comparison to the strong student-centered (S) form.

It appears that these primary school children gained knowledge at the out of school learning setting regardless of the used teaching approach.

On the subject of short-term differences, we discuss, that the difference in learning success might have been consistent from post to retention test if a consolidation phase had been added in the days following the program as should be common practice after a visit to an out-of- school learning setting but was not part of our intervention.

When comparing both approaches with a didactic leader (G, T), we prefer our modified guided learning at workstations (G) since constructivist phases can be implemented without losses concerning learning success. Moreover, the (at least temporary) presence of a teacher in the role of a didactic leader ensures maintained discipline and counteracts off-task behavior.

To make sure, different emotional states did not factor in our program, we measured children's situational emotions directly after the morning intervention using a short scale that evaluated interest, wellbeing and boredom. We found, that these emotions remained consistent over both learning settings as well as different forms of instruction. While interest and wellbeing remained constantly high, boredom values remained low.

We take this as a sign of high quality designing and conducting the intervention.

(3) In the afternoon of the one-day intervention, children were given the opportunity to investigate the wildcat further, this time using the conceptual change theory in combination with a more complex and fascinating content: cats' vision in dusk and dawn.

Children were confronted with their preconceptions which had been sampled prior to the study and turned into three distinctive topics reflected in a special questionnaire.

In a pre-, post and retention test design we included the most common alternative conceptions, the scientifically correct conceptions as well as other preconceptions.

We gathered a high heterogeneity of preconceptions and defined three groups based on conceptual change literature: “Conceptual change”, “Synthetic Models” and “Conceptual Growth”. In addition to these we identified two more groups after our data analysis: “Knowledge” and “Non-addressed Concepts”.

We found that instruction according to the conceptual change theory did not work with primary school children in our intervention. The conceptual change from the addressed alternative conceptions as well as from other preconceptions towards the scientifically correct conceptions was successfully achieved only on occasion.

In our case and depending on the topic only one third to one fourth of the children actually held the addressed conception while the rest was not targeted by the instruction. Moreover, we conclude children holding other conceptions were rather confused than educated by the confrontation. We assume that children of this age group may be overchallenged by the conceptual change method.

Zusammenfassung

Bildung für nachhaltige Entwicklung soll unter anderem dazu führen, dass Kinder langfristig umweltfreundliches Verhalten zeigen. Um dies zu erreichen, sind verschiedene Faktoren nötig - in dieser Studie lag unser besonderes Augenmerk auf drei Punkten: den Umwelteinstellungen der Kinder, dem umweltrelevanten Wissen, besonders im Hinblick auf die Lebensbedingungen und den Schutz der europäischen Wildkatze sowie weiterführendem, komplexeren, biologischen Wissen.

Zuerst fragten wir uns in Bezug auf die Umwelteinstellungen, ob es möglich ist, die Einstellungen der Grundschulkinder zum Thema „Erhaltung der Natur“ im Laufe nur eines Tages am Wildpark zu beeinflussen.

Umweltwissen war der Bestandteil der zweiten Frage, wie Grundschulkinder am außerschulischen Lernort gute Lernerfolge erzielen können. Wir testeten unseren modifizierten Ansatz „Geführtes Lernen an Stationen“ (G), der instruktionale und konstruktivistische Elemente beinhaltet und verglichen ihn einerseits mit einem stärker lehrerzentrierten (T) sowie andererseits einem stark schülerzentrierten (S) Lernen an Stationen, das wir auch als „freies Lernen an Stationen“ bezeichneten.

Die dritte Frage beschäftigte sich schließlich damit, ob es gelingen kann, faszinierendes, tiefergehendes Wissen mit Hilfe der „Conceptual Change Theorie“ an Grundschulkinder zu vermitteln.

Hintergrund der didaktischen Arbeit mit Grundschülern am außerschulischen Lernort Wildpark ist die Kooperation zwischen der Fachgruppe Didaktik der Julius-Maximilians-Universität Würzburg mit dem „Wild-Park Klaushof“ bei Bad Kissingen. Im Rahmen dieser Zusammenarbeit stellt die Fachgruppe Didaktik Biologie angehende Biologielehrerinnen und -lehrer als Referenten von Führungen gemäß des „Geführten Lernen an Stationen“ zur Verfügung. Diese Führungen wurden inhaltlich und didaktisch ebenfalls von Lehramtsstudierenden in der Biologiedidaktik ausgearbeitet, meist im Rahmen der schriftlichen Hausarbeiten gegen Ende des Lehramtsstudiums.

Die Führungen sind konstruktivistisch angelegt, bieten hohe Selbsttätigkeit der Schülerinnen und Schüler und folgen dem Prinzip des problemorientierten Unterrichts.
Die Schülerinnen und Schüler arbeiten nicht völlig frei, es handelt sich aber auch nicht um einen rein lehrerzentrierten Vortrag, sondern eine Mischung aus beiden Formen, die wir als „Geführtes Lernen an Stationen“ (G) bezeichnen. In dieser Variante stellt der Referent die

didaktische Leitung der Führung dar, der Impulse und Anleitungen gibt, immer für Fragen zur Verfügung steht, jedoch Anteile von Selbsttätigkeit ermuntert und begleitet.

Im Zeitraum von April 2014 bis November 2015 nahmen 692 Grundschulkinder der dritten Klassen bayerischer Grundschulen in 35 Klassen an der Studie am Wild-Park Klaushof sowie in ihren eigenen Klassenzimmern in der Schule teil. Durchschnittlich waren die Kinder 8.88 ± 0.56 Jahre alt, das Alter variierte zwischen 8 und 11 Jahren. 48,6 % der teilnehmenden Kinder waren Jungs, 51,4 % Mädchen.

Im Vormittagsteil des Programms wurde im Rahmen einer problemorientierten Unterrichtseinheit gemeinsam mit den Schülerinnen und Schülern die Frage aufgeworfen, warum die europäische Wildkatze (*Felis silvestris silvestris*), eine Zeigerart für intakte Ökosysteme, nicht überall vorkommt, wo sie vorkommen könnte. Gemeinsam wurden Aspekte zu Morphologie, Ökologie und Verhalten der Wildkatze erarbeitet; die Frage konnte jedoch auch dann noch nicht beantwortet werden.

Erst eine Verknüpfung der Verbreitungskarten und der gelernten Fakten führte zur Erkenntnis, dass die Wildkatze bestimmte Barrieren (Autobahnen, offene Wiesen- und Ackerflächen, bebaute Flächen etc.) nicht überwinden kann und hier der Eingriff des Menschen nötig ist. Nicht nur allgemein, sondern auch ganz konkret wurde der eigene Einsatz der Kinder, zum Beispiel im Rahmen der Mitarbeit in einer Naturschutz-Organisation oder einer Geldspende angeregt.

(1) Zur Messung der Umwelteinstellungen verwendeten wir das 2-MEV Modell (two major environmental factors), das die Umwelteinstellungen in zwei Dimensionen darstellt, zum einen die Tendenz zur Erhaltung, zum anderen die Ausnutzungstendenz der Umwelt.

Die Fragebögen wurden zu drei Testzeitpunkten ausgefüllt - einem Vortest ca. eine Woche vor dem Programm, einem Nachtest unmittelbar nach Beendigung des Programms und einem Behaltenstest etwa sechs bis acht Wochen nach dem Programm.

Die Umwelt-Einstellungen konnten tatsächlich verändert werden, nicht nur am Wildpark, sondern auch in der Schule, wo Klassen das Programm zu Kontrollzwecken ebenfalls durchliefen.

Auch blieb der Einfluss über alle verwendeten Lehrmethoden konsistent. Besonders überrascht waren wir von der Art der Änderung der Einstellungen zur Naturerhaltung.

Statt sich wie erwartet von schwächerer Tendenz zur Erhaltung in Richtung stärkere Tendenz zur Naturerhaltung zu ändern, erfolgte die Änderung genau entgegengesetzt.

Wir vermuten, dass die Kinder dieser Altersgruppe die Inhalte der Intervention reflektiert haben und dies einen Einfluss auf ihre Einstellungen zur Naturerhaltung hatte, was sich in einem realistischeren Ankreuzverhalten niederschlug.

Zusammenfassend sehen wir es als möglich an, die Einstellungen zur Umwelt von Grundschulkindern mit einem Ein-Tagesprogramm zu verändern.

(2) Auch für die Erhebung des Umweltwissens wählten wir die bereits erwähnten drei Testzeitpunkte für den Wissensfragebogen, der Fragen zur Morphologie, Ökologie und Verhalten der Wildkatze beinhaltete. Die Anzahl richtiger Antworten erhöhte sich vom Vor- zum Nachtest sowie vom Vor- zum Behaltenstest signifikant bei allen Schülerinnen und Schülern, es wurde also erfolgreich gelernt. Zwischen den einzelnen Führungsformen konnten wir signifikante Unterschiede nur kurzfristig vom Vor- zum Nachtest zwischen den beiden Methoden mit dem didaktischen Begleiter, also dem stärker lehrerzentrierten (T) und dem „Geführten Lernen an Stationen“ (G) einerseits und dem stark schülerzentrierten freien Lernen (S) andererseits erkennen. Der kurzfristige Wissenserwerb war mit didaktischem Begleiter (G, T) höher als ohne.

Insgesamt konnte also ein Lernerfolg verzeichnet werden, unabhängig von der Führungsform. Allerdings vermuten wir, dass der kurzfristige Unterschied sich auch mittelfristig ausgewirkt hätte, wenn im Anschluss an den Besuch im Wildpark eine Nachbereitung stattgefunden hätte, was gewöhnlich zum Besuch des außerschulischen Lernorts gehören sollte, jedoch nicht Bestandteil dieser Untersuchung war.

Vergleicht man die beiden Ansätze mit didaktischen Begleitern (G, T), bevorzugen wir nach wie vor unser „Geführtes Lernen an Stationen“ (G), da hier die Einbindung konstruktivistischer Phasen möglich ist. Darüber hinaus kann die (zumindest zeitweise) Anwesenheit eines Lehrers in der Rolle des didaktischen Begleiters sicherstellen, dass Disziplin gewahrt wird und Störungen vermieden werden.

Um die situationalen Emotionen der Schülerinnen und Schüler mit einbeziehen zu können, beziehungsweise Effekte von situationalen Emotionen auf Umwelteinstellungen oder Wissenserwerb ausschließen zu können, wendeten wir zusätzlich eine Kurzskala zur Erfassung von Interesse, Langeweile und Wohlbefinden an. Diese Skala wurde nur einmalig angewendet, direkt im Anschluss an das Vormittagsprogramm.

Wir konnten keine Unterschiede bei den erhobenen situationalen Emotionen finden - weder zwischen den Lernorten Schule und Wildpark noch zwischen den drei verschiedenen Führungsformen (G, T, S), überall zeigten sich hohe Werte für Interesse und Wohlbefinden sowie niedrige Werte für Langeweile.

Dieses Ergebnis zeigt für uns die hohe didaktische Qualität der Entwicklung und Durchführung des Programms.

(3) Am Nachmittag des Ein-Tages-Programms beschäftigten sich die Kinder weiter mit der Wildkatze, diesmal folgten wir einer anderen Methode der Wissensvermittlung, der „Conceptual Change Theorie“ in Kombination mit komplexerem und gleichzeitig faszinierendem Wissen zum Dämmerungssehen der Katze. Gemäß dem Prinzip der didaktischen Rekonstruktion wurden Wissensinhalte im Rahmen dieser Intervention nicht kontinuierlich erarbeitet wie im Vormittagsprogramm, sondern es fand eine Konfrontation der Schülerinnen und Schüler mit ihren eigenen Schülervorstellungen zum Thema Dämmerungssehen bei Mensch und Katze statt.

Diese Vorstellungen wurden vorab in einem offenen Fragebogen erhoben und in drei Themenschwerpunkte gegliedert, die sich anschließend im Fragebogen zur Erhebung des Konzeptwechsels widerspiegelten. Auch dieser Fragebogen wurde zu den eingangs erwähnten drei Testzeitpunkten angewendet. Gemäß der Theorie erwarteten wir im Ankreuzverhalten drei Gruppen: „Conceptual Change“, „Synthetic Models“ sowie „Conceptual Growth“. Darüber hinaus fanden wir zwei weitere Gruppen „Knowledge“ und „Non-addressed Concepts“.

Wir stellten fest, dass der Konzeptwechsel der Kinder von der wissenschaftlich nicht korrekten Schülervorstellung hin zur wissenschaftlich korrekten Vorstellung in unserer Intervention nicht gelang, nur punktuell kreuzten wenige Schülerinnen und Schüler das entsprechende Muster an. Auch der Wechsel in den anderen Gruppen hin zur wissenschaftlich korrekten Vorstellung funktionierte kaum. In unserem Fall hatten darüber hinaus je nach Thema nur ein Drittel bis ein Viertel der beteiligten Kinder überhaupt die adressierte Vorstellung, was unserer Meinung nach dazu führt, dass der Großteil der Kinder mit anderen Vorstellungen durch die Anwendung der „Conceptual Change Theorie“ eher verwirrt wurde. Wir vermuten, dass Grundschulkinder der dritten Klasse durch diese Form des Unterrichts überfordert sind.

1. Introduction

Our intention to enable cognitive learning success and education towards environmental sustainability at a wildlife park was well matched with the philosophy of the "Wild-Park Klaushof" near Bad Kissingen: to allow people, especially students hands-on access to wildlife in order to facilitate environmental education ("Bildung für Nachhaltige Entwicklung", BNE) which is rooted in the Bavarian Constitution (Bayerische Verfassung, Art. 131, Absatz 2).

The cooperation between the section Didactics of Biology at the Julius-Maximilians-University Würzburg and the wildlife park soon extended to the regional schools, leading to the project "NAWIK^2" (Naturwissenschaftliches Arbeiten im Wildpark Klaushof Kissingen), science-oriented education in the wildlife park. All parties signed binding cooperation agreements to secure rights and obligations. These signers are: The Julius-Maximilians University Würzburg, the city of Bad Kissingen, the regional school ministry and the principals of the regional schools.

Undergraduate university students develop programs for schools, other students serve as highly qualified guides for different educational programs on wildlife, for example the Eurasian lynx (*Lynx lynx*), Red deer (*Cervus elaphus*) or the European wildcat (*Felis sylvestris sylvestris*). Providing materials for the wildlife park "Wild-Park Klaushof" beneficial to conveying educational topics customized for all respective animals and curricula has been a focus of the section Didactics of Biology for the last ten years.

We assumed that quality of materials and education was ensured by the fact, that all students had already received years of didactical training at the University on their way to becoming science teachers and development of all programs was supervised by university lecturers.

It was our objective in this study to evaluate the impact of these programs in our one-day intervention, where we especially focused on three important aspects: affecting environmental values and teaching environmental knowledge while measuring situational emotions as well as instruction on advanced complex knowledge using the conceptual change theory of our target audience so far- third grade primary school children.

1.1 Outdoor education

Science education has many different aspects. There is a huge range of methods and angles and there is one I especially want to stress and examine- learning science outside of school, also known as outdoor education. Different definitions and categorizations have been made in the past and are still being made (e.g. Nundy, 2001; Rennie, 2007).

Out-of-school learning settings can be categorized in a lot of different ways. Once you leave the classroom with your students, you can experience formal or informal learning environments, informal being characterized as voluntary and not based on a curriculum (Rennie, 2007) like various exhibits about different topics in a museum.

Our objective was a formal one- we intended to transform the out-of-school learning setting wildlife-park into an outdoor classroom (green classroom) with a program that followed the school's science curriculum and provided didactic materials in addition to the learning opportunities provided by the outdoor learning setting's original encounters such as natural wildlife and habitat surroundings.

Studies have already shown cognitive learning success at out-of-school learning settings like botanical gardens (e.g. Sellmann & Bogner, 2012a; Wiegand, Kubisch & Heyne, 2013) and museums (Sturm & Bogner, 2010). We assume that original encounters, charts, posters and specially prepared materials allow an outdoor setting like a wildlife park to obtain qualities of a museum or otherwise prepared didactic and pedagogical setting.

Outdoor education is often shown in a positive context (e.g. Rios & Brewer, 2014; Waite, 2011), whereas we also were confronted with teachers' doubts concerning maintained discipline out of the classroom. We found few articles on disturbances and off-task behavior at the out-of-school learning setting (Brovelli, von Niedernhäusern & Wilhelm, 2011; Falk & Balling, 1982) which will be further discussed in Chapter 3).

1.2 The European wildcat

The European wildcat (*Felis silvestris silvestris*) is a carnivorous mammal of the cat family (*Felidae*), genus *Felis*. It is generally bigger than the domestic cat (*Felis catus*). There are no color varieties as in the domestic cat, the coat is grey brown with individual patterns of black stripes with a bushy, blunt-ending tail (black ending) with several black rings (Wildcatconservation.org).

Mating between Wildcat and domestic cat (*Felis catus*) is possible. The European wildcat serves as a model species for intact near-to-nature forest habitats. It avoids human dwellings and densely populated areas. Wildcats are considered solitary. Every territory must meet a minimum of requirements, especially shelter, open spaces within the forest to hunt prey such as rodents and birds as well as access to water. (Haltenorth, 1957)

Since it stalks its prey it has to be undisturbed by human activities and noise. In Germany, as well as in other European countries, the wildcat habitat is dissected, preventing individuals to seek new territories or range freely in their own territory without being harmed. The European wildcat is protected under national (Bundesnaturschutzgesetz, BNatSchG, Paragraph 7) as well as international European law (Anhang A der EG-Verordnung NR. 338/ 97 von 1996). It is also subject to habitat regulations according to "FFH- Richtlinie (Fauna-Flora- Habitat-Richtlinie) IV" (all online resources can be found at the end of the references).

The European wildcat is mostly active in dawn and dusk. Cats' eyes are relatively large when compared to the size of the skull. The eyes are located in the head in a way that they are directed towards the front and provide good stereoscopic vision. (Haltenorth, 1957)

While humans' pupils are small and round, cats' pupils are stenopeic when nearly closed and round and big when fully dilated. Moreover, cats' eyes are several times more photosensitive than those of humans. Not only does the physiological shape of the pupil allow more light into the eye, there are also more rods in total. (Haltenorth, 1957)

A special part of the eye's fundus area, the so called "tapetum lucidum", a choroideal structure close to the retina, presumably reflects light that has not yet stimulated the retina back into the scotopic receptor cells for a second opportunity to be absorbed (Bergmanson & Townsend, 1980). This structure was introduced to the primary school children as "reflective layer" (see figure 5, right; Appendix 8.2.3 figures 8 and 9).

1.3 Environmental values- the 2-MEV Model

Key factors of a successful environmental education have already been identified, for example system knowledge, action related knowledge and effectiveness knowledge as well as attitude toward nature (e.g. Bogner & Wiseman, 2004; Liefländer, Bogner, Kibbe & Kaiser, 2015; Roczen, Kaiser, Bogner & Wilson, 2013; Sellmann & Bogner, 2012b;). Roczen et al., 2013 illustrate the relations between different forms of knowledge, attitude towards nature and the general ecological behavior (see figure 1). Our focus was to increase environmental knowledge of primary school children using the special learning opportunity provided by original encounters at a wildlife park. This environmental knowledge includes three components shown in figure 1: Environmental System Knowledge (SYS), Action-Related Knowledge (ACT) and Effectiveness Knowledge (EFF).

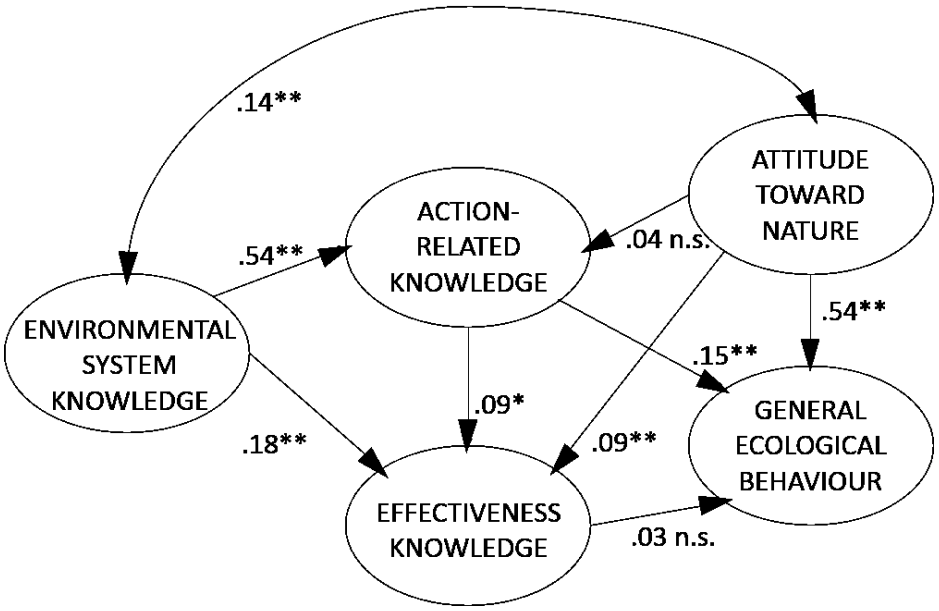

Figure 1: Proenvironmental competence in adolescents. Adapted from "A competence model for environmental education". by N. Roczen, F.G. Kaiser, F.X. Bogner and M. Wilson, 2013, Environment and Behavior 46 (8), p. 979.

Environmental education and outdoor ecology often try to promote conservation of nature as well as protection of the environment (Bogner & Wiseman, 2004). They also raise awareness towards the point, that measuring environmental perception, especially with adolescents, is very complex.

To record any possible changes in environmental values of the primary school children in our study, we used the 2-MEV (two major environmental values) - model by Bogner (Bogner and Wiseman, 2006). In this model, the factor ‘preservation’ represents a more biocentric attitude with high valuation of nature and preservation of resources. Man and nature are supposed to be rather equal. Opposed to this, the factor ‘utilization’ represents the more anthropocentric attitude, where man is supposed to rule and utilize nature. Both values are independent (Wiseman and Bogner, 2003).

The model has been cited and confirmed in numerous studies. It proves to be a valid instrument for measuring adolescents’ attitudes towards the environment (Boeve-de Pauw and van Petegem, 2011; Borchers et al., 2013; Johnson and Manoli, 2008; Milfont and Duckitt, 2004). Each dimension (preservation and utilization) consisted of ten items (see Appendix 8.1.1) with a five point Likert scale ranged from ‘strongly disagree’ (‘1’) to ‘strongly agree’ (‘5’) including an ‘undecided/neutral’ category (‘3’) (Bogner and Wiseman, 2004). The questions shown in the Appendix were translated by the author of this dissertation.

1.4 Emotions

Emotions play a significant role in learning and achievement (Mayring & Rhöneck, 2003). While enduring, so called “trait” emotions (Ulich & Mayring, 1992), are not easily affected by educational instructions, we focus on the current situational emotions (Mayring and Rhöneck, 2003; Randler et al., 2011) when evaluating our instruction.

Doing so, we follow the concept of distinguishing between students’ enduring ‘trait’ emotions and the ‘state’ emotions during the respective learning situation (Randler et al., 2011).

We applied a short scale (see Appendix 8.1.2) to evaluate three dimensions in state emotions- interest, wellbeing and boredom with three items each (Randler et al., 2011) and a five point Likert scale ranged from ‘strongly disagree’ (‘1’) to ‘strongly agree’ (‘5’) including an ‘undecided/neutral’ category (‘3’) (Bogner and Wiseman, 2004). The fact that the short scale proved to be sensitive to age and subject (Randler et al., 2011) was not a problem, since we did not vary age group or subject.

1.5 Learning

As an educator, facilitating learning processes is one major goal. I want to take a closer look on the neurobiology behind learning. According to Gekle et al. (2015), learning can be divided into associative and non-associative learning, the former being relevant in working with students, the latter being important for understanding basic processes. Non-associative learning means immediate response to a stimulus, for example the gill and siphon withdrawal reflex of Aplysia. This type of learning is restricted to reflexes. Three forms of response can be discerned: habituation, dishabituation and sensitization. Associative learning occurs, when a relation between two consecutive stimuli is established. It is based on emotional influences through the amygdala as well as reflexes facilitated by the cerebellum. Associative and non-associative learning are part of the non- declarative (implicit) memory, a part of which is also procedural memory, where motor skills are stored, for example motoric programmes that are involved in riding a bike. “Neural facilitation” (neocortex) is also a part of the non-declarative memory. Non-declarative memory is mostly independent from declarative memory and is located in the striatum, cerebellum and amygdala. (Gekle et al., 2015)

Furthermore, Gekle et al. (2015) state, that for learning to occur in the human brain we need memory. Sensory memory stores current sensory information very shortly until it is overwritten by new sensory impressions. Short term memory stores selective information for up to a few minutes (without repetition) in “chunks” of about seven. Working memory is a special type of short term memory. Our long term memory consolidates special information from short-term or working memory. The process of storing information in long term memory is facilitated by linking new information with information that is already stored and can be influenced by several physiological parameters, for example cortisol or endorphins. We distinguish two main categories of human long term memory: declarative (explicit) memory and non-declarative (implicit) memory. Declarative memory stores factual knowledge in form of semantic and episodic content. It is located mainly in hippocampus, gyrus parahippocampalis and prefrontal cortex. (Gekle et al., 2015)

Educational aspects of learning are discussed using learning theories that developed and changed throughout history, main ideas being behaviourism, cognitivism, and constructivism. The teaching methods used in this study use all these theories with a focus on constructivism.

1.6 The one-day program

After the permission for the study was granted by the regional school ministry, I found teachers who were willing to participate in our program and scheduled the visits. Also, parents' approval was obtained.

Prior to the pretests the open questionnaire for students' conceptions on the eye was applied (preliminary test, see Appendix 8.1.4). When all instruments had been completed, the pretests for the pilot classes started in the last week of april 2014. I visited all students in their respective classrooms to fill out the pretest questionnaires and gave them a first overview about the project day. I especially stressed the point, that the day at the wildlife park would be an educational one, students and teachers were instructed to treat the outdoor education like a regular day at school. Teachers promised to advise students to file all materials alongside the regular school materials on the subject. This was a first crucial step of ensuring a "formal" learning setting outdoors. The schedules for the one-day program can be obtained in Appendix 8.3.

Figure 2: Teacher and students at the wildlife park`s green classroom. Left: Instruction by teacher on wildcat habitats, right: students working self-sufficiently with the workbook (attached to clipboards) and the puzzle on the wildcat's hunting behavior (pictures were taken by Cornelia Schenk).

On the project day students and teachers arrived by bus usually between the hours of 7:30 and 8:30 am. At the gates of the wildlife park a short introduction took place on how to behave inside the park and basic rules were given to ensure a successful day for all creatures involved- students, teachers, free roaming and fenced animals, park personnel and other visitors.

Then the group made its way through the park towards the green classroom (see figure 2), a special building with seating accommodations and presenting materials (flip chart, whiteboard etc.).

The first part of the program - “Is there still hope for the wildcat” (see Appendix 8.3.1) started at the wildcat enclosure. As a motivation for students a wildcat was presented (see figure 3, left). To make sure of its presence, a special treat was given- mice instead of the usual chickens. This worked very well, often the wildcat would already appear at the fence while the introduction took place. In school this original encounter was made possible by stuffed specimens of a European wildcat and a domestic cat (see figure 3, right).

Figure 3: Original encounters. Left: European wildcat “Luna” at the wildlife park (picture taken by Andrea Heinle), right: stuffed specimens of wildcat and domestic cat on the desk at school (picture taken by Sabine Glaab).

Phenomenon orientation for students was implemented by use of special maps showing habitats, where the wildcat actually dwells and possible habitats that are uninhabited even when close to the inhabited ones (see figure 2, left as well as maps in Appendix 8.2.2).

This phenomenon generates the problem, why wildcats inhabit only certain possible areas and not others and why there is no habitation. Students suggested possible explanations, subsequently the plan to solve the problem was mapped out: we need to get acquainted with the wildcats’ morphology, ecology and behavior.

Workstation 1 conveyed the morphology lesson, station 2 the ideal habitat requirements and station 3 hunting and prey (see figure 4, left). Every important piece of information was stored in the workbook (see Appendix 8.2.1) all students had gotten beforehand. After repeating and consolidating the hunting phases, students played the role of wildcat and prey respectively and enacted the hunting process using masks (see Appendix 8.2.2). When the process was sufficiently practiced, children were allowed and encouraged to play with the masks making up their own rules or using no rules at all. After this break, the teacher emphasized on the prey being mostly mouse-species and rarely birds. By this time, students already knew many facts about the wildcat and their habitat demands but they weren't able to answer the main question yet.

To get to the answer, students were being presented with the maps from before. They recognized habitats to be suitable for the wildcat but still didn't know why some of the suitable habitats are uninhabited. To achieve this, two teams were formed, and students built two more or less identical suitable habitats by using natural materials (twigs, branches, stones etc.). The habitats were separated by a rug displaying houses and streets (see figure 4, right).

Almost instantly the children started building a bridge between the two habitats and realized, that human interaction is needed for connecting the habitats, not only in their model but also on the map. To consolidate the new insight, we played a habitat-game.

Options to engage in wildlife preservation were discussed, specific to children's hometowns, where and when nature conservation groups met, what projects they worked on, as well as suggestions, where to donate money.

Figure 4: Materials at the wildlife park. Left: the wildcat as a predator (picture taken by Hannah Heyland), right: an animal in need (picture taken by Sabine Glaab).

Instantly after the morning program (Intervention I), students completed the knowledge questionnaire on the European wildcat as well as the short scale for situational emotions.

The second part of the program- "Cats' vision in dusk and dawn" (Intervention II) took place after one hour of recess (see Appendix 8.3.2). Children were a bit tired but eager to learn more about their favorite topic of the day- the wildcat. This time we focused on the phenomenon of vertebrate vision in general, morphology of the cat's eye as well as vision in dusk and dawn and the fascinating differences between human and cat vision. We had already established after the preliminary test that students were well aware of the fact, that the wildcat has a better vision in conditions of reduced light than humans. Therefore, our objective was to find out, why.

The problem-oriented lesson of our second intervention revolved around the question why cats see better in dusk and dawn than humans and started in a conventional way of teacher-centered instruction to establish basic facts about the eye (see Appendix, 8.3.2).

Vision was a whole new topic for most of the children due to the fact that the "old" Bavarian curriculum for the third grade allowed teachers to choose between eye and ear as topic for senses and most classes had been previously instructed on hearing, not vision, since "the ear" would be completely excluded in the "new" Bavarian curriculum "Lehrplan Plus").

After learning about basic morphology and function of the eye's pupil by instruction and easy experiments the first alternative conception was targeted: "Humans are able to see in the darkness". Students were confronted with their own alternative conceptions, the conception was refuted and information was secured in the workbook.

After ensuring students' understanding that the pupil narrows and widens, the second alternative conception was targeted: "the iris allows us to see colors". Students were made aware of this by the provoking teacher's statement "A lot of you wrote, that the iris is there to see colors. Then somebody with blue eyes should only see blue". A picture was held up where everything is blue. The same picture was consecutively shown in two different variations - green and brown. Students reacted to this conception by understanding, that this can't be true. The conception was refuted, and the true function of the iris explained, taking up the established fact that the pupil can't get wider or narrower on its own and needs a structure around it to do this - the iris.

All new facts were written down into the workbook and the third alternative conception was targeted: “wildcats’ eyes shine in the dark”. Again, the teacher provoked a reaction by asking, if it really can be that wildcats’ eyes shine in the dark and supported this by holding up a picture of a cat`s eyes with “headlights” (see figure 5, left).
Again the conception was refuted and the scientifically correct answer presented with the help of a model of the cat’s eye reflecting light using a reflective tape (see figure 5, right as well as Appendix 8.2.3 figures 8 and 9).

Figure 5: Alternative conceptions on cats` vision in dusk and dawn and their refutation. Left: alternative conception, right: model of “reflective layer” (pictures taken by Andrea Heinle).

Directly following the completion of the afternoon part of the program (Intervention II), children answered the questionnaire on alternative conceptions (see Appendix, 8.1.5) as well as the 2-MEV scales (see Appendix, 8.1.1). After that the whole group took a tour through the wildlife park. Around 15:30 pm students headed home.

Table 1: Quasi-experimental design of the study: Groups of instruction. The teaching approach "Guided learning at workstations" (G) was applied at the wildlife park as well as in school. The other approaches only took place at the wildlife park (T, S).

Time	Teacher-centered (T)	Guided Learning (G)	Free learning (S)	Control
30 min	pre-tests knowledge, 2-MEV and conceptual change at school one week before intervention			
	Instructional unit preservation-specific content on wildcat (Intervention I)			
180 min (including a 30 min break)	Teacher-centered Instruction following workstations (teacher-centered)	Guided learning at workstations (student-centered guided)	Free learning at workstations (student-centered)	--
30 min	Post-tests knowledge and state emotions immediately after Intervention (I)			
60 min	break			
90 min	Alternative conceptions unit (Intervention II)			
30 min	post-tests 2-MEV and conceptual change			
30 min	retention tests knowledge, 2-MEV and conceptual change at school 6-8 weeks after intervention			

In the "old" Bavarian primary school curriculum for grade three (in effect in the years 2014 and 2015, replaced by the "new" Lehrplan Plus in the school year 2015/16) for the subject "Heimat- und Sachunterricht" the topic "forest animals" (3.5.2 Tiere des Waldes) was located in „animals and plants" (Tiere und Pflanzen, Lernfeld 7) and "living with nature" (Leben mit der Natur, 3.5). Children should be able to distinguish some animals by their appearance, name them correctly and depict relations between predator and prey using an example. The European wildcat fits this description perfectly and has been a popular subject for the last few years already. The need for human interaction when faced with preservation of nature can also be located in topic "significance of forests" (3.5.4 Bedeutung des Waldes). The optical sense is rooted in the topic "my body" (mein Körper, 3.2.1). Children should learn about the significance of the eye, its meaning and relevance as well as propagation of light (3.2.3 Optische Phänomene). Since all topics in the program where perfectly fitted for the Bavarian curriculum, the project day at the wildlife park could regarded as an outdoor classroom which was very appealing especially for teachers and headmasters.

1.7 Learning at workstations

Learning at workstations can be defined as a mode of presenting information on a topic as various stations with a free or set order and different possibilities to work as a group, in teams or alone (Pfeiffer, 2007). What students should learn could be regarded as a whole, while different shares of that whole are presented individually. The knowledge content of these shares should be acquired by students on their own. (Munser-Kiefer, 2014)

Different ways of structuring these workstations include “opening” them to free pick of order or social form as opposed to “closing” them with completely pre-structured tasks without any possibilities to choose (Munser- Kiefer, 2014).

Sturm & Bogner (2008) define learning at workstations as an educational approach, where students complete tasks in small groups at various workstations, therefore providing a cooperative learning environment. Berck & Graf (2010) state that learning at workstations usually starts with an introduction phase with students and teacher present. An overview should be given- how many workstations are there, order, content, information about the general procedure.

After completing the workstations students should be provided with a closing discussion, where results can be compared, the workstations can be reviewed, and metacognitive competences can be trained (Berck & Graf 2010). The teacher’s role changes. They are not superfluous but serve as an advisor, someone to set impulses. All three teaching approaches used in this study implement workstations with different degrees of student and teacher engagement (see Chapter 3).

1.7.1 Teacher-centered instruction (T)

The stronger teacher-centered approach (T, TW) was only applied at the wildlife park and is based on the cognitivist view of a provider and receiver of knowledge during the learning process. We root this approach in Blanchard et al. (2010) Level 0 (Verification). They state, that the teacher in this level of inquiry provides the student with the question to be investigated as well as the methods of data gathering. While conclusions are not immediately obvious to students, the teacher serves as a guide towards the expected solutions (Blanchard et al., 2010).

After meeting the wildcat, the teacher leads the students to a question, provides pieces of information necessary for answering said question while following several workstations. We assume the teacher in this stronger teacher-centered approach to also be a stronger "didactic leader" (Helmke, 2014). The teacher will help interpret the data (Blanchard et al., 2010) and after completing the workstations the question is answered and consolidated in the explorer workbook. "TW" stands for "teacher-centered approach at wildlife park".

1.7.2 Stronger student-centered approach (S)

The stronger student-centered approach (S) may also be regarded as a "free learning at workstations". It was only applied at the wildlife park and the only approach without a didactic leader. Students were presented with workstations that they completed without any help of the teacher. According to Blanchard et al. (2010), in inquiry Level 3 (Open) students generate the question and therefore take responsibility for all aspects of the investigation. Also, they did not have one assigned teacher in the role of a didactic leader for the day but rather undergraduate students making sure that everything worked according to schedule. This time, children checked the facts by themselves with the help of prepared answer cards.

1.7.3 Guided learning at workstations (G)

In this mixed approach, "guided learning at workstations" (G) that was applied at the wildlife park (GW) as well as in schools (GS), students also try to solve the question, only this time the teacher 's role changes from main "actor" to "accompanier". Still a didactic leader, the focus this time shifted from the teacher more towards children's self-sufficient working phases. While Blanchard et al. (2010) define their Level 2 (Guided) as 'students are responsible determining the method of investigation and how to interpret the results', we differ slightly, as the methods of investigation are given by the teacher. In this approach students work on the workstations more self-sufficiently, here the background is a fusion of cognitivism and constructivism. This time, students are forced to construct their own knowledge on the base of the materials provided. After completing each workstation, the information is discussed with all participating students as well as with the teacher (Heyne & Bogner, 2012). Our approach takes into consideration the fact that a certain structure is needed to keep the discipline and the right learning environment for all students.

1.8 Conceptual change

The constructivist view of learning, where students construct their knowledge in an active process (Wu & Tsai, 2005) emphasizes the fact that what students already know is very important throughout the learning process (Ausubel, 1968).

Learners' conceptions, their mental models of objects of events (Glynn & Duit, 1995), need to be addressed, especially if those conceptions differ from the scientific concept.

Strike and Posner (1982) propose four steps to foster a successful accommodation leading to a conceptual change (Kubisch & Heyne, 2015; Strike & Posner, 1982): There must be a "dissatisfaction with existing concepts". Secondly, the new conception must be intelligible. The third step should be, that the new, scientific conception has to appear initially plausible. As a fourth and last phase the conception should appear fruitful to solve further problems of the same or a similar kind (Strike & Posner, 1982).

We assembled our instructional phase based upon these four pillars using a practical approach by Petermann, Friedrich and Oetken (2008), "Das an Schülervorstellungen orientierte Unterrichtsverfahren", instruction using the conceptual change theory.

First we needed to get to know the alternative conceptions, then define the problem, refute and secure the new knowledge (Petermann, Friedrich, & Oetken, 2008). Considering reading and presenting skills in primary school children we used the confrontation with pictures (Franke & Bogner, 2011; Kubisch & Heyne, 2015) and a teacher-centered discussion during the refutation part instead of refutation text (Tippett, 2010).

We intended to create a "cognitive conflict" (Franke & Bogner, 2011; Limon, 2001) by confronting students with their own alternative conceptions in a context that would assure the initial perception of said alternative conception to be neither plausible, therefore not useful to solve the current problem, nor fruitful as a solution for future problems (Tippett, 2010). Our main focus was the expected heterogeneity of alternative conceptions and the resulting groups within our participating classes. These groups were conceptual change, synthetic models (Vosniadou et al., 2001) and conceptual growth (Tippett, 2010).

1.8.1 Constructing the preliminary test

To obtain students' alternative conceptions we followed Treagust (1988). Our first task was to define the content (Treagust, 1988). We investigated the main scientific concepts on human vision and the differences between humans' and cats' night vision on a third grade level following the curriculum for elementary schools. Then we collected possible answers in the literature (Çelikten, İpekçioğlu, Ertepınar, & Geban, 2012; Gropengießer, 1997; Guzetti et al., 1997; Kattmann et al., 1997).

To obtain information about students' misconceptions (Treagust, 1988) we created an open questionnaire. To get a high validity, we presented all students later to participate in the study with the test a few months after school had started to make sure to get their very own alternative conceptions not yet influenced by their science curriculum.

1.8.2 Constructing the diagnostic test

For test construction of the main diagnostic instrument to detect changes in conceptions we also followed Treagust (1988) with a slight alteration. We set out to "Defining the content" (Treagust, 1988) by analyzing the open questionnaires in regard to the main content we already defined prior to constructing the open questionnaire. The phase "Obtaining information about students' misconceptions" (Treagust, 1988) took place after carefully evaluating the open questionnaires. We coded the different conceptions into categories and counted the appearances of the most frequently named conceptions. We ranked the conceptions based on the frequency of their appearance. We singled out three major topics. For the development of our diagnostic test instrument later to be used in a pre-, post- and retention design for third grade students we decided not to use the two-tier method (Treagust, 1988) but merely the multiple-choice items constructed for the three major topics to avert confusion of the primary school children.

1.9 Statistics

Within the vast field of education, and therefore also in our study, one of the biggest challenges was looking into our students' heads and trying to measure personal values, knowledge and situational emotions in a way that would be scientifically significant and pedagogically meaningful. Tukey (1980) said it best when he stated on page 24: "Science […] does not begin with a tidy question. Nor does it end with a tidy answer." We carefully planned our design, randomized and used control groups. For all statistical calculations we used IBM SPSS 24.

Many conventions have already been made, for example when it comes to the matter of effect size. We calculated the effect size (r) according to Cohen (1988), based on number of cases (N) and z-scores (z) and followed the convention to assume a small effect with 0.10, a medium one with 0.30 and with 0.50 a large effect (Liefländer et al. 2015). There is also the concept of educational significance when effect sizes exceed 0.25 (Scharfenberg & Bogner, 2013).

$$r = \frac{z}{\sqrt{N}}$$

We started a pilot of our study with 5 classes (n= 91 students) before the actual intervention to test the instruments and make sure all materials and infrastructure were in order. The actual intervention consisted of 35 classes with 599 (out of 692) students who completed all respective questionnaires.

Since all our data stems from third grade primary school children in elementary schools around the same region - Bad Kissingen, Northern Bavaria, and students had to be educated in distinct entities - their respective "classes" due to scheduling of transportation, leave of school and maintaining of discipline, we had to make sure our samples were as randomly selected as possible. Therefore, classes were randomly assigned by means of a dice to different treatment groups. Technically, we make a difference between two samples- Intervention I and Intervention II (see table 1), while in reality some students will appear in both samples and some only in one sample.

To find out, whether our data fit the criterion for a normal distribution, we used Kolmogorov-Smirnov testing as well as graphical tools. In all conducted samples, we reached the conclusion, that we have to assume our data to be non-parametric (Lienert und Raatz, 1998). To determine, if our non-parametric data of independent samples stems from the same distribution, we used the Kruskal-Wallis test (more than 2 samples), the Mann-Whitney U-Test (2 samples) and for two related samples the Wilcoxon signed-rank test.

Our test design was quasi-experimental and based on hypotheses. When we saw fit, we tried explorative correlations to get a clearer view of the data. For determining possible linear dependences, we used the Spearman correlation coefficient with bootstrapping.

To test the reliability of our instruments, we computed Cronbachs α (Field, 2013; Cronbach, 1951).

For the Likert-scale instruments, we also checked factor loadings on the respective dimensions and percentage of explained variance (see Appendix 8.1.1).

All values are given in the form mean ± SD (standard deviation)
Standard deviation is defined as the root of the variance, with the variance being the average square deviation of all values from the arithmetic mean.

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2. Environmental Values
Green classroom vs. classroom: Influence of teaching approaches, learning settings and state emotions on environmental values of primary school children

2.1 Abstract

We evaluated environmental values of primary school children during a one-day program at a wildlife park and compared the outcomes concerning two different forms of instruction (teacher-centered, student-centered) as well as two different surroundings of learning settings (wildlife park, school) while observing state emotions. 441 primary school children (average age 8.87 ± 0.56 years) learned about the importance of preserving the habitat of the European wildcat. A questionnaire based on an established model was administered. Students' preservation values changed significantly at the wildlife park as well as at school with no significant differences between forms of instruction and state emotions overall.

2.2 Introduction

Forests and their wildlife are a part of the curriculum for the third grade in German primary schools. Children should get to know domestic and wildlife animals and their habitats for different important reasons. The Bavarian constitution promotes not only an education towards responsibility concerning nature and environment but also towards appreciation for nature and wildlife and building of character. Students should learn to appreciate the region they live in, value its living things and acknowledge the need to preserve these (ISB, 2014). The Bavarian ISB (Institute for School Quality and Educational Research) understands the conveying of these values as an important step towards a peaceful coexistence and social equity (ISB, 2014).

Environmental education programs target enhancing knowledge as well as environmental attitudes and as a result intend to foster environmentally friendly behaviour (Byrka et al., 2010; Kaiser et al., 2008; Sellmann and Bogner, 2012b).
Education towards sustainability and environmental education has received considerable attention, therefore our objective at the section Didactics of Biology at the University of Würzburg over the last years, beginning in 2008, has been to build and maintain a strong

cooperation between the wildlife-park Klaushof near Bad Kissingen as an ideal background for original encounters, the nearby schools and university students studying to become teachers. We used the experiences drawn from these educational visits to construct a one-day program to address practical disadvantages of longer interventions.
A large body of research has already shown the learning setting does have an impact on environmental values (Borchers et al., 2013; Sellmann and Bogner, 2010), therefore we partly designed our intervention as a comparison between different learning settings. To control the influence of state emotions at different learning settings, we measured boredom, wellbeing and interest in all settings.

Not only the learning setting, but also the form of instruction has an impact on environmental values (Boeve-de Pauw and van Petegem, 2011; Liefländer et al. 2015). Education towards environmental values works. Since environmental values can be influenced by lessons, our following question was, how to convey our lesson: more teacher-centered, or more constructivist motivated, student-centered. In order to reduce the effect of different teachers on different forms of instruction, all instruction parts were given by the same teacher, a member of our workgroup, who was unknown to all students. According to Hattie (2012), teachers' beliefs and commitments are great influences on student achievement. We focused especially on the need for human interaction when faced with the issue of preservation of an endangered species such as the European wildcat (Felis silvestris silvestris).

2.3 Objective

Our new perspective is to focus on primaryschool children as well as close the gap of effectivity of short out-of-school environmental programs. Usually, these programs last more than two days (Liefländer et al., 2013; Johnson and Manoli, 2008) which leads to difficulties in today's tight curriculum. The second emphasis was methodologically on the influence of different teaching approaches on environmental values in an out-of- school learning setting that makes it possible and practicable for children to experience ideal habitat conditions in healthy surroundings and affect their environmental values positively. We wanted to explore whether a stronger focus on a constructionist method (guided learning at workstations) conveys the environmental message more sustainably than a more teacher-centered approach. To be able to control additional factors, value data was collected in school using the student-centered guided learning at workstations as well as children's state emotions at both venues.

2.4 Hypotheses

(1) The need for humans to preserve rather than utilize nature was implied in the program and intensified by the surrounding ideal conditions in the wildlife park. Based on this account, we expected preservation values to increase significantly, when compared before and after the program at the wildlife park.

(2) The instruction method at the wildlife park should have an impact on students' environmental attitudes. We assumed a higher constructivist approach (guided learning at workstations) would increase understanding, since the respective environmental attitudes would be conveyed better by a student-centered guided approach than a teacher-centered one.

(3) When comparing the constructivist motivated guided approaches (student-centered) at the wildlife park and school (as control) we predicted higher preservation values at the wildlife park. Also, we expected boredom values to be lower with higher interest and wellbeing values at the wildlife park.

2.5 Methods

2.5.1 Student sample

The study took place during the school year 2013/2014. Most of the 441 participating students were in the second term of grade three. 51% were girls. At the time of the program, students' age ranged from 8 to 11, mean age being 8.87 ±0.56 years old. Age was not analysed as a variable to the homogeneity of our sample (Bogner and Wiseman, 2004). The participating classes were assigned randomly to the different approaches. 141 children participated in the teacher-centered approach at the wildlife park (TW), 163 in the student-centered instruction guided learning approach at the wildlife-park (GW) and 137 experienced the guided learning approach (GS) in their respective classrooms in school.

2.5.2 Test design and instruments

We used two questionnaires at three different testing times. The questionnaire based on the 2-MEV model (2 major environmental values) consisted of ten questions relevant to the 'preservation' of nature as well as ten questions on 'utilization' of nature (Bogner and Wiseman, 2004). The short scale to document state emotions consisted of 9 questions (Randler et al., 2011). In both instruments, all items were scored on a 5-point Likert scale that ranged from 'strongly disagree' representing the value '1' to 'strongly agree' representing the value '5' and included an 'undecided/neutral' category (representing the value '3' (Bogner and Wiseman, 2004). State emotions were tested once – right after the intervention (post-test). The 2-MEV questions were presented one week before the program (pre-test) and again six to eight weeks later (retention test). 441 Students completed all questionnaires. We assured them of their anonymity and instructed them to answer truthfully and on their own.

2.5.3 Measuring environmental values- the 2-MEV Model

To record the alleged changes in environmental values we used the 2 major environmental values-model by Bogner (Bogner and Wiseman, 2006). In this model, the factor 'preservation' represents a more biocentric attitude with high valuation of nature and preservation of resources. Man and nature are supposed to be rather equal. In contrast, the factor 'utilization' represents the more anthropocentric attitude, where man is supposed to rule and utilize nature. Both values are independent (Wiseman and Bogner, 2003). The model has been cited and confirmed in numerous studies. It proves to be a valid instrument for measuring adolescents' attitudes towards the environment (Boeve-de Pauw and van Petegem, 2011; Borchers et al., 2013; Johnson and Manoli, 2008; Milfont and Duckitt, 2004). Each dimension (preservation and utilization) consisted of ten items with a five point Likert scale. The questions were translated by the authors of this article.

2.5.4 Measuring emotions: a short scale

Situational emotions play an important role in learning (Randler et al., 2011; Mayring and Rhöneck, 2003). We follow the concept of distinguishing between students' enduring 'trait' emotions and the 'state' emotions during the respective learning situation (Randler et al., 2011). We applied a short scale to evaluate three dimensions in state emotions- interest, wellbeing and boredom with three items each (Randler et al., 2011) and a five point Likert

scale ranged from‘strongly disagree’ (‘1’) to ‘strongly agree’ (‘5’) including an ‘undecided/neutral’ category (‘3’) (Bogner and Wiseman, 2004). The fact that the short scale proved to be sensitive to age and subject (Randler et al., 2011) was not a problem, since we did not vary age group or subject.

2.5.5 Content, venue and teaching approaches of the educational program

The program was developed at the section Didactics of Biology at the University of Würzburg on the base of programs already developed by undergraduates. Teachers and scientists were involved in the process. As a motivation for students a living wildcat is presented in its enclosure at the wildlife park, as we especially stressed the principle of original encounters (Bogner and Wiseman, 2004). Phenomenon orientation is implemented by use of special maps showing inhabited and possible habitats that are uninhabited. This phenomenon generates the problem, why wildcats inhabit only certain areas that fulfil habitat requirements and not others, and what exactly determines the selection of habitat. Students suggest possible explanations, subsequently the plan to solve the problem is mapped out: they have to get acquainted with the wildcats’ morphology, ecology and behaviour. To get to the answer, students are being presented with the maps from before. They recognize habitats to be suitable for the wildcat but still don’t know why some of the suitable habitats remain uninhabited. Students then build two identical suitable habitats by using natural materials or word/picture cards. The habitats are separated by a rug displaying houses and streets. Almost instantly the children start building a bridge between the two habitats and realize, that human interaction is needed in order to connect the habitats thus preserving the wildcat. For control purposes, the program was similarly implemented in school using pictures or taxidermized specimens instead of real objects. In order to avoid influences of different instructors, all instructions were given by the same teacher throughout the study.

2.5.6 Teacher-centered instruction (TW)

One group at the wildlife park (TW) was presented with a teacher-centered approach based on the cognitive view of a ‘provider’ and ‘receiver’ of knowledge during the learning process. After meeting the wildcat, the teacher serves as a lecturer and leads the students to the problem specified above, provides pieces of information necessary for solving the

problem while following through several workstations together. After completing the workstations, the learning objectives were consolidated in a workbook.

2.5.7 Student-centered instruction guided learning at workstations (GW, GS)

Another group at the wildlife park (GW) as well as the school group (GS) also tried to solve the question, only this time the teacher's role changes from lecturer to facilitator. This time students worked at the workstations more 'self-sufficiently' with a stronger focus on constructivism. Students are forced to construct their own knowledge on the basis of the materials provided. However, it was important to us that the teacher was involved in every workstation's consolidation phase to ensure individual and common accuracy and understanding. This special guided approach takes into consideration the fact that a certain structure is needed to keep the discipline and the right learning environment for all students.

2.6 Statistical analysis

Missings were deleted listwise, meaning that students who completed only one test were not included in the statistical analysis. When testing our data using Kolmogorov-Smirnov testing as well as graphical tools we reached the conclusion that we have to assume our data to be non-parametric (Lienert and Raatz, 1998). To find out if our non-parametric data of independent samples stems from the same distribution, we used the Mann-Whitney U-Test and the Wilcoxon signed-rank test for related samples. For determining possible linear dependences, we used the Spearman correlation coefficient with bootstrapping. Cronbachs α was computed in order to test reliability of the instruments we used (Field, 2013). The effect size r was calculated and interpreted according to Cohen (1988) with 0.10 as a small effect, with 0.30 as a medium effect and with 0.50 as a large effect (Liefländer et al., 2015). Construct validity of the 2-MEV instrument was checked and confirmed. Due to their factor loadings, all items matched their respective dimension. (Boeve-de Pauw and Van Petegem, 2011). The instrument shows Cronbachs $\alpha = 0.796$ for preservation and 0.685 for utilization.

2.7 Results

2.7.1 Environmental Values

Preservation and utilization values as well as emotions were measured using a five-point Likert scale, and tabulated using the mean scores. Our program targeted the preservation component, not the utilization values. Therefore, since we found no meaningful results as could be expected, after careful consideration the utilization values were excluded.

Group as a whole

Taking a look at the data as a whole (combining all venues and forms of instruction), children were affected by the intervention. Preservation values changed from pre-test 3.89±0.72 to retention test 3.66±0.81, Wilcoxon signed rank test p=0.000 **, r=-0.361. A closer look is shown below.

At the wildlife park

In group comparison different instruction methods

We were especially interested in the change of preservation values at the wildlife park. Therefore, we tabulated mean values and measured the difference between pre-test and retention test. In table 1 we show that the effects for dropping preservation values from pre- to retention test happen in all approaches. Lower scores represent less tendencies towards preservation.

Table 1: Preservation: Values for Wilcoxon-Tests (p-values and effect sizes) as well as mean values and standard deviation (SD) are shown at both instructional approaches at the wildlife park (TW, GW) plus student-centered guided approach in school (GS)

	TW		GW		GS	
Preservation	p-value	effect size	p-value	effect size	p-value	effect size
pre-test to retention test	0.000	0.432	0.003	0.236	0.000	0.427
mean values	mean ± SD		mean ± SD		mean ± SD	
pre-test	3.902 ± 0.748		3.865 ± 0.748		3.942 ± 0.644	
retention test	3.583 ± 0.804		3.715 ± 0.820		3.667 ± 0.813	

Between groups comparison

When comparing the retention tests between the approaches, we find no significant differences regardless of venue and form of instruction. Mann-Whitney tests show p=0.127 between TW and GW, p= 0.635 between TG and GS and p=0.379 between TW and GS.

2.7.2 Emotions

Between group comparison

In table 2 as well as in figure 1 the mean values of all experimental groups are shown as well as the differences in values at different approaches and venues. Boredom mean scores were relatively low overall, with corresponding high interest and wellbeing values.

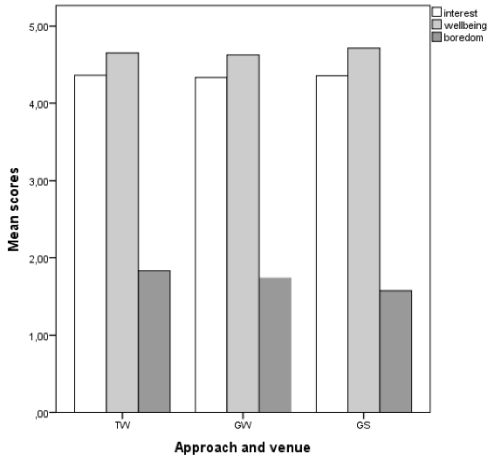


Figure 1: State emotions at different approaches and venues

Table 2: State Emotions: p-values for Mann-Whitney U-Tests between both approaches at the wildlife-park (TW vs. GW) and guided learning at both venues (GW vs. GS) as well as mean values and standard deviation (SD) for boredom, interest and wellbeing overall are shown.

		TW vs. GW	GW vs. GS
	mean ± SD	p-values	p-values
bore	1.716 ± 0.950	0.751	0.053
interest	4.349 ± 0.784	0.563	0.890
wellbeing	4.662 ± 0.669	0.606	0.210

Correlations Emotions and Environmental Values after the program

While there are no significant differences in emotions overall between different venues and approaches, we can find overall correlations (Spearman-Rho) between state emotions in the post test and preservation values in the retention test as follows: boredom: -0.263, interest:0.383 and wellbeing: 0.303.

2.8 Discussion

Programs that aim at conveying environmental education towards children and adolescents usually affect components of environmental awareness and connectedness with nature, especially those programs targeting primary school children (Bogner and Wiseman, 1999; Liefländer, 2013). Our one-day program on the preservation of the European wildcat indeed had an impact on environmental values. Our objective to close the gap on efficacy of short-term programs was therefore reached. When we compared the environmental values one week before the program to the ones six to eight weeks later, we found changes concerning the preservation factor. Contrary to our first hypothesis, where we predicted a change from lower to higher ones, preservation values seem to have changed 'for the worse'. This effect could be discerned within the group as a whole, at both instructional approaches at the wildlife park as well in both venues. Most researchers to date found the opposite effect – an increase of preservation values (Sellmann & Bogner, 2013), therefore we took a closer look on this unusual outcome. Drissner at al. (2010) found a similar unfavourable change and assumed a more critical approach to the questions when asked a second or even a third time after having had ample time to ponder the effects to be possible reasons for this outcome. As an example they present the question, whether students would donate pocket money to save the environment (Drissner et al., 2010).

We share this assumption and take it a step further. In our opinion, the changes signal real involvement of students in how to define their own responsibilities. Beforehand, the rather commonplace questions 'Would you collect garbage in your spare time or 'Would you join an environmental group' were probably answered in a way that students assumed to be more socially accepted. Later on, after having experienced the personal consequences, the questions were far more specific. The children realised, that it was in fact their own allowance money, spare time and effort that would help preserve endangered species, not just any people in general. It is one thing to generally favour socially desirable actions but quite another to actually devote your own time and money to that cause.

Uzzell et al. (1995) raise awareness towards the fact that although there is a concern for the environment, the transition from concern to action is often lacking. During our program very distinct ways to help were shown, environmental groups in students` hometowns were addressed, names of people to contact, sometimes even classmates or other

kids from school who had already joined environmental groups. We conclude this seemingly unfavourable but meaningful result to show the impact of our intervention.
As already stated in the introduction, environmental awareness is high in the Bavarian education system. We therefore assume that students entered the program at a high level of environmental awareness, heightened by the fact that the contents of the third grade curriculum which formed the base of our program, especially stresses on the environment.

Comparing the results to Bogner (1998), Drissner et al. (2010) concluded the need for a longer intervention period. On the other hand, despite their program lasting five days and four nights, Johnson and Manoli (2008) found a similar decrease within one of the primary factors of preservation 'intent of support'. They are not sure how this happened but point out, that they worked with younger kids (10-11 years of age) than is usually the case when applying the MEV model. They assumed the environmental perceptions of younger students to be 'more amenable to change' (Johnson and Manoli, 2008). We disagree and state that the one-day program already affects primary school children in a realistic assessment of environmental consequences.

Oerke and Bogner (2011) discuss social desirability as a potential bias in the self-reported measurement of environmental attitude and behavioural assessment. Within their study, they find a positive relation between social desirability and preservation values (Oerke and Bogner, 2011). Therefore, social desirability probably plays a role in our outcome, especially when concerning the high values (possible ceiling effect) in the pre-test (Liefländer and Bogner, 2016). A similar unfavourable decline in attitudes toward preservation was found after a short-term-program by Drissner et al. (2010) and before by Haase (2003). Drissner et al. also suspected socially desirable answers.

Moreover, Hattie (2012) summarizes the great influence a teacher's beliefs and commitments have on learners. This also may have been the case here, since all instructions were given by the same teacher.

Taking a look at our second hypothesis, we did not find a greater influence of the student-centered approach on preservation as opposed to the teacher-centered one at the wildlife park. Only when comparing the differences between pre- and retention tests at the different instructional approaches at the wildlife park, we found a significance with a small

effectsize showing slightly higher but negligible influence of the guided approach. Many studies show a positive influence of constructionist motivated teaching approaches (Heyne and Bogner, 2012; Kubisch and Heyne, 2013; Sturm and Bogner, 2010). Presumably important factors like original encounters, natural experiences, researcher as teacher and materials provided at the out-of-school learning setting lead to high motivation and learning results (Drissner, 2010; Wiegand, Kubisch and Heyne, 2013) regardless of the instructional method. High overall positive state emotions in our study add to this.

In our third hypothesis we assumed the guided approach to have a greater impact on preservation values at the wildlife park compared to the schools but we found no significant differences. The venue of our program seems to have no significant influence on preservation values. In this case also the teacher effect could be taken into consideration.

Regarding students' state emotions, we predicted higher interest and lower boredom values at the out-of-school learning setting as well as in the higher constructivist approach. We were surprised to see, that state emotions as measured with the short scale developed by Randler et al. (2011) did not differ between settings and instructional methods. Presumably this is due to the fact, that the usual instructional pattern was opened up both at the wildlife park as well as in the school. Usual structures were changed and a new teacher was introduced (David-Lang, 2013). Additionally, the program contains high amounts of self-activity, hands-on work and playful securing of knowledge that probably leads to high motivation and interest in all approaches and venues. (Sturm and Bogner, 2010; Schaal and Bogner, 2005).

When exploring the correlations between emotions and environmental values, we found that higher values in wellbeing and interest as well as lower values in boredom were correlated with 'better' preservation values (Boeve-de Pauw and van Petegem, 2011). Less bored and more interested students leaned more towards preservation of nature, at the wildlife park as well as in school. A similar effect could be shown in Fröhlich, Sellmann and Bogner (2013).

"Focus wildlife park: outdoor learning at workstations for primary school children" by Sabine Glaab and Thomas Heyne, published by Taylor & Francis Group in Applied Environmental Education and Communication on 08/01/2019, available online: http://www.tandfonline.com/10.1080/1533015X.2018.1554461

3. Environmental Knowledge
Focus wildlife park: Outdoor learning at workstations for primary school children – a recipe for disaster?

3.1 Abstract

268 children (age 8,75 ± 0.65) spent one day at a wildlife park studying facts on the preservation of the European wildcat. Our objective was to evaluate a teaching approach combining constructivist and instructional characteristics, guided learning at workstations (G), to ensure cognitive achievement alongside high motivation and maintained discipline. To test the efficacy, we compared it to a teacher-centered approach (T) as well as to a student-centered one we named 'free learning at workstations' (S). Our results show that the approaches with didactic leaders (T and G) show higher knowledge values while state emotions did not differ between approaches.

3.2 Introduction

In order to foster sustainable environmental action in children it is important to provide an effective form of environmental education. Key factors of a successful environmental education have already been identified, for example system knowledge, action related knowledge and effectiveness knowledge as well as attitude toward nature (e.g. Bogner & Wiseman, 2004; Liefländer, Bogner, Kibbe & Kaiser, 2015; Roczen, Kaiser, Bogner & Wilson, 2013; Sellmann & Bogner, 2012). Roczen et al., 2013 illustrate the relations between different forms of knowledge, attitude towards nature and the general ecological behavior (see figure 1). Our focus was to increase environmental knowledge including the types of knowledge mentioned above of primary school children using the special learning opportunity provided by original encounters at a wildlife park. This environmental knowledge includes three components shown in figure 1: Environmental System Knowledge (SYS), Action-Related Knowledge (ACT) and Effectiveness Knowledge (EFF).

We compared different teaching approaches and their effects on learning success on morphology, ecology and preservation of the European wildcat, situational emotions as well as maintaining an effective outdoor learning experience at a wildlife park regardless of distractions by the living nature surrounding the primary school children and their teachers.

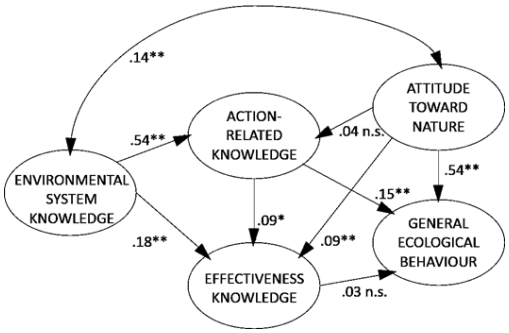


Figure 1: Proenvironmental competence in adolescents. Adapted from "A competence model for environmental education". by N. Roczen, F.G. Kaiser, F.X. Bogner and M. Wilson, 2013, Environment and Behavior 46 (8), p. 979. Numerical values are standardized multiple regression coefficients, factor loadings or a Pearson correlation coefficient (double-headed arrow) indicating strengths of relations.

Our intervention took place at an environmental educational center: The wildlife park "Wild-Park Klaushof". Over the last years, starting in 2008 we built and maintain a strong cooperation with this park. From 2014 until 2018 198 undergraduate guides educated 3379 children in 205 classes on subjects with environmental background.

3.3 Objective

Our objective was to study how primary school children can obtain good cognitive learning results at the out-of-school learning setting wildlife park while feeling well and being interested in learning as well as focused on the topic without distractions and at the same time how to limit off-task behavior in an out-of-school learning environment when applying constructivist components during an educational intervention. So far studies already have shown good cognitive learning results using conventional learning at workstations for students at out-of-school learning settings such as museums (Sturm & Bogner, 2010) and botanicals gardens (Sellmann & Bogner, 2012a; Wiegand, Kubisch & Heyne, 2013).

Discipline problems, lack of cognitive learning results and constant distractions by wildlife seemed to be the main concerns of most participating teachers when applying constructivist teaching approaches. We wanted to address teachers' fears and find a solution on how to overcome them using our 'guided learning at workstations' (G) with the combination of constructivist and instructional aspects.

Thus we transferred our good experiences with the modified 'guided learning at workstations' with low achievers in the classroom (Heyne & Bogner, 2012) to the out-of-school learning setting wildlife-park.

For our current study we provided the same learning environment at a wildlife park as well as three different teaching approaches during our educational intervention on the European wildcat Felis silvestris silvestris. Sturm & Bogner (2008) found higher achievement scores in a teacher-centered and higher motivational ratings in the student-centered approach, therefore we did not only measure cognitive achievement but situational ("state") emotions as well when comparing the modified approach (G) to a stronger teacher- (T) and student-(S) centered one.

3.4 Hypotheses

(1) We expected the modified approach G 'guided learning at workstations', a combination of alternating phases of stronger guidance as well as independent learning, to lead to better results in the cognitive knowledge questionnaire than S (free learning at workstations) or T (teacher-centered) at the out-of-school learning setting wildlife park.
(2) We predicted students' boredom values should decline while interest and well-being values should increase with decreasing focus on the teacher (T-G-S).

3.5 Out-of-school learning setting wildlife park- pros and cons

This study took place at the out-of-school learning environment wildlife park. It is important to factor in the specifics of this place of learning as opposed to a classroom or other out-of-school learning- environments such as laboratories, museums, specially designed exhibitions or science fairs. In general, Esser (1969) defined education at out-of-school learning settings as all biological education endeavours purposefully and systematically looking for original encounters with the biological environment. Since then, a lot of similar definitions have been given while the main statement remains. Nundy (2001) states that outdoor teaching encourages students in a way that a classroom setting can't. Moreover, Scharfenberg, Bogner and Klautke (2007) compared one pedagogical approach at a classroom to an out-of-school setting and found higher cognitive learning results in the latter. We therefore assume the learning setting to have an impact on cognitive results.

Throughout the relevant literature, outdoor science learning is shown in a very positive context. (e.g. Rios & Brewer, 2014; Waite, 2011). Yet when talking to the teachers participating in our study and discussing the probability of spending a school day at a wildlife

park in order to achieve cognitive learning success we came across several reservations. A few of these concerns can be found in Brovelli, von Niederhäusern & Wilhelm (2011), who address potential disturbances and their prevention at an out-of-school learning setting. Falk & Balling (1982) mention higher cognitive load resulting in off-task behavior like attention deficiencies or aggressive behavior. We don't want to stress negative effects but care to address teachers' concerns to make sure, order and discipline as well as high interest and wellbeing at the out-of-school learning setting can be achieved with cognitive learning success on top.

Klahr and Nigam (2004) contrast inquiry-based learning being not as effective as direct instruction. This, as stated above, is a fear, teachers often have, but Blanchard et al. (2010) show that a guided inquiry-based learning results in increased learning and good retention of knowledge. In a quantitative study with 1700 middle school and high school students they found higher knowledge scores and long-term retention in the guided inquiry-based unit compared to a teacher-centered instruction. They were interested in Conceptual Knowledge, Procedural Knowledge as well as Nature of Science and Science Inquiry.

According to Hollstein (1999) especially at an out-of-school learning environment, strong guidance is needed to successfully initiate learning processes. Sturm and Bogner (2010) compared learning at workstations at two different learning environments- out-of-school setting museum and classroom. They found that knowledge scores were higher at the out-of-school learning environment in comparison to the classroom setting. They assume that the locality leads to higher cognitive achievement (Sturm & Bogner, 2010) at least if the field trip is properly prepared and later on revised by the teacher.

3.6 Compatibility of Construction and Instruction- a match made in heaven

From a student's point of view Chi and Wylie (2014) classify in their ICAP-framework (Interactive, Constructive, Active, Passive) four examples of learning activities by mode of engagement, the order being passive, active, constructive and interactive. However, Blanchard et al. (2010) show four levels of inquiry taken from Abrams et al., 2007 on how the involvement of teacher and student can be quantified. They distinguish source of the question, data collection methods and interpretation of results (see table 1). In Level 0 ('Verification') all three domains mentioned below are given by the teacher, in Level 1 ('Structured') the interpretation of results is open to students, in Level 2 ("guided") only the source of question is given by the teacher and in Level 3 ("open") all three tasks are open to students. Our three

different teaching approaches T, G and S follow Blanchard et al. (2010) like this: T corresponds to ‘Verification`, G to ‘Guided’ and S to ‘Open’.

Table 1: Levels of Inquiry (Abrams et al., 2007) adapted from Schwab (1962) and Colburn (2000), taken from Blanchard et al. (2010).

	Source of the question	Data collection methods	Interpretation of results
Level 0: Verification	given by teacher	given by teacher	given by teacher
Level 1: Structured	given by teacher	given by teacher	open to student
Level 2: Guided	given by teacher	open to student	open to student
Level 3: Open	open to student	open to student	open to student

3.7 Methods

3.7.1 Student sample

Our study took place with 14 third grade classes (age mean 8,75 ± 0.65) in summers of 2014 and 2015 in an out-of-school learning setting at the wildlife-park X (14 classes, N=268). All participating schools were located in the region around Bad Kissingen, a town in northwestern Bavaria (Germany). 100 children participated in the teacher-centered approach (T), 67 in the student-centered instruction guided learning approach (G) and 101 experienced the strong student-centered learning approach (S). All participating students (44% were boys) and teachers arrived in their usual class units during the school year. A control group of n = 18 also visited the wildlife park but completed the questionnaires without attending the instruction.

3.7.2 Test design and instruments

All students received the information beforehand, that the day at the wildlife park should be treated as a day in school containing lessons and breaks in similar structure to their classroom schedule. One week before the visit all students completed a questionnaire testing their knowledge about the wildcat (pre-test). The same questionnaire (with items in different order) was presented right after the lesson (post-test) and again as a delayed post-test 6-8 weeks after the visit (retention test). Upon arriving, all students were given the opportunity to observe the wildcat in a near-natural habitat moving and feeding. Our independent variable was the mode of instruction (G, T, S). While the content stayed the same, we varied the way it was presented to the students (see table 2). Our dependent variables were cognitive achievement and situational emotions.

Table 2: Quasi-experimental design of the study.

Groups of instruction/ learning at workstations			
Teacher-centered (T)	Guided Learning (G)	Free learning (S)	Control
pre-tests at school one week before intervention were completed by all groups			
Instructional unit with content on wildcat for T, G and S (morphology, ecology, preservation)			
teacher-centered instruction	student-centered guided learning	stronger student-centered	no instruction
post-tests immediately after intervention were completed by all groups			
retention tests in the classroom were completed 6-8 weeks after intervention			

3.7.3 Learning at workstations

Learning at workstations can be defined as a mode of presenting information on a topic as various stations with a free or set order and different possibilities to work as a group, in teams or alone (Pfeiffer, 2007). What students should learn could be seen as a whole while different shares of that whole are presented individually. The knowledge content of these shares should be acquired by students on their own. (Munser-Kiefer, 2014). Different ways of structuring these workstations include “opening” them to free pick of order or social form as opposed to “closing” them with completely pre-structured tasks without any possibilities to choose (Munser- Kiefer, 2014).

Sturm & Bogner (2008) define learning at workstations as an educational approach, where students complete tasks in small groups at various workstations, therefore providing a cooperative learning environment. Berck & Graf (2010) state that learning at workstations usually starts with an introduction phase with students and teacher present. An overview should be given- how many workstations are there, order, content, information about the general procedure. After completing the workstations students should be provided with a closing discussion, where results can be compared, the workstations can be reviewed and metacognitive competences can be trained (Berck & Graf, 2010). The teacher’s role changes. They are not superfluous but serve as an advisor, someone to set impulses. All three teaching approaches implement workstations with different degrees of student and teacher engagement.

6.7.4 Teaching approaches of the educational program

Teacher-centered instruction (T)

One group (T) was presented with a teacher-centered approach based on the cognitivist view of a provider and receiver of knowledge during the learning process. We root this approach in Blanchard et al. (2010) Level 0 (Verification). They state, that the teacher in this level of inquiry provides the student with the question to be investigated as well as the methods of data gathering. While conclusions are not immediately obvious to students, the teacher serves as a guide towards the expected solutions (Blanchard et al., 2010). After meeting the wildcat, the teacher leads the students to a question, provides pieces of information necessary for answering said question while following several workstations. The teacher will help interpret the data (Blanchard et al., 2010) and after completing the workstations the question is answered and consolidated in the explorer workbook.

Student-centered instruction guided learning at workstations (G)

Another group (G) also tries to solve the question, only this time the teacher ‘s role changes from main “actor” to “accompanier”. While Blanchard et al. (2010) define their Level 2 (Guided) in a way that students determine the method of investigation and choose the mode of interpreting the results, we differ slightly, as the methods of investigation are given by the teacher. In this approach students work on the workstations more self-sufficiently against the backdrop of a fusion of cognitivism and constructivism. This time, students are forced to construct their own knowledge on the basis of the materials provided. After completing each workstation, the information is discussed with all participating students as well as with the teacher (Heyne & Bogner, 2012). Our approach takes into consideration the fact that a certain structure is needed to keep the discipline and the right learning environment for all students.

Stronger student-centered approach Free Learning at Workstations (S)

Students in group S were presented with workstations that they completed without any help of the teacher. According to Blanchard et al. (2010), in inquiry Level 3 (Open) students generate the question and therefore take responsibility for all aspects of the investigation. Also, they did not have one assigned teacher for the day but rather student guides making sure that everything worked according to schedule. This time, students checked the facts by themselves afterwards with answer cards.

3.7.4 Instructional Unit

All students were presented with an inquiry-based discovery learning inspired intervention (equivalent to four consecutive lessons in school), therefore all students should be provided with the same initial processes that should lead to the insight that the European wildcats' habitats are there but scattered so that the wildcats cannot roam free and it is our duty (human beings in general but also including the present students) to link the habitats via animal bridges and special hedges. Randomly assigned to the instruction forms of T, G and S students learn about the wildcats' morphology (workstation 1: Pet cat equals wildcat), ecology (workstation 2: Camouflage specialist) and behavior (workstation 3: Predator and prey) and afterwards draw the conclusion, that human involvement is needed in order to protect and preserve the wildcat.

3.7.5 Measuring emotions- a short scale

In order to measure the situational ("state") learning emotions after our instructions, we applied a short scale by Randler et al. (2011). This instrument has shown strong reliabilities before (Randler, 2009; Randler et al., 2011). Three items were used respectively for the psychological constructs wellbeing, boredom and interest. Children were able to report their state emotions on a five-point Likert scale ranging from 1= not at all to 5= very much with an undecided/ neutral category (3).

3.7.6 Statistical analysis

Missings were deleted listwise. Analysing our data using Kolmogorov-Smirnov testing as well as graphical tools we reached the conclusion, that we have to assume our data to be non-parametric (Lienert & Raatz, 1998). To find out, if our non-parametric data of independent samples stems from the same distribution, we used the Kruskal-Wallis test (more than 2 samples), the Mann-Whitney U-Test (2 samples) and for related samples the Wilcoxon signed-rank test. Cronbachs α was computed in order to test reliability of the instruments we used (Field, 2013). The effect size r was calculated according to Cohen (1988) with 0.10 as a small effect, with 0.30 as a medium effect and with 0.50 as a large effect (Liefländer et al. 2015). Cronbachs alpha for the knowledge questionnaire showed values of 0.56 (post-test) and 0.59 (retention test).

3.8 Results

Group as a whole

Taking a look at the data as a whole (all approaches combined, N=268), children were affected by the intervention. Knowledge scores increased significantly from pre-to post- test (Wilcoxon signed rank test p= 0.000 **, r= 0.729) as well as from pre- to retention test (p= 0.000**, r= 0.664). In the control group, students showed no significant learning success, neither from pre-to post-test (p= 0.944 n.s.) nor from pre- to retention test (p= 0.075 n.s.).

In group comparison

All groups showed significant learning success between pre- and post-test as well as between pre- and retention test. Mean values and standard deviation (SD) are shown in table 3. P-Values and effect sizes for all three approaches are shown in table 4.

Table 3: Values for knowledge scores at different forms of instruction. Mean ± SD.

	T	G	S
sum pre-test	7,95 ± 2.41	8,58 ± 1.81	8,70 ± 1.942
sum post-test	11,43 ± 1.77	11,49 ± 1.28	10,36 ± 1.895
sum retention test	10,43 ± 2.41	10,99 ± 1.65	10,54 ± 1.724

Table 4: Within-group comparison of knowledge (Wilcoxon signed rank test) for the three approaches: p-values, effect sizes in parentheses.

	T	G	S
pre-test to post-test	0.000 (0,785)	0.000 (0,821)	0.000 (0,583)
pre-test to retention test	0.000 (0,608)	0.000 (0,814)	0.000 (0,646)
number of students	100	67	101

Between group comparison

Since the knowledge scores in the pre-test do not differ between groups, we assumed similar knowledge beforehand and tested the results of the post- and retention tests between groups. Students who were presented with the teacher-centered instruction (T) as well as students constructing their knowledge by means of the guided learning at workstations (G) showed similar gain in knowledge whereas students who took part in a far more student-centered approach (S) showed less gain in knowledge from pre-to post-test (see table 5). The only significant differences with small effect sizes can be found when comparing T to S and G to S. There were no significant differences between approaches in the retention test scores (see table 5).

Table 5: Between group comparison of knowledge (Mann-Whitney U-test): p-values, effect sizes in parentheses

	T vs. G	T vs. S	G vs. S
sum pre-test	0.213	0.058	0.590
sum post-test	0.520	0.000 (0.218)	0.000 (0.160)
sum retention test	0.322	0.318	0.061

Emotions

There are no significant differences between the different teaching approaches. All students showed similar high levels of wellbeing and interest as well as low boredom values as shown in table 6 and 7.

Table 6: Emotions- differences between approaches.

	T vs. G	T vs. S	G vs. S
wellbeing	0.615	0.754	0.451
interest	0.854	0.748	0.828
boredom	0.263	0.694	0.381

Table 7: Values for state emotions at different forms of instruction. Mean ± SD.

	T	G	S
wellbeing	4.575 ± 0.852	4.686 ± 0.601	4,429 ± 1.161
interest	4.170 ± 0.928	4.256 ± 0.817	4,188 ± 1.036
boredom	1.729 ± 0.951	1.835 ± 0.964	1,721 ± 0.907

3.9 Discussion

Guided approaches similar to our (G) showed successful cognitive achievement at out-of-school learning settings (e.g. Sturm & Bogner, 2010; Wiegand, Kubisch & Heyne 2013). Therefore, in our first hypothesis we expected similar good results in the knowledge questionnaire at the wildlife park. Since our students did not differ in the results of the pretests we feel in a position to compare the knowledge results of the different approaches. Our modified approach G however could achieve a higher short-term learning success than the student-centered approach S, but not compared to T. We assume that the stronger presence of an educator leads to better cognitive outcome at the out-of-school learning setting, regardless of whether the educator guides the whole learning process instructively or just phases.

Moreover, the short term learning advance does not persist into the medium term, where no significant differences between all approaches can be discerned. We assume the lack of follow-up instruction within the weeks following our instructional unit to play a role in this outcome. When teachers and their students left the premises of the wildlife park, no further intervention took place on our part. For our purposes, in order to measure the impact of our programme on knowledge retention, we stressed that no post-visit revision should take place by the teachers until the retention test questionnaires were completed. As opposed to those special circumstances, field trips and outdoor education should always be properly recapitulated and consolidated at school in the days or weeks following the visit (Sauerborn & Brühne, 2007).

In our second hypothesis, we predicted less boredom and higher values in interest and wellbeing corresponding to higher focus on the students. This effect could not be found. Our data shows that all students were highly interested at the wildlife park, felt well and showed only little boredom regardless of the way the information was presented to them. Referring to Nundy, 2001, Sturm & Bogner (2010) assume outdoor teaching to motivate and encourage students in a way that might not be possible in a classroom. Out-of-school learning settings are often linked with elevated motivation and less boredom (Fröhlich, Sellmann & Bogner, 2013). In the light of this we assume the degree of involvement of the teacher to have no negative influence on students' situational emotions at the out-of-school learning setting.

Moreover, we assume teachers in their role as a companion to facilitate learning processes while preventing off-task behavior and successful dealing with distractions without leading to negative situational emotions. Therefore, our data as well as our observations suggest that teachers' fear of inquiry based learning at the wildlife park has no foundation. Inquiry based student-centered phases are possible in our scenario, especially if combined with securing phases of educational instruction and securing of knowledge. In our intervention, the involvement of the teacher as a didactic leader (Helmke, 2014) seems to counteract adverse effects such as off-task behavior and distractions at the out-of- school learning setting wildlife park.

3.10 Conclusion

We conclude three findings. (1) We assume the permanent presence of an educator is not necessary for learning success at an out-of-school learning setting and the implementation of constructivistic phases within a program is possible. (2) In our intervention, even the stronger presence of an educator at the out-of-school learning setting did not seem to lead to negative situational emotions. Medium term (post-test) results show cognitive learning, high interest and well-being as well as little boredom. (3) In our opinion the (at least temporary) presence of an educator guarantees supervision and limitation of off-task behavior on one hand and the facilitation of constructivistic learning phases in an altogether positive learning environment especially at the out-of-school learning setting.

4. Conceptual Change
Confront and Cluster: How different groups of primary school children respond to instruction towards conceptual change at an out-of-school learning setting

4.1 Abstract

We sampled the alternative conceptions of 257 third grade students (8-11 years old) using an open questionnaire. The answers were categorized into three topics and used to construct a multiple choice instrument. Following the pretest our instruction phase contained the confrontation with the students' own alternative conceptions about humans' and cats' vision at a wildlife-park. Immediately after instruction, the multiple choice instrument was presented as a post test and several weeks later as a retention test. Due to the heterogeneity within our student sample we defined and found five different groups. Our data shows that the instruction of primary school children using confrontation according to the conceptual change theory does not lead to a change of conceptions or to synthetic models, furthermore we found no detectable conceptual growth. Finally, students with the accepted scientific conception as well as students with other concepts seemed to be confused by this instruction.

4.2 Introduction

What students already know is very important throughout the learning process (Ausubel, 1968). Learners' conceptions, their mental models of objects of events (Glynn & Duit, 1995), need to be addressed, especially if those conceptions differ from the scientific concept. Strike and Posner (1982) propose four steps to foster a successful accommodation leading to a conceptual change (Kubisch & Heyne, 2015; Strike & Posner, 1982): First and foremost there must be a "dissatisfaction with existing concepts". Secondly, the new conception must be intelligible. The third step should be, that the new, scientific conception has to appear initially plausible. As a fourth and last phase the conception should appear fruitful to solve further problems of the same or a similar kind (Strike & Posner, 1982).

We assembled our instructional phase based upon these four pillars using a practical approach by Petermann, Friedrich and Oetken (2008), "Das an Schülervorstellungen orientierte Unterrichtsverfahren", instruction using the conceptual change model. First we needed to get to know the alternative conceptions, then define the problem, refute and secure the new

knowledge (Petermann, Friedrich, & Oetken, 2008). Considering reading and presenting skills in primary school children we used the confrontation with pictures (Kubisch & Heyne, 2015; Franke & Bogner, 2011) and a teacher centered discussion during the refutation part instead of refutation text (Tippett, 2010).

We wish to emphasize that our approach was a discontinuous one (Jung, 1986; Strike & Posner, 1982; Tippett, 2010). We ensured to use students' alternative conceptions as a starting point but instead of establishing a continuous form of learning on top of that, we intended to create a "cognitive conflict" (Franke & Bogner, 2011; Limon, 2001) by confronting them with their own alternative conceptions in a context that would assure the initial perception of said alternative conception to be neither plausible, therefore not useful to solve the current problem, nor fruitful as a solution for future problems (Tippett, 2010). Duit (1995) also states a discontinuity in the process, caused by a change in directions when students are confronted with their own concept.

Our main focus was the expected heterogeneity of alternative conceptions and the resulting groups within our participating classes. While Poehnl and Bogner (2013a) determined two levels of prior knowledge, "experts" and "novices" based on the number of correct scientific conceptions, we wanted to differentiate further and therefore tried a more qualitative approach to detect changes in conceptions. We strongly assumed heterogeneity of different conceptions to be a major factor for conceptual change and designed groups of prior knowledge accordingly (Poehnl & Bogner, 2013a; Tippett, 2010; Vosniadou et al., 2001).

"Conceptual change": We apply this term to students that started out with an alternative conception and changed it throughout an instruction phase to the scientific conception by means of "accommodation", the actual integration of the new, scientific information following a restructuration of prior knowledge (Tippett, 2010) and rejection of the alternative conception.

"Synthetic models": In order to define the process in which new scientific knowledge is added to the alternative conceptions we used Vosniadou et al. (2001), where mixed models of knowledge stored in the learner's mind are described. Killermann, Hiering and Starosta (2013) apply the german term "Kompartmentalisierung", compartmentalization of knowledge, painting a vivid picture of how the different models are stored in different compartments in the learner's mind. They define the process as accepting the scientific model while still embracing the alternative conception (Killermann, Hiering, & Starosta, 2013).

"Conceptual Growth": conceptual growth in general may be applied to more than one process (Tippett, 2010). In contrast to "accommodation" described above, "assimilation" (Strike & Posner, 1982) represents a scenario where the new scientific information is stored along with

the alternative conception (Tippett, 2010) or is added when there was no prior knowledge, leading to a growth rather than a change in conceptions. To define conceptual growth in a way we could detect in the questionnaires we limited the term to the growth of knowledge when there was no prior conception, meaning the students marked “I don’t know” in the pretest and the scientific conception in the posttest.

4.3 Hypotheses

(i) Alternative Conceptions: The “conceptual change” group should respond to the discontinuous approach according to Strike and Posner (1982) by changing their alternative conceptions towards the scientific conceptions.
(ii) There should occur a “synthetic models” group keeping the alternative conception alongside the scientific approved one.
(iii) No conception at the start: The instruction should result in a “conceptual growth” group.
(iv) Exceeding these groups we defined a knowledge’-group as well as a “non-addressed concepts”—group. We expected these groups to be confused by the discontinuous approach.

4.4 Methods

4.4.1 Study Design

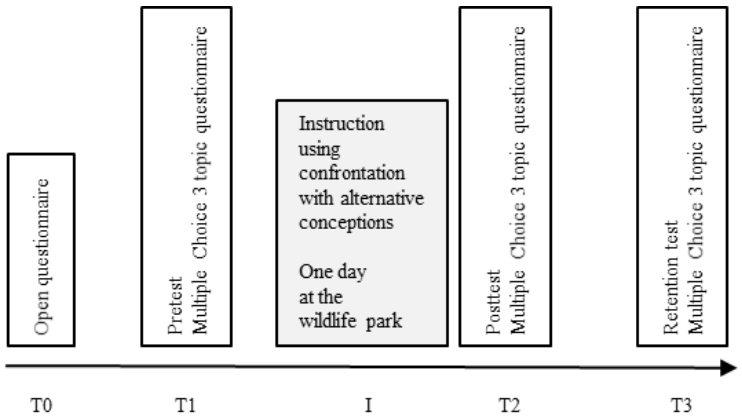


Figure 1. Overview of the Tests and Their Times as Well as the Instruction Phase

T0: 10 weeks prior to the first pretest, T1: Pretest one week before instruction, I: Instruction, T2: Posttest immediately following the instruction, T3: Retention test 6-8 weeks after instruction

4.4.2 Constructing the Open Questionnaire

To obtain students' alternative conceptions we followed Treagust (1988). Our first task was to define the content (Treagust, 1988). We investigated the main scientific concepts on human vision and the differences between humans' and cats' night vision on a third grade level following the curriculum for elementary schools. Then we collected possible answers in the literature (Çelikten, İpekçioğlu, Ertepınar, & Geban, 2012; Gropengießer, 1997; Guzetti et al., 1997; Kattmann et al., 1997).

In order to obtain information about students' misconceptions (Treagust, 1988) we created an open questionnaire. To get a high validity, we presented all students later to participate in the study with the test a few months after school had started in order to get their very own alternative conceptions not yet influenced by their science curriculum.

4.4.3 Instructions for Answering the Open Questionnaire

During the test students were given a short introduction by the same researcher into the human eye's parts and their names to prevent wrong answers due to confusion or lack of knowledge of nomenclature. Furthermore, students were instructed to answer regardless of specific knowledge to really get all the information and not only answers from students that were sure to know the right answer, as they are usually instructed to do in school.

4.4.4 Constructing the diagnostic test to measure the changing of conceptions

For test construction of the main diagnostic instrument (T1, T2 and T3, see Figure 1) we also followed Treagust (1988) with a slight alteration. We set out to "Defining the content" (Treagust, 1988) by analyzing the open questionnaires in regard to the main content we already defined prior to constructing the open questionnaire. The phase "Obtaining information about students' misconceptions" (Treagust, 1988) took place after carefully evaluating the open questionnaires. We coded the different conceptions into categories and counted the appearances of the most frequently named conceptions. We ranked the conceptions based on the frequency of their appearance. We singled out three major topics. For the development of our diagnostic test instrument later to be used in a pre-, post- and retention design for third grade students we decided not to use the two tier method (Treagust, 1988) but merely the multiple choice items constructed for the three major topics in order to avert confusion of the primary school children.

4.4.5 Topics in the Multiple Choice Instrument

For Topic 1 “humans need light in order to see” we asked the question “Is it possible for humans to see something when it is completely dark?” For clarification purposes students were instructed to assume “real” darkness, not dusk or dawn or some faint light source. We provided the scientific concept “no, humans need light to see”, the most common alternative conception “yes, humans can see in total darkness, they just have to get used to the darkness”, “I don’t know” as well as positive and negative distractors sampled from the open questionnaire.
Topics “Wildcats can see better in the dusk or dawn than humans” and “function of the iris” were treated equally. For Topic 2 “Why is it that in dusk or dawn wildcats are able to see better than humans?” The scientific concept was “Wildcats’ eyes reflect the light” with the most common alternative conception “Wildcats’ eyes shine in the dark”. Topic 3 “What do humans and wildcats need the iris for?” could be answered “The iris makes the pupil bigger or smaller” or “The iris allows to see colours” respectively.

4.4.6 Student Sample

Our study took place with 16 third grade classes in summer 2014 in an out-of-school learning setting at a wildlife-park (16 classes, n = 257). The diagnostic test was made up of three topics, every topic consisting of seven choices: “I don’t know” (later to be used as “no concept”), the scientifically right concept, the most common alternative conception as well as four distractors. The students were allowed to mark any number of answers they found to be correct in order to get a real overview and not force them chose one concept over another when both were equally important to them.

4.4.7 Instructional Unit

The confrontation with the most common alternative conception was built into the instruction by showing of pictures and discussing the content, thereby addressing and correcting the conception. All students were given the same instructional unit, materials and pictures. The instruction was presented by the same researcher as a constructivist problem-oriented lesson revolving around the question “Why do cats see better in dusk and dawn?” From the open questionnaire it was clear that all students knew cats have superior vision in dusk and dawn, therefore we could ask the question that way. Instructor and students took the role of scientists trying to solve the question and the confrontation with students’ alternative conceptions was

built into the lesson along the way. Every student had a workbook containing tasks we solved as a group and then filled in individually.

While talking about the eye's structure we found out that the pupil is in fact an opening to allow light into the eye. At that point the confrontation and discussion of the alternative conception "yes, humans can see in total darkness, they just have to get used to the darkness" took place. Right after that there arose the question, how the pupil can get bigger and smaller. At that point we targeted the conception "The iris allows to see colours". Finally, we put together all the reasons for the cat to have better night vision and added the confrontation "Wildcats' eyes shine in the dark".

4.4.8 Group Definition by Marking Behavior

We defined three groups (see Table 1) as we saw fit according to conceptual change theory literature (Tippett, 2010; Vosniadou et al., 2001). We predicted these groups to be found due to the possible behaviour during the three points of measurement: pre-, post- and retention test.

"Conceptual change": Students in this group started out in the pretest (T1) with the most common alternative conception. In the posttest (T2) directly following the instructional unit they changed their prior conception to the scientifically approved conception and stayed with that conception also during the retention test (T3) administered about two months later.

"Synthetic models": These students started with the most common alternative conception to which they later "added" the scientific conception in a way that both conceptions are stored alongside. "Conceptual Growth": "I don't know" was marked in the pretest (T1), followed by the scientific concept in post- and retention test.

Table 1. Group Definition According to the Literature by Order of Marking Over Time

Group	Conceptual change	Synthetic Models	Conceptual Growth
Pretest	Alternative conception	Alternative conception	No conception
Posttest	Scientific conception	Alternative and scientific conception	Scientific conception
Retention test	Scientific conception	Alternative and scientific conception	Scientific conception

In addition to these groups we postulated one more group "knowledge" and found another one "non-addressed concepts" (see table 2):

"Knowledge": In this group students always marked only the right conception consistently during all tests. We used this group to test whether students with the right conception would be

confused by the confrontation with other students' alternative conceptions.

"Non-addressed concepts": Students in this group marked neither the scientific conception nor the alternative one, they also did not mark "I don't know" but one or more of the four remaining conceptions that were not addressed during the instruction phase. We found a variety of alternative conceptions in the open questionnaire data that we did not address in our instruction but used to build the multiple choice diagnostic test.

The "non-addressed" as well as the "knowledge"-group are tabulated "reversed". Instead of searching for all markings other than the scientific conception, we use the scientific conception and show the reverse effect.

Table 2. Group Definition New Groups by Order of Marking Over Time

Group	Knowledge	Non-addressed concepts
Pretest	Scientific conception	Other conceptions
Posttest	Scientific conception	Scientific conception
Retention test	Scientific conception	Scientific conception

4.5 Results

4.5.1 Heterogeneity

Overview for topics 1 through 3 (see Table 3)

Table 3. Overview Markings in the Pretest (T1) All Topics (Percentage of Markings in the Pretest)

	Topic 1	Topic 2	Topic 3	mean
Alternative conception	23%	20%	30%	25%
Scientific conception	29%	9%	11%	16%
No conception	6%	16%	29%	17%
Other conceptions	42%	55%	30%	42%

We tabulated the pretests to get a better overview and found the predicted heterogeneity in regard to students' prior knowledge. Considering all three topics twenty-five percent of the students started out with the addressed alternative conception. This was the group we targeted with our instruction. A major part, forty-two percent, consists of students with one or more different conceptions that were not addressed later. Equally distributed were "no conception" (sixteen percent) and "scientific conception" (seventeen percent).

4.5.2 Groups

We worked with a nominal data set and didn't change the variables into metric ones in order to preserve the full information content. We used descriptive statistics to illustrate the amount of various ways to respond to the confrontation.

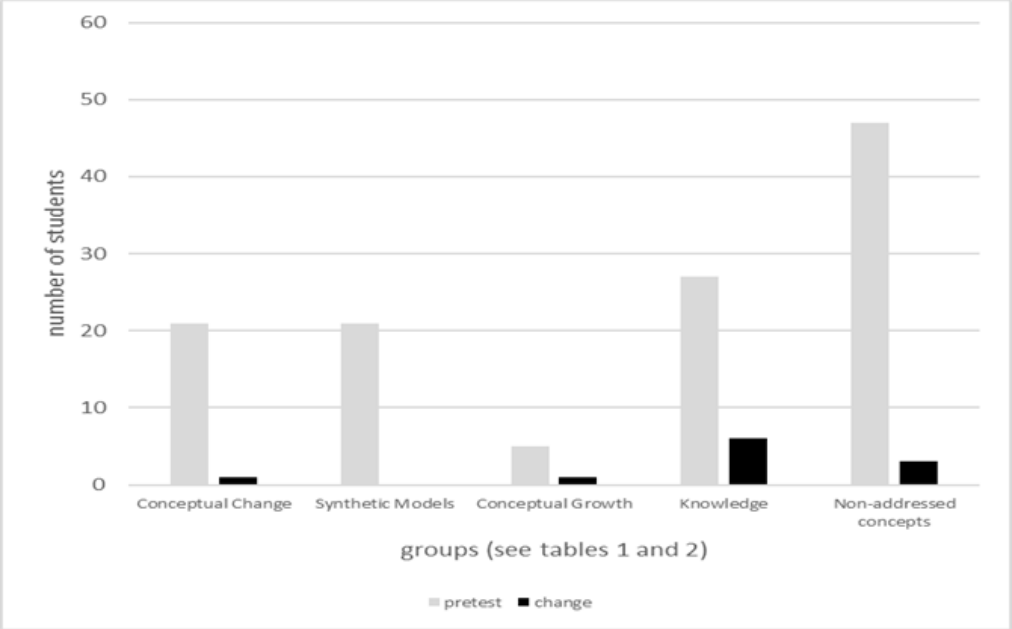


Figure 2. Marking behavior Topic 1

Grey bars represent the number of students who marked the corresponding answer in the pretest (T1). The answer corresponding to the group can be found in Tables 1 and 2. For example, the grey bar in the "conceptual change" group stands for 21 students marking "alternative conception" in the pretest. The black bar ("change" throughout all tests) shows the change in marking behaviour throughout the three tests also according to Tables 1 and 2. For example the black bar in the conceptual change group represents 1 student who marked "alternative conception" in the pretest (T1), the "scientific conception" in the posttest (T2) and the "scientific conception" in the retention test (T3).

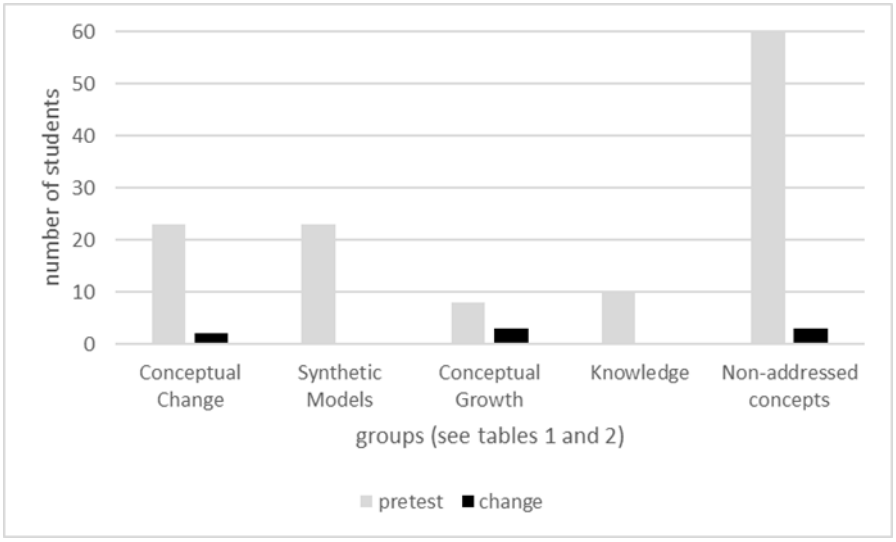


Figure 3. Marking Behaviour Topic 2

Grey bars represent the number of students who marked the corresponding answer in the pretest (T1). The answer corresponding to the group can be found in Tables 1 and 2. For example, the grey bar in the "synthetic models" group stands for 23 students marking "alternative conception" in the pretest. The black bar ("change" throughout all tests) shows the change in marking behaviour throughout the three tests also according to Tables 1 and 2. For example the black bar in the synthetic models group represents 0 students who marked "alternative conception" in the pretest (T1), the alternative and the scientific conception in the posttest (T2) and the alternative and the scientific conception" in the retention test (T3).

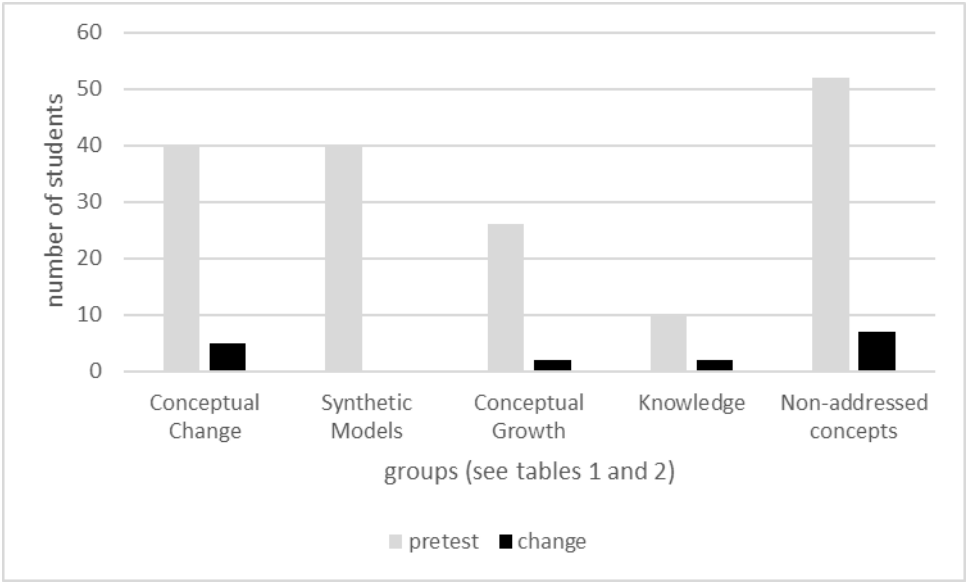


Figure 4. Marking Behaviour Topic 3

Grey bars represent the number of students who marked the corresponding answer in the pretest (T1). The answer corresponding to the group can be found in Tables 1 and 2. For example, the grey bar in the "conceptual growth" group stands for 26 students marking "no conception" in the pretest. The black bar ("change" throughout all tests) shows the change in marking behaviour throughout the three tests also according to Tables 1 and 2. For example the black bar in the conceptual growth group represents 2 students who marked "no conception" in the pretest (T1), the "scientific conception" in the posttest (T2) and the "scientific conception" in the retention test (T3).

Alternative Conceptions: Conceptual change and Synthetic Models

Conceptual change: We tried to find out whether a successful conceptual change in the sense of Strike and Posner (1982)'s accommodation would be achieved. This study with third grade students promotes that this goal could not be achieved (see Figures 2, 3, 4).

Synthetic Models: We couldn't detect a lot of students that stored the information according to the "assimilation" theory that should lead to mixed models (see Figures 2, 3, 4).

No Conception: Conceptual Growth

This group was rather small to begin with due to the fact that only few students started out with no concept at all. Even those few students did not add the new scientific information frequently (see Figures 2, 3, 4).

Scientific approved conception: Knowledge

Only few students maintain the right conception throughout the study (see Figures 2, 3, 4).

Non addressed conceptions

Students with different non addressed conceptions did not change to the right conception (see Figures 2, 3, 4).

4.6 Discussion

Our data shows that there is in fact the heterogeneity of students' prior knowledge we predicted (Tippett, 2010). We would like to emphasize that about half the students were confronted with a conception they didn't hold in the first place while only around 25% could really be targeted with the alternative conception they actually held (see Table 3).

Contrary to our first hypothesis our methods of confronting third grade students with their alternative conceptions using pictures (Franke & Bogner, 2011; Kubisch & Heyne, 2015) could not foster changes in conceptions. This discontinuous way of learning (Duit, 1995; Strike & Posner, 1982) does not seem to be an appropriate approach for changing alternative conceptions in primary school children, neither for the targeted group nor for the other, non-targeted groups that did not start with the addressed alternative conception found in the open questionnaire.

Students who entered the instruction with the scientific approved conception or no conception at all seemed to be confused as there were only a few students who held the scientific approved conception later on. These findings for the "knowledge" group are backed up by Poehnl and Bogner (2013a), who assume an "expertise reversal effect" also their results cannot be compared verbatim since they focused on a modified refutation text and cognitive load theory.

Regarding our second hypothesis the instruction also did not lead to an assimilation resulting in Synthetic Models. This model, described throughout the literature (Vosniadou et al., 2001), could not be found within our data at all.

Finally the substantial non-addressed conceptions group reacted as well with a lack of change in conceptions. After all, they are confronted not only with the scientific conception but at the same time with a conception they never actually had. This seems to lead to confusion.

Of course we have to take into consideration that the means of confrontation might have to be changed. Kubisch and Heyne (2015) already assumed their pictures "were so explicit and memorable that the students rather remembered these instead of the scientifically correct ones". This may also be the case in this study although we had to deal with limited alternatives regarding third grade students` reading comprehension.

In addition Jung (1986) states that the scientific conception has to be repeated many times by the teacher, otherwise students would rather forget it and return to their alternative conceptions. In our study we had a time limit therefore they could be repeated only a few times.

Summarizing these findings we reach the conclusion that primary school children seem to be overstrained by the instruction following the conceptual change theory. From our point of view confronting this age group with more than one alternative conception during the instruction phase in each topic probably also does not lead to a change to the scientific conception, on the contrary might lead to causing even more confusion.

To test our resulting theories we need to apply a true control group with a traditional instruction without confrontation. We believe that the additional cognitive load of this discontinuous way should not be used for third grade students. To make sure we plan a comparative study where one group is confronted with their alternative conceptions and the other one is instructed without confrontation (Kubisch & Heyne, 2015). We assume the traditional instruction will lead to a better cognitive outcome for primary school children.

To evaluate the results of the planned comparative study a cognitive questionnaire should be developed to quantify cognitive outcome in addition to recording changes in conceptions. In pursuance of getting a better grasp of a change in conceptions we constructed an instrument that was not only based on factual knowledge but truly integrated the actual conceptions of our participating students. Due to the mode of construction the opportunities of statistical analysis were limited.

4.7 Conclusion

We found a wide variety of prior knowledge in our study, therefore we propose that in order to instruct successfully, the heterogeneity of prior knowledge must be taken into consideration. Our remaining question thereby is how to accomplish this with primary school children. Our data strongly suggests that the processes and models predicted in conceptual change literature do not apply to third grade students in an out-of-school learning setting.
Assuming that the discontinuous conceptual change process rather overstrains primary school children in general, we recommend a different kind of instruction, especially the constructivist teaching approach “guided learning at workstations” (Heyne & Bogner, 2012; Wiegand, Kubisch, & Heyne, 2013). These prior studies have shown great success in a combination of constructivist teaching approaches and teacher-centered instruction, especially in an out-of-school learning setting as is the case at a wildlife park.

5. Preservation of the Wildcat
"Ist die Wildkatze noch zu retten?" Die Wildkatze als Leitart intakter Ökosysteme

5.1 Abstract

Der Schleichjäger ist ein faszinierendes Wildtier nicht nur für sich genommen, sondern vor allem als Indikatorart »gesunder« Ökosysteme. Nur dort ist die Europäische Wildkatze (*Felis silvestris silvestris*) dauerhaft zu finden. Wer diese Tierart und ihre spezifischen Bedürfnisse versteht, begreift die Notwendigkeit, ihr einen Platz in unserer Kulturlandschaft zu schaffen.

5.2 Fachdidaktische Vorbemerkungen

Ein außerschulischer Lernort wie ein Wildpark bietet ideale Voraussetzungen zur Durchführung dieses phänomen- wie problemorientierten Unterrichtsganges; alternativ kann die Unterrichtseinheit aber auch im Klassenzimmer stattfinden. Als Unterrichtsmethode kommt das sog. »Geführte Lernen an Stationen« zum Einsatz, das instruktionale und konstruktivistische Elemente verbindet. Der Unterricht möchte ein Bewusstsein für die spezifischen Bedürfnisse der Tierart Wildkatze schaffen und arbeitet im Idealfall neben den Medien mit Stopfpräparaten und Originalen.

5.3 Ziele der Stunde

Die Schülerinnen und Schüler

►► betrachten Wild- und Hauskatze anhand von Stopfpräparaten vergleichend (Farbe des Fells, Form und Musterung des Schwanzes); sind keine Stopfpräparate vorhanden, können Abbildungen herangezogen werden;

►► ermitteln mithilfe von unsortierten Satzteilen, dass die Wildkatze in ihrem Lebensraum aufgrund der unauffälligen Fellfarbe gut getarnt ist;

►► ermitteln anhand von Stichwörtern (Baumhöhlen, Steinhaufen …), dass ein Wald mit geeigneten Versteckmöglichkeiten den idealen Lebensraum für diese Tierart darstellt;

►► begreifen, dass die Wildkatze primär Mäuse erbeutet und keine Singvögel;

►► kennen die typischen Phasen des Jagdablaufs und ahmen sie spielerisch nach;

►► bauen den Lebensraum der Wildkatze nach und begreifen, dass diese Zeigerart auf eine Habitatvernetzung durch den Menschen angewiesen ist.

5.4 Kompetenzerwartungen

Die Schülerinnen und Schüler

►► beschreiben und erklären Wechselwirkungen im Organismus, zwischen Organismen sowie zwischen Organsmen und unbelebter Materie;

►► beschreiben und erklären die Angepasstheit ausgewählter Organismen an die Umwelt;

►► beschreiben und beurteilen die Auswirkungen menschlicher Eingriffe in einem Ökosystem.

5.5 Unterrichtsverlauf

5.5.1 Hinführungsphase

Als Motivation wird die Wildkatze in einem Wildparkgehege beobachtet. Im Klassenzimmer wird das situationale Interesse durch Bilder bzw. eine Hauskatze erreicht. Die Phänomenorientierung erfolgt durch eine Landkarte (figure 6, see Appendix 8.2.2), auf der geeignete Verbreitungsgebiete der Wildkatze zu sehen sind. Diese sind manchmal von Wildkatzen besiedelt, manchmal trotz nächster Nachbarschaft nicht. Dieses Phänomen generiert bei den Schülerinnen und Schülern das Problem, warum Wildkatzen nur in bestimmten Gebieten vorkommen bzw. sie nicht einfach die benachbarten geeigneten Gebiete besiedeln.

5.5.2 Erarbeitung

Nach zielgerichteter Vermutungsbildung folgt die Lösungsplanung hinsichtlich der Notwendigkeit einer genauen Beschäftigung mit der Morphologie (Welche Merkmale zeigt diese Katzenart bzw. wie kann sie sicher von der Hauskatze unterschieden werden?), der Ökologie (Was braucht sie?) und dem Verhalten (Wie lebt sie?). Bei der Morphologie vergleichen die Schülerinnen und Schüler unter Anleitung die Stopfpräparate einer Wild- und einer Hauskatze und fixieren ihre Ergebnisse in den Arbeitsmaterialien (see Appendix 8.2.1).

Zur Ökologie wird ein idealer Lebensraum betrachtet, entweder in einem Biotopgehege oder ebenfalls in Form von Abbildungen. Die Schülerinnen und Schüler ermitteln dabei zum einen erforderliche abiotische Faktoren, zum anderen wird im biotischen Kontext die auffallend gute Tarnung im Vergleich zu sonstigen typischen Waldbewohnern thematisiert.

Fließend erfolgt der Übergang zum Jagdverhalten, das die Schülerinnen und Schüler selbst anhand von Bild- und Wortkarten zusammenpuzzeln; anschließend spielen sie die Jagd in den einzelnen Phasen mit entsprechenden Masken nach (figure 7, see Appendix 8.2.2). Im Unterrichtsgespräch wird im Anschluss thematisiert, dass die Wildkatze kein Singvogeljäger ist und ihre Nahrung zu über 90 Prozent aus Mäusen besteht. Nun kennen die Schülerinnen und Schüler die relevanten Faktoren für einen geeigneten Lebensraum, können Vorurteilen begegnen, aber die Problemstellung trotzdem nicht lösen.

5.5.3 Erkenntnisfindung

Zur Klärung des Phänomens werden die Kinder wieder mit der anfangs eingesetzten Landkarte konfrontiert. Sie erkennen, dass es mehrere Gebiete in Deutschland gibt, in denen die Wildkatze all das findet, was zuvor erarbeitet wurde. Trotzdem bleiben benachbarte Gebiete unbesiedelt. Um das Problem zu lösen, werden gemeinsam mit Naturmaterialien bzw. Bildkarten (Äste, Reisig, Steine, Absperrband, Bildkarte oder Plüschtier-Wildkatze) nebeneinander zwei Habitate gebaut, zwischen denen ein Teppich aus Straßen und Häusern den Weg versperrt.

Mit vereinten Kräften bauen die Kinder eine Brücke zwischen beide Lebensräume (figure 2, right) und erkennen so, dass der Mensch für eine erfolgreiche Besiedelung eines

Nachbarhabitats aktiv eingreifen muss, indem bewaldete Korridore bzw. Grünbrücken gebaut werden, denn ohne diese Maßnahmen erfolgt keine Besiedlung der geeigneten Lebensräume (figure 6, see Appendix 8.2.2). Wildkatzen überqueren nachweislich keine größeren Freiflächen oder gar Wohngebiete.

5.5.4 Gesamtsicherung

Die Gesamtsicherung erfolgt in Form eines Lebensraumspiels. Regeln und Materialien befinden sich im Umweltbildungspaket »Für die Katz« auf der Homepage des Bund für Umwelt und Naturschutz Deutschland (bund.net).

6. General Discussion

The cooperation between the section of Didactics at the Julius-Maximilians University Würzburg and the wildlife park "Wild-Park Klaushof" has been and still is a success: since this study started in 2014, already 198 wildlife programs were conducted by undergraduates in the wildlife park "Wild-Park Klaushof" with 3379 children in 205 classes.

Therefore, I am glad to present the results of our evaluation on the impact on a program concerning the European wildcat and its preservation on primary school children.

The out-of-school learning setting wildlife park provides student visitors with the opportunity for original encounters. While this is true for any visit to the wildlife park, it is our mission to make that opportunity a part of the regular curriculum of primary schools in the vicinity of the wildlife park "Wild-Park Klaushof". As shown before (see chapter 1), the topics forest and its wildlife fit perfectly into the Bavarian third grade curriculum. Nevertheless, a mere original encounter is not enough for sustainable learning success and environmental education.

Prior to the current design of our study we had planned a longer educational program in order to have a stronger impact on students, as for example Bogner (1998) found in comparison between a one- and a five-day program.

Yet when doing research on the topic we found teachers and headmasters to have many reservations against visiting a wildlife park with students even for one day, let alone more than one day. They told us about the tight schedule that often makes even a half day away from school difficult.

Therefore, we decided to design a learning scenario that wouldn't keep students away from school too long yet would convey everything we planned on teaching. Short-term education at the out-of-school learning setting has been supported before, for example by Kossack & Bogner (2012) and Drissner et al. (2010).

692 children in 35 classes participated in our study. The pilot was conducted with 91 students in 5 classes. In our morning intervention at the wildlife park 180 of these children experienced the strong teacher-centered approach (T, TW), 163 our modified "guided learning at workstations" (G, GW) and 101 conducted the strong student-centered (S) approach at the wildlife park.

In their respective classrooms in school we educated 137 students according to our guided approach (G, GS). A control group of 18 students in one class took part in another program at the wildlife park. In the afternoon, 257 students in 16 classes were educated according to the conceptual change theory at the wildlife park.

6.1 Environmental Values

In this study we found out, that it was in fact possible to affect primary school children's values towards preservation of nature. During our program, children did not only gather environmental knowledge about the European wildcat, they also realized the need for human interaction for the sake of preserving endangered wildlife by building two habitats suitable for the wildcat. Those habitats were separated by streets and buildings (on a special picture rug) and it was children's accomplishment to build a bridge between the habitats. Based on this, we discussed the need for human interaction in preservation further and very specific to children's hometowns. We told them for example, where and when nature conservation groups met in their vicinity or where to donate money.

The impact, the program made on the participating children could be found not only at the wildlife park, as we predicted, but also when conducting the program at school. We have to take into consideration that no matter if classroom or wildlife-park, all students experienced a day out of the ordinary with a deviant temporal and spatial structure.

Moreover, we found, the form of instruction also did not change the impact the program had on students. Whether they got the information during our modified guided learning at workstations (G) or a strong teacher-centered approach (T) made no difference in the outcome. Mann-Whitney tests showed no significant differences, neither between the strong teacher- centered approach (TW) and the guided approach (GW) at the wildlife park, nor between both guided approaches at school (GS) and at the wildlife park (GW) and not even between the strong teacher-centered (TW) approach at the wildlife park and the guided approach at school (GS).

Previous studies have already shown a general positive influence of constructivist elements (Heyne & Bogner, 2012; Sturm & Bogner, 2010; Wiegand, Kubisch & Heyne, 2013). Also, as Drissner et al. (2010) and Wiegand, Kubisch & Heyne (2013) already stated, original encounters, natural experiences as well as having a researcher as a teacher at the out-of-school learning setting have a general positive impact.

We presume, for example, the stuffed animals we brought into the classrooms to make a near-original encounter possible, had a stronger impact than the pictures that are usually used in a conventional lesson by schoolteachers. The teacher-effect itself as mentioned by Hattie (2012) has to be taken into consideration.

The result that surprised us the most was the change of the preservation values in the "wrong direction", suggesting that students leant less towards preservation of nature after the program than before. Both Drissner et al. (2010) and Johnson and Manoli (2008) also got this result with children a little older than our targeted age group (between 10 and 12 years of age). While Drissner et al. (2010) concluded, the intervention period should be longer, Johnson and Manoli (2008) got the result after a five-day program, therefore we assume the duration not to be the reason. Johnson and Manoli (2008) assumed the 10-11 year old children they were working with to be "more amenable to change".

It was the assumption of Drissner et al. (2010), however, that students answer the questions more critically when asked a second or even a third time after having time to think about the effects. We share this opinion and take it one step further. We presume, that students understood the repercussions of "pro-preservation" behavior on their very own free time and possibly allowance money a whole lot better after the program than before. Also, beforehand they were probably not aware of the full effects as well as the amount of work involved in pro-preservation efforts.

In this context, the tendency towards social desirable answers was probably outweighed by the impact on personal welfare.

We also have to discuss the general high environmental awareness in Bavaria, where education leading to responsible behavior towards nature and the environment is rooted in the constitution (Bayerische Verfassung, Artikel 131, Absatz 2). This pro-environmental background may have led to the already high preservation values to begin with. Students already showed a high level of bias towards preservation when filling out the pre-test questionnaire.

Another possible explanation could be the fact, that a concern for the environment does not necessarily cause actions on behalf of preservation of nature (Uzzell, Rutland, & Whistance, 1995).

Moreover, the tendency to give socially desirable answers, that was studied with 11-12 year old children by Oerke & Bogner (2011), should be investigated further in our work with primary school children. Answering in a socially desirable way could have influenced the mode of checking the Likert scale boxes on the environmental values questionnaire, in our opinion especially in the pre-test.

These tests were applied in the classroom with the teacher present. Although teachers were instructed not to interfere, the mere presence might have caused a bias towards an answer the teacher would prefer. More research should be conducted on this topic, perhaps using a lie scale alongside the other questionnaires in a way that for example Oerke & Bogner (2011) did.

6.2 Environmental Knowledge

First introduced by Heyne & Bogner (2012), the modified approach „guided learning at workstations“ has been used in several interventions and proved to lead to successful learning results (Wiegand, Kubisch & Heyne, 2013) under different circumstances. Elements of instruction and constructivism are fused in a way that the teacher's role changes from lecturer to facilitator and students work at the workstations more self-sufficiently. It is not easy to place the approach in terms of student-or teacher-centered, therefore we see the teacher in the role of a didactic leader (Helmke, 2014) rather than an "instructor".

When studying the cognitive learning results with different forms of instructions at the wildlife park our first result was, that all groups showed a significant difference between pre- and post-test as well as pre- and retention test knowledge questionnaire values, indicating learning success. Previous studies have shown, that outdoor science learning often leads to learning success (e.g. Rios & Brewer, 2014; Waite, 2011).

Although learning success was achieved after our preferred approach "guided learning at workstations" (G) as well as after a strong teacher-centered instruction (T), we are still convinced, that the modified guided approach holds its advantages: Implementation of constructivist phases is possible, and students can work more self-sufficiently. During our studies we found that many teachers seemed to prefer the higher student activity, although they often feared, inquiry-based methods in combination with the circumstantial distractions at the out-of school learning setting would lead to off-task behavior as well as less concentration among students.

The fact, that learnings success could also be achieved with a strong student-centered approach (S), let us to assume that the facilitation of really experiencing original encounters with wildlife and their habitat, carefully designed materials and highly motivated researchers in the role of teachers lead to good cognitive and affective results, independent of the learning setting and form of instruction. This could be a starting point for allowing more self-sufficient work phases at the wildlife park, for example using tablets or smartphones as sources of information.

When comparing the differences in pre- and post-test learning success between the two approaches with a didactic leader (G, T) and the strong student-centered approach (S), we found an advantage of the strong teacher-centered approach (T) as well as the guided learning at workstations (G), that did not, however, transcend into the retention test. We assume this was due to the fact that no additional consolidation had taken place in the days following the program, as should be good practice after a day of outdoor education (Sauerborn & Brühne, 2007).

Although the presence of a teacher in the role of a didactic leader and facilitator does not seem to be necessary, we presume that the (at least temporary) presence guarantees a successful learning environment for all students, with constructivist elements and cognitive learning success.

6.3 Situational emotions

Throughout all learning settings and forms of instruction, students´ situational emotions remained consistent. We found high values for interest and wellbeing with corresponding low values of boredom. Even a stronger focus on the teacher did not lead to less positive and more negative emotional values at the wildlife park.

The high positive and low negative emotional values at the wildlife park may be explained by different factors like the introduction of a new teacher (Hattie, 2012), original encounters (Bogner & Wiseman, 2004), being outdoors (e.g. Fröhlich, Sellmann & Bogner, 2013; Nundy, 2001; Rios & Brewer, 2014), “learning at workstations” as a learning environment that fosters motivation and feeling of competence (e.g. Sturm & Bogner, 2019; Ryan & Deci, 2000) and high percentage of self-sufficient phases (Sturm und Bogner, 2010).

When we take into consideration our similar results at school, we can probably eliminate being outdoors while stressing high percentage of self-sufficient phases, original encounters in the form of materials brought to school, the role of a new teacher that was a researcher and unknown to students as well as the different spatial and temporal structure.

Overall we take the consistent positive emotions as a sign of quality of our program, the development, design as well as the conduct.

Similar to the environmental values questionnaire, the possibility of the children providing socially desirable answers (Oerke & Bogner, 2011) should be taken into consideration. Here also more research should be conducted with a lie scale alongside the other questionnaires in a way that for example Oerke & Bogner (2011) did.

6.4 Conceptual change theory

For our afternoon lesson we wanted to explore our topic, the European wildcat, even further. A suitable subject that was both fascinating and more advanced than the environmental knowledge conveyed in the morning, proved to be cat's vision in dusk and dawn. As a teaching method we chose the conceptual change theory, which had been a topic of research in our workgroup before (Kubisch & Heyne, 2015) and which we also wanted to explore further. At first, we were not sure how to implement this part of the study into the one-day visit without overchallenging the children on account of cognitive load (Poehnl & Bogner, 2013b) but since children showed good cognitive results, high motivation and little boredom in the mornings in the pilot, we extended the program to a second intervention that took place in the afternoons after an extended lunch recess. Children were eager to learn more about the wildcat and kept up discipline and motivation.

The forms of instruction used in the morning were all based on a continuous approach of accumulating information by more or less direct instruction, as well as construction of own knowledge (Wiegand, Kubisch, & Heyne, 2013). In the afternoon, however, we used a discontinuous process (e.g. Duit, 1995; Strike & Posner, 1982) that should lead to a change in conceptions from alternative conceptions to the scientifically correct conceptions (e.g. Tippett, 2010; Vosniadou et al., 2001).

In order to achieve this, the regular instruction was interrupted by a confrontation with the alternative conception using pictures (e.g. Franke & Bogner, 2011; Glaab & Heyne, 2017; Kubisch & Heyne, 2015), which was then refuted and the instruction continued (e.g. Tippett, 2010; Vosniadou et al., 2001).

Prior to the intervention, we were especially interested in the conceptions children already held, therefore we constructed an open questionnaire (preliminary test, see Appendix 8.1.4) which lead us to the most common preconceptions. We had the advantage, that all 257 students, that later completed the program on humans' and wildcats' vision and marked the items in the diagnostic instrument had previously also answered the preliminary open questionnaire. Therefore, we could be sure, that the conceptions were actually their own and not conceptions of another sample of children.

Our goal was, to really confront the students with their very own alternative conceptions. Unfortunately, we found that by the time of our intervention only one third to one fourth of the children (depending on the topic) still held those alternative conceptions found before, so most students were confronted with a preconception that was not their own. We presume this to be a great disadvantage in the conceptual change method. Motivated by the preliminary open questionnaire students had time to gather information on the topics and therefore had a learning opportunity between preliminary test and pre-test.

In retrospect, it might have been better to confront more alternative conceptions, which we don't think would have been applicable in the little time given in the afternoon. Moreover, the lesson might have been confusing with a confrontation of even more alternative conceptions.

After doing research on the main scientific concepts on human vision in general as well as in dusk and dawn and comparing it to cat vision on a third grade level following the curriculum for elementary schools, we collected possible answers in the literature (e.g. (Çelikten, İpekçioğlu, Ertepınar, & Geban, 2012; Gropengießer, 1997; Guzetti et al., 1997; Kattmann et al., 1997), designed the questionnaires (Treagust, 1988) and defined three groups of possible marking behavior in the tests according to conceptual change literature (e.g. Tippet, 2010; Vosniadou et al., 2011).

Children in our first group “Conceptual change” should start with the addressed alternative conception in the pretest, followed by the scientifically correct conception in the post- and retention test. This “conceptual change” could be found only on occasion. Therefore, we assume, that our instruction according to the conceptual change theory did not work with third grade primary school children in our intervention.

The second group “Synthetic Models” should also start with the alternative conception but in the post- and retention test add the scientifically correct conception. This group could not be found at all. Therefore, we assume, this phenomenon as described for example in Vosniadou et al. (2001) did not take place in our third grade primary school children.

Our third group, “Conceptual Growth” (Tippett, 2010) should start with no conception at all and lead to marking the scientifically correct conception later on. This was also found only on occasion.

In addition, the “Non-addressed Concepts” group, children who held a non-addressed preconception that would later change towards the scientifically correct conception, only worked on occasion. The “Knowledge” group, where children entered the program already holding the scientifically correct conception and should hang on to this conception in the post- and retention test could also only be found rarely.

We assume, that our instruction towards conceptual change led to confusion of third grade primary school children, especially for children, who did not hold the addressed conception. The teaching method in our study did not lead to a conceptual change, therefore we assumed the method also to have no impact towards the scientific correct conception upon the other groups.

We have to take several limitations into consideration for our findings. The form of confrontation with pictures instead of refutation texts may have caused additional confusion, since the pictures were probably highly memorable (Kubisch & Heyne, 2015) and probably had a strong impact on children’s short-term memory. Even more important is the fact that, according to Jung (1986), the scientifically correct conception has to be repeated many times by the teacher or students might forget and return to their alternative conception, this repetition wasn’t possible in our limited time set and, as mentioned before, there was no consolidation in the days after the program.

We presume, that this different way of instruction overchallenges primary school children. One way to study this further would be to teach our subject in a continuous way, for example using our “guided learning at workstations” and compare the results to the present ones.

Moreover, to make sure, our subject wasn’t the reason for our result, a new study could test conceptual change theory with primary school children using a different subject than we did. If this also does not lead to success, perhaps older children should be educated instead of primary school children. Yet we assume older children already know a lot more about vertebrate vision due to the school curriculum and alternative conceptions may be very rare, therefore another subject might have to be chosen.

Even with older children, there is still the limitation mentioned before, that a preliminary test, where the alternative conceptions are retrieved, may lead to a pursuit of information on the subject prior to the pre-test.

6.5 Future prospects

The objective of our intervention was to educate children in the third grade of Bavarian primary schools at the out-of-school learning setting wildlife park using different teaching approaches and methods, comparing the wildlife park to a school setting and impact children’s environmental values. We believe we achieved our goal and will therefore continue using our “guided learning at workstations” (G) alongside stronger teacher (T) - and stronger student-centered (S) elements while educating primary school children at the wildlife park “Wild-Park Klaushof”. Although the one-day program seemed to be sufficient, more research should be done in the future on these short programs, perhaps compared to longer lasting ones.

As supported by Kossack & Bogner (2012) for connectedness with nature, it might also be a possibility to integrate regular short-term environmental education programs into the regular school curriculum when longer visits are not practicable.

We still believe, that the original encounter is a key factor in environmental education and were convinced, that we would place a strong recommendation for outdoor education at the wildlife park right here, yet after we found no difference in fostering changes in environmental values between wildlife park and school, we started discussing the nature and value of original encounters. In our opinion, more research could be conducted on the advantages of outdoor learning at the wildlife park in comparison to environmental programs in school. However, given the special circumstances of our study, where additional material was brought to the classrooms and the teacher was also a researcher, we assume that in the daily school routine the visit to the wildlife park would save time and preparation for the teacher.

While educating classes at the wildlife park, we found the demand for digital education at the wildlife park has been and still is growing. In addition to the opportunity for original encounters, the possible benefit of using tablets or smartphones with special apps and interactive elements of securing knowledge should also be tested, especially since we found teaching approaches with higher student activity to lead to good cognitive learning results with primary school children at the wildlife park.

As mentioned before in the discussion, we are interested to continue research on conceptual change theory at the wildlife park with a different topic and different age groups of students. Also we would like to teach the same subject, cats´ vision in dusk and dawn, using a continuous teaching approach like our “guided learning at workstations” instead of conceptual change theory and compare the results to our study.

7. References

Abrams, E., Southerland, S. A., & Silva, P. C. (2007). *Inquiry in the classroom: Challenges and opportunities. Assessing student understanding in an inquiry-based learning environment.* Greenwich CT: Information Age Publishing. Retrieved from: https://books.google.de/books?id=pR1HypFfGjAC.

Ausubel, D. P. (1968). *Educational psychology. A cognitive view*. New York: Holt, Rinehart & Winston.

Barke, H.-D. (2006). *Chemiedidaktik. Diagnose und Korrektur von Schülervorstellungen* [Chemistry didactics. Diagnosis and correction of students' conceptions]. Berlin, Heidelberg, Germany: Springer (Springer-Lehrbuch).

Berck, K.H., & Graf, D. (2010). *Biologiedidaktik. Grundlagen und Methoden. [Didactics of biology. Theories and methods.]*. Wiebelsheim, Germany: Quelle & Meyer

Bergmanson, J. P. G., & Townsend, W.D. (1980). The morphology of the cat tapetum lucidum. *American Journal of Optometry & Physiological Optics 57* (3), 138-144.

Blanchard, M. R., Southerland, S. A., Osborne, J. W., Sampson, V. D., Annetta, L. A., & Granger, E. M. (2010). Is inquiry possible in light of accountability? A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction. *Science Education 94* (4), 577–616.

Boeve-de Pauw, J., & van Petegem, P. (2011). The effect of Flemish eco-schools on student environmental knowledge, attitudes, and affect. *International Journal of Science Education 3* (11), 1513-1538.

Bogner, F. X. (1998). The influence of a short term outdoor ecology education on long-term variables of environmental perspective. *The Journal of Environmental Education 29*, 17-29.

Bogner, F. X., & Wiseman, M. (1997). Environmental perception of rural and urban pupils. *Journal of Environmental Psychology 17* (2), 111–122. doi: 10.1006/jevp.1997.0046

Bogner, F. X., & Wiseman, M. (1999). Toward Measuring Adolescent Environmental Perception. *European Psychologist 4* (3), 139–151. doi: 10.1027//1016-9040.4.3.139

Bogner, F.X., & Wiseman, M. (2004). Outdoor ecology education and pupils' environmental perception in preservation and utilization. *Science Education International* 15 (1), 27-48.

Bogner, F. X., & Wiseman, M. (2006). Adolescents' attitudes towards nature and environment: Quantifying the 2-MEV model. *Environmentalist 26* (4), 247–254. doi: 10.1007/s10669-006-8660-9

Borchers, C., Boesch, C., Riedel, J., Guilahoux, H., Ouattara, D., & Randler, C. (2013). Extra-curricular primary school teaching shows positive impact on environmental knowledge and attitudes. *International Journal of Science Education 4* (3), 240-259. doi: 10.1080/21548455.2013.803632

Brovelli, D., von Niederhäusern, R., & Wilhelm, M. (2011). Ausserschulische Lernorte in der Lehrpersonenbildung.- Theorie, Empirie und Umsetzung an der PHZ Luzern [Outdoor learning for teachers- theory, empiricism and application at the PHZ Luzern]. *Beiträge zur Lehrerinnen- und Lehrerbildung 29* (3), 342-352.

Byrka, K., Hartig, T., & Kaiser. F.G. (2010). Environmental attitude as a mediator of the relationship between psychological restoration in nature and self-reported ecological behavior. *Psychological Reports 107* (3), 847-859.

Çelikten, O., İpekçioğlu, S., Ertepınar, H., & Geban, Ö. (2012). The effect of the Conceptual change oriented instruction through cooperative learning on 4th Grade students' understanding of earth and sky concepts. *Science Education International*, *23* (1), 84-96.

Chi, M. T. H., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist 49* (4), 219–243.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Colburn, A. (2000). An inquiry primer. *Science Scope, 23* (6), 42-44.

Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297 - 334.

Drissner, J., Haase, H.-M., & Hille, K. (2010). Short-term Environmental Education - Does it work? - An evaluation of the 'Green Classroom'. *Journal of Biological Education 44* (4): 149–155. doi: 10.1080/00219266.2010.9656215

Duit, R. (1995). Vorstellungen und Lernen von Physik und Chemie. Zu den Ursachen vieler Lernschwierigkeiten [Conceptions and learning in physics and chemistry. About the causes for several learning difficulites]. *Plus Lucis*, *2*, 11-18.

Esser, H. (1969). *Der Biologieunterricht [Biology education in schools]*. Hannover, Germany: Hermann Schroedel Verlag.

Falk, J.H., & Balling, J.D. (1982). The field trip milieu: Learning and behaviour as a function of contextual events. *The Journal of Educational Research 76* (1), 22-28.

Field, A. (2013). *Discovering statistics using IBM SPSS Statistics*. Fourth Edition. London: Sage Publications Ltd.

Franke, G., & Bogner, F. X. (2011). Cognitive influences of students' alternative conceptions within a Hands-On gene technology module. *Journal of Educational Research*, *104* (3), 158-170.

Fröhlich, G., Sellmann, D., & Bogner, F.X. (2013). The influence of situational emotions on the intention for sustainable consumer behaviour in a student centered intervention. *Environmental Education Research 19* (6), 747-764.

Gekle, M., Wischmeyer, E., Gründer, S., Petersen, M., Schwab, A., Markwardt, F., Klöcker, N., Pape, H.C., Baumann, R., & Marti, H. (2015). *Taschenlehrbuch Physiologie. [Pocket textbook physiology].* Stuttgart, Germany: Georg Thieme Verlag.

Glaab, S., & Heyne, T. (2017). Confront and cluster-How different groups of primary school children respond to instruction towards conceptual change at an out-of-school learning setting. *World Journal of Educational Research 4* (3), 417-429. doi: 10.22158/wjer.v4n3p417

Glynn, S. M., & Duit, R. (1995). Learning science in the schools. In *Research reforming practice*. Mahwah, New Jersey: L. Erlbaum Associates.

Gropengießer, H. (1997). Schülervorstellungen zum Sehen [Students' alternative conceptions about vision]. *Zeitschrift für Didaktik der Naturwissenschaften*, *3* (1), 71-87.

Guzzetti, B. J., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993). Promoting Conceptual change in science. A comparative Meta-Analysis of instructional interventions from reading education and science education. *Reading Research Quarterly*, *28* (2), 116-159.

Haltenorth, T. (1957). *Die Wildkatze [The wildcat].* Wittenberg Lutherstadt, Germany: Ziemsen.

Hammann, M., & Asshoff, R. (2014). Schülervorstellungen im Biologieunterricht. *Ursachen für Lernschwierigkeiten* [Students' alternative conceptions in biology education. Causes for learning difficulties]. Seelze, Germany: Kallmeyer in Verbindung mit Klett.

Hattie, J. (2012). *Visible learning for teachers. Maximizing impact on learning*. Milton Park, UK: Routledge.

Helmke, A. (2014). *Unterrichtsqualität und Lehrerprofessionalität. Diagnose, Evaluation und Verbesserung des Unterrichts [Quality of education and teacher professionalism. Diagnostics, evaluation and improvement of education].* Bobingen, Germany: Kallmeyer in Verbindung mit Klett Friedrich.

Heyne, T., & Bogner, F.X. (2012). Guided learning at workstations about drug prevention with low achievers in science education. *World Journal of Education 2* (6), 1-12. doi: 10.5430/wje.v2n6p1

Hollstein, G. (1999). *"Nicht immer eine Führung!" Selbstständiges Lernen an Stationen im Zoo [Not always guided instruction! Inquiry based learning at workstations at a zoo]. Lernziel: Stationenarbeit. Eine neue Form des offenen Unterrichts [Objective: Learning at workstations. A new method of inquiry based education]*. Hegele (Ed.). Weinheim, Germany: Beltz Verlag.

Johnson, B., & Manoli, C.C. (2008). Using Bogner and Wiseman's Model of Ecological Values to measure the impact of an earth education program on children's environmental perceptions. *Environmental Education Research 14* (2), 115-127.

Jung, W. (1986). Alltagsvorstellungen und das Lernen von Physik und Chemie [Everyday misconceptions and learning in physics and chemistry]. Naturwissenschaften im Unterricht. *Physik, Chemie*, *34* (13), 2-6.

Kaiser, F.G., Roczen, N., & Bogner, F.X. (2008). Competence formation in environmental education: advancing ecology-specific rather than general abilities. *Umweltpsychologie* [Environmental Pschology] *12* (2), 56-70.

Kattmann, U. (2007). Die Bedeutung von Alltagsvorstellungen für den Biologie-Unterricht [The importance of everyday misconceptions in biology education]. *Unterricht Biologie*, *31* (329), 2-6.

Kattmann, U., Duit, R., Gropengießer, H., & Komorek, M. (1997). Das Modell der Didaktischen Rekonstruktion-Ein Rahmen für naturwissenschaftsdidaktische Forschung und Entwicklung [The model of didactic reconstruction—A framework for research and development in science didactics]. *Zeitschrift für Didaktik der Naturwissenschaften*, *3* (3), 3-18.

Killermann, W., Hiering, P., & Starosta, B. (2005). *Biologieunterricht heute. Eine moderne Fachdidaktik* [Biology education today. A modern subject didactics]. Donauwörth, Germany: Auer.

Killermann, W., Hiering, P., & Starosta, B. (2013). *Biologieunterricht heute. Eine moderne Fachdidaktik* [Biology education today. A modern subject didactics]. Donauwörth, Germany: Auer.

Klahr, D., & Nigam, M. (2004): The equivalence of learning paths in early science instruction: Effect of direct instruction and discovery learning. *Psychological Science 15* (10), 661–667. doi: 10.1111/j.0956-7976.2004.00737.x.

Kossack, A. & Bogner, F.X. (2012). How does a one-day environmental education programme support individual connectedness with nature? *Journal of Biological Education 46* (3), 180-187. doi: 10.1080/00219266.2011.634016

Kubisch, F., & Heyne, T. (2015). Students' alternative conceptions about the Lotus Effect. To confront or to ignore? *Journal of Biological Education*, *50* (1), 86-100.

Liefländer, A. K., Fröhlich, G., Bogner, F. X., & Schultz, P.W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research 19* (3): 370–384. doi: 10.1080/13504622.2012.697545

Liefländer, A.K., Bogner, F.X., Kibbe, A. & Kaiser, F.G. (2015). Evaluating environmental knowledge dimension convergence to assess educational program effectiveness. *International Journal of Science Education 37* (4), 1-19. http://dx.doi.org/10.1080/09500693.2015.1010628

Liefländer, A.K., & Bogner, F.X. (2016). Educational impact on the relationship of environmental knowledge and attitudes. *Environmental Education Research 0* (0), 1-14. http://dx.doi.org/10.1080/13504622.2016.1188265

Lienert, G.A., & Raatz, U. (1998). *Testaufbau und Testanalyse [Test construction and test analysis]*. Weinheim, Germany: Beltz.

Limón, M. (2001). On the cognitive conflict as an instructional strategy for conceptual change: A critical appraisal. *Learning and Instruction*, *11* (4-5), 357-380.

Mayring, P., & von Rhoeneck, C. (eds.). (2003). *Learning Emotions- The influence of affective factors on classroom learning*. Frankfurt am Main (Germany): Peter Lang GmbH Europäischer Verlag der Wissenschaften.

Milfont, T. L., & Duckitt, J. (2004). The structure of environmental attitudes. A first- and second-order confirmatory factor analysis. *Journal of Environmental Psychology 24* (3), 289–303. doi: 10.1016/j.jenvp.2004.09.001

Munser-Kiefer, M. (2014). Formen und Qualitätsmerkmale offenen Unterrichts. [Forms and quality criteria of open education] In W. Einsiedler, M. Götz, A. Hartinger, F. Heinzel, J. Kahlert & U. Sandfuchs (Eds.) *Handbuch Grundschulpädagogik und Grundschuldidaktik*. Bad Heilbrunn, Germany: Verlag Julius Klinkhardt.

Nundy, S. (2001). *Raising achievement through the environment: A case for fieldwork and field centres*. Peterborough: National Association of Field Studies Officers

Oerke, B., & Bogner, F.X. (2011). Social Desirability, Environmental Attitudes, and General Ecological Behaviour in Children. *International Journal of Science Education 35* (5), 713-730. doi: 10.1080/09500693.2011.566897

Petermann, K., Friedrich, J., & Oetken, M. (2008). Das an Schülervorstellungen orientierte Unterrichtsverfahren [Education based on students' alternative conceptions]. *CHEMKON*, *15*(3), 10-18.

Pfeiffer, S. (2007). *Lernen an Stationen im Sachunterricht. [Learning at workstations in primary school education.]* Baltmannsweiler, Germany: Schneider Verlag Hohengehren.

Poehnl, S., & Bogner, F. X. (2013a). A modified refutation text design: Effects on instructional efficiency for experts and novices. *Educational Research and Evaluation*, *19* (5), 402-425.

Poehnl, S. & Bogner, F.X. (2013b). Cognitive load and alternative conceptions in learning Genetics: Effects from provoking confusion. *The Journal of Educational Research, 106*, 183–196. doi:10.1080/00220671.2012.687790

Randler, C. (2009). Association between emotional variables and school achievement. *International Journal of Instruction 2* (2), 3–10.

Randler, C., Hummel, E., Glaser-Zikuda, M., Vollmer, C., Bogner, F. X. & Mayring, P. (2011). Reliability and validation of a short scale to measure situational emotions in science education. *International Journal of Environmental and Science Education 6* (4), 359–370.

Rennie, L.J. (2007). Learning Science Outside of School. In: Abell, S. K., Lederman, N. G., (eds.). *Handbook of research on science education*. New Jersey: Lawrence Erlbaum Associates.

Roczen, N., Kaiser, F. G., Bogner, F. X., & Wilson, M. (2013). A competence model for environmental education. *Environment and Behavior 46* (8), 972–992. doi: 10.1177/0013916513492416

Rios, J. M., & Brewer, J. (2014). Outdoor education and science achievement. *Applied Environmental Education & Communication, 13* (4), 234-240. doi: 10.1080/1533015X.2015.975084

Ryan, R. M., & Deci, E.L. (2000). Self-determination theory and the facilitation of Intrinsic Motivation, Social Development, and Wellbeing. *American Psychologist* 55 (1): 68-78. doi: 10.1037110003-066X.55.1.68

Sauerborn, P., & Brühne, T. (2007). *Didaktik des außerschulischen Lernens. [Didactics of outdoor learning and education]*. Baltmannsweiler, Germany: Schneider Verlag Hohengehren.

Schaal, S., & Bogner, F.X. (2005). Human visual perception- learning at workstations. *Journal of Biological Education 40* (1), 32-37.

Scharfenberg, F.-J., Bogner, F.X., & Klautke, S. (2007). Learning in a gene technology lab with educational focus: Results of a teaching unit with authentic experiments. *Biochemistry and Molecular Biology Education, 35* (1), 28-29.

Scharfenberg, F. -J., & Bogner, F.X. (2013). Instructional efficiency of tutoring in an outreach gene technology laboratory. *Research in Science Education 43*, 1267-1288.

Schwab, J. J. (1962). *The teaching of science as enquiry.* In J. J. Schwab & P. F. Brandwein, The teaching of science. Cambridge, MA: Harvard University Press.

Sellmann, D. & Bogner, F.X. (2012a). Climate change education: quantitatively assessing the impact botanical gardens as an informal learning environment. *Environmental Education Research 19* (4), 415-429. doi: 10.1080/13504622.2012.700696

Sellmann, D. & Bogner, F.X. (2012b). Effects of a 1-day environmental education intervention on environmental attitudes and connectedness with nature. *European Journal of Psychology of Education 28* (3), 1077-1086. doi:10.1007/s10212-012-0155-0

Strike, K. A., & Posner, G. J. (1982). Conceptual change and science teaching. *European Journal of Science Education*, *4* (3), 231-240.

Sturm, H., & Bogner, F. X. (2008). Student-oriented versus teacher-centred: The effect of learning at workstations about birds and bird flight on cognitive achievement and motivation. *International Journal of Science Education 30* (7), 941–959.

Sturm, H., & Bogner, F.X. (2010). Learning at workstations in two different environments: A museum and a classroom. *Studies in Educational Evaluation 36*, 14–19.

Tippett, C. D. (2010). Refutation text in science education: A review of two decades of research. *International Journal of Science and Mathematics Education*, *8* (6), 951-970.

Treagust, D. F. (1988). Development and use of diagnostic tests to evaluate students' misconceptions in science. *International Journal of Science Education*, *10* (2), 159-169.

Tukey, J.W. (1980). We need both exploratory and confirmatory. *The American Statistician 34* (1), 23-25.

Ulich, D., & Mayring, P. (1992). *Psychologie der Emotionen [psychology of emotions]*. Stuttgart, Germany: Kohlhammer.

Uzzell, D., Rutland, A., & Whistance, D. (1995). Questioning values in environmental education. In Y. Guerrier, N. Alexander, J. Chase, & M. O'Brien (Eds.), *Values and environment: A social science perspective* (pp. 171–182). Chichester, UK: John Wiley & Sons.

Vosniadou, S., Ioannides, C., Dimitrakopoulou, A., & Papademetriou, E. (2001). Designing learning environments to promote conceptual change in science. *Learning and Instruction*, *11* (4-5), 381-419.

Waite, S. (2011). Teaching and learning outside the classroom: personal values, alternative pedagogies and standards. *Education 3–13, 39* (1), 65-82. doi: 10.1080/03004270903206141

Wiegand, F., Kubisch, A., & Heyne, T. (2013). Out-of-school learning in the botanical garden. Guided or self-determined learning at workstations? *Studies in Educational Evaluation 39* (3), 161–168. doi: 10.1016/j.stueduc.2013.06.001

Wiseman, M., & Bogner, F.X. (2003). A higher-order model of ecological values and its relationship to personality. *Personality and Individual Differences 34*, 783-794.

Online Sources

Anhang A der EG-Verordnung NR. 338/ 97 von 1996 [Appendix from European regulations]
https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=LEGISSUM%3Al11023
aufgerufen am 27.07.2018 um 17:08 Uhr

Bayerische Verfassung [Bavarian Constitution]
http://www.gesetze-bayern.de/Content/Document/BayVerf-131
aufgerufen am 27.07.2018 um 16:43 Uhr

Bund für Umwelt und Naturschutz
https://www.bund.net/
aufgerufen am 03.08.2018 um 16:38

Bundesnaturschutzgesetz (BNatSchG) [Federal Law for wildlife conservation]
https://www.gesetze-im-internet.de/bnatschg_2009/__7.html
aufgerufen am 27.07.2018 um 17:07 Uhr

Flora-Fauna-Habitat-Richtlinie [Habitat regulations for flora and fauna]
http://www.ffh-gebiete.de/ffh-anhangiv-anhang4-anhangv-anhang5/
aufgerufen am 27.07.2018 um 16:46 Uhr

ISB (Institut für Schulqualität und Bildungsforschung [Institute for school quality and educational research] (2014): Lehrplan Plus Bayern [Bavarian primary school curriculum]
http://www.lehrplanplus.bayern.de/leitlinien/grundschule
aufgerufen am 08.08.2018 um 16:40

Wildcatconservation.org
https://wildcatconservation.org/wild-cats/eurasia/European-wildcat/
aufgerufen am 27.07.2018 um 16:49 Uhr

8. Appendix

8.1 Scales

8.1.1 MEV-Scales

		Preservation
.123		Muss der Mensch sich der Natur anpassen?
.649		Erzählst Du oft anderen, wie wichtig es ist, der Natur zu helfen?
.731		Wenn Du einmal Extra Taschengeld bekommst, würdest Du einen Teil davon an eine Naturschutzgruppe spenden?
.590		Macht es Dir großen Spaß, in die Natur zu gehen?
.472		Fühlst Du dich wohl in der Natur, wenn es still ist?
.633		Beobachtest Du gern Tiere in der Natur?
.689		Möchtest Du gern wissen, welche Tiere im Wald leben?
.756		Würdest Du in einer Naturschutzgruppe mitmachen, wenn Du älter bist?
.758		Würdest Du helfen, Geld zu sammeln um der Natur zu helfen?
.640		Würdest Du in Deiner Freizeit in der Natur Abfall aufsammeln?
		Utilization
	.549	Findest Du, dass wir **nur** nützliche Tiere und Pflanzen schützen müssen?
	.348	Findest Du, dass der Umweltschutz oft den Fortschritt aufhält?
	.392	Findest Du, dass Menschen wichtiger sind als andere Lebewesen?
	.234	Sind Tiere und Pflanzen dazu da, dem Menschen zu nützen?
	.393	Darf man eine geschützte Blume pflücken, wenn es mehr als eine davon gibt?
	.387	Müssen wir Straßen bauen, damit wir raus in die Natur fahren können?
	.500	Findest Du, dass wir Wälder abholzen müssen, um Getreide anzubauen?
	.547	Sollte der Mensch über die Natur herrschen?
	.439	Machen sich die Menschen zu viele Gedanken darüber, dass die Umwelt verschmutzt wird?
	.338	Wirfst Du Deinen Müll auf den Boden, wenn Du im Wald bist?
4.90	2.29	eigenvalues
24.52	11,46	% of the variance

Englisch: (vom Autor übersetzt)

		Preservation
.123		Human beings have to adapt themselves to the environment
.649		I often try to persuade others that the environment is an important thing
.731		If I get extra pocket money I would donate a part of it to an environmental organization
.590		I really like going on trips into the countryside / nature
.472		I have a sense of wellbeing in the silence of nature
.633		I would really enjoy watching animals in nature
.689		It is interesting to know what kind of creatures live in the forest
.756		I would like to join and actively participate in an environmentalist group
.758		I am prepared to help out in a fund-raising effort for environmental protection
.640		I would collect garbage in my spare time
		Utilization
	.549	It is only necessary to protect useful animals and plants
	.348	Environmental protection often slows down progress
	.392	Human beings are more important than other creatures
	.234	Plants and animals exist primarily to be used by humans
	.393	It is ok to pluck an endangered plant if there are more of them at one place
	.387	We must build more roads so people can travel to the countryside
	.500	We need to clear forests in order to grow crops
	.547	Humans were meant to rule over the rest of nature
	.439	People worry too much about pollution
	.338	I throw my garbage on the floor when I'm in the forest
4.90	2.29	eigenvalues
24.52	11,46	% of the variance

8.1.2 Emotions- Short scale

Original items of the situational emotion short scale	***English translation***
WB_1 Die Stunde hat mir Freude gemacht.	The lesson pleased me.
I_1 Ich fand das Thema wichtig.	I found that topic important. That topic was important.
B_1 Ich habe mich gelangweilt.	I felt bored.
WB_2 Ich war mit der Stunde zufrieden.	I was satisfied with the lesson.
B_2 Ich war mit den Gedanken heute öfter woanders.	(Today) I was sometimes absent with my thoughts.
WB_3 Der Unterricht hat mir Spaß gemacht.	I enjoyed the lesson.
I_2 Was ich über das Thema erfahren habe, bringt mir was.	The information on that topic yields something to me.
I_3 Ich möchte mehr über das Thema erfahren.	I want to learn more about that topic.
B_3 Die heutige Stunde war zum Einschlafen.	The lesson was to sleep in.

8.1.3 Knowledge questionnaire

Fragebogen zur Wildkatze: Kreuze an! Nur eine Antwort ist richtig!

1. Wie jagt eine Wildkatze ihre Beute?
   a) ☐ Anschleichen-Lauern-Beute fassen-Springen
   b) ☐ Springen-Lauern-Anschleichen-Beute fassen
   c) ☐ Anschleichen-Lauern-Springen-Beute fassen
   d) ☐ Lauern-Springen-Anschleichen-Beute fassen

2. Warum können Wildkatzen nicht einfach von einem Wildkatzen-Wald in den nächsten laufen?
   a) ☐ Weil sie nicht so weit laufen können
   b) ☐ Weil sie immer dort bleiben, wo sie geboren sind
   c) ☐ Weil sie sich auf Straßen und Wiesen nicht verstecken können
   d) ☐ Weil es keine Wildkatzen-Wälder in Deutschland gibt

3. Wie sieht der Schwanz einer Wildkatze aus?
   a) ☐ Er ist am Ende spitz
   b) ☐ Er ist ganz grau
   c) ☐ Er ist buschig und am Ende schwarz
   d) ☐ Er ist dünn und hellbraun

4. Was können wir tun, um der Wildkatze zu helfen?
   a) ☐ Wir können Sie füttern, damit sie nicht mehr jagen muss
   b) ☐ Wir können Wegweiser aufstellen, wo der nächste Wildkatzen-Wald ist
   c) ☐ Wir können Wildkatzen-Wiesen anlegen, auf denen sie sich wohlfühlt
   d) ☐ Wir können Wildkatzen-Wälder anlegen, in denen sie sich wohlfühlt

5. Was für ein Gebiss hat die Wildkatze?
   a) ☐ Sie hat ein Gebiss wie eine Kuh und frisst Gras
   b) ☐ Sie hat spitze Zähne und frisst Fleisch
   c) ☐ Alle Zähne der Wildkatze sehen gleich aus
   d) ☐ Sie hat ein Gebiss wie ein Mensch

6. Welche Spur gehört zur Wildkatze?
   a) ☐ 
   b) ☐ 
   c) ☐ 
   d) ☐ 

7. Warum gibt es so wenige Wildkatzen in Deutschland?
   a) ☐ Weil ihr Lebensraum immer kleiner wird
   b) ☐ Weil sie so viele Feinde haben
   c) ☐ Es gibt viele Wildkatzen, sie sind aber gut getarnt
   d) ☐ Es gibt sehr viele Wildkatzen

8. Wildkatzen schlafen tagsüber meistens. Wo machen sie das am liebsten?
    a) ☐ Auf großen Feldern
    b) ☐ In Gebüschen oder unter umgefallenen Bäumen
    c) ☐ Ganz oben in den Bäumen
    d) ☐ Am Wegrand

9. Was macht eine Wildkatze, wenn sie einen Menschen sieht?
    a) ☐ Sie läuft auf ihn zu
    b) ☐ Sie greift ihn an
    c) ☐ Sie warnt mit einem lauten Miau
    d) ☐ Sie bleibt in ihrem Versteck

10. Was frisst die Wildkatze am liebsten?
    a) ☐ Eidechsen
    b) ☐ Vögel
    c) ☐ Mäuse
    d) ☐ Frösche

11. Wo jagt eine Wildkatze ihre Beute?
    a) ☐ In einem Wald ohne Verstecke
    b) ☐ Oben in den Bäumen
    c) ☐ Auf Wegen
    d) ☐ In einem Wald mit vielen Verstecken

12. Kannst Du eine Wildkatze zu Hause als Haustier halten?
    a) ☐ Ja, wenn ich sie füttere
    b) ☐ Nein, die Wildkatze ist kein Haustier
    c) ☐ Ja, sie ist zwar am Anfang scheu aber wird dann zutraulich
    d) ☐ Nein, weil sie den Menschen angreift

13. Gibt es Unterschiede zwischen Hauskatzen und Wildkatzen?
    a) ☐ Wildkatzen sind keine Hauskatzen
    b) ☐ Wildkatzen gehören zu den Löwen
    c) ☐ Wildkatzen sind verwilderte Hauskatzen, die weggelaufen sind
    d) ☐ Hauskatzen und Wildkatzen sind dasselbe

8.1.4 Preliminary test preconceptions

1. Welche Teile des Auges brauchen wir zum Sehen? **Kreuze an** und beschreibe ihre Aufgabe!

x	Teil des Auges	Aufgabe
	Augenbraue	
	Wimpern	
	Augapfel	
	Pupille	
	Regenbogen-haut (Iris)	
	Netzhaut	

2. Können wir auch im Dunkeln sehen?

☐ Ja, wir können auch im Dunkeln sehen

☐ Nein, wir können nicht im Dunkeln sehen

Erkläre Deine Antwort!

3. Wer sieht in der Dämmerung besser- die Katze oder der Mensch?

☐ Die Katze sieht besser

☐ Der Mensch sieht besser

Erkläre Deine Antwort!

Überlege: Gibt es bei der Katze im Auge Teile, die der Mensch nicht hat und andersherum?

8.1.5 Conceptual change questionnaire

Fragebogen zum Sehen in der Dämmerung- Kreuze an!
Es können auch mehrere Antworten richtig sein!

1. Wozu brauchen Menschen und Wildkatzen im Auge die Regenbogenhaut?

a)	☐	Die Regenbogenhaut hält das Auge fest
b)	☐	Die Regenbogenhaut macht die Pupille größer und kleiner
c)	☐	Damit das Auge schöner aussieht
d)	☐	Die Regenbogenhaut schützt die Pupille
e)	☐	Die Regenbogenhaut macht, dass man Farben sehen kann
f)	☐	Ich weiß es nicht
g)	☐	Die Regenbogenhaut hat verschiedene Farben

2. Warum können Wildkatzen in der Dämmerung besser sehen als Menschen?

a)	☐	Weil die Pupillen der Wildkatze in der Dämmerung größer werden als die des Menschen
b)	☐	Weil die Augen der Wildkatze das Licht reflektieren
c)	☐	Weil die Pupillen der Wildkatze in der Dämmerung kleiner werden als die des Menschen
d)	☐	Weil die Augen der Wildkatzen leuchten
e)	☐	Weil die Wildkatze nachtaktiv ist
f)	☐	Weil die Wildkatze eine andere Regenbogenhaut hat als der Mensch
g)	☐	Ich weiß es nicht

3. Können Menschen etwas sehen, wenn es ganz dunkel ist?

a)	☐	Ja, weil die Augen der Menschen in der Dunkelheit leuchten
b)	☐	Ich weiß es nicht
c)	☐	Nein, weil Menschen nicht nachtaktiv sind
d)	☐	Ja, weil die Pupille der Menschen dann ganz groß wird
e)	☐	Ja, Menschen können sehen, wenn es ganz dunkel ist, sie müssen sich nur an die Dunkelheit gewöhnen
f)	☐	Nein, weil die Pupille der Menschen zu klein ist
g)	☐	Nein, weil Menschen Licht zum Sehen brauchen

8.2 Materials

8.2.1 Workbook

For all approaches the same workbook was used. For the stronger student-centered approach additional material was provided.

Wildkatzen-Forschungsbericht von

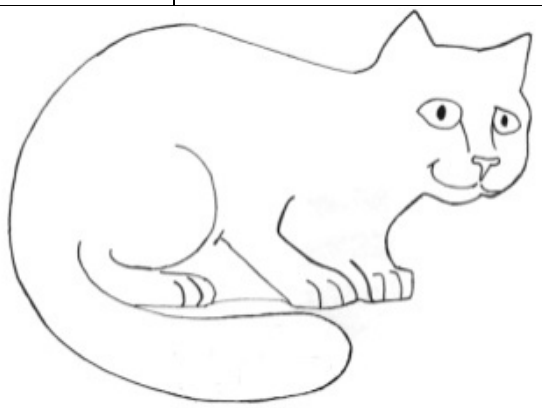
STATION 1- ERKENNEN

1.Dein erster Auftrag: Betrachte die beiden Katzen im Glaskasten. Hast Du schon eine Idee, welche die Wildkatze ist?

2.Fülle die Tabelle aus:

	Wildkatze	**Hauskatze**
Farbe des Fells	*ockerfarbenes bis rötliches Fell, schwache Fellzeichnung*	*vielfarbig, oft stark ausgeprägte Fellzeichnung*
Besonders fällt auf:	*Schwarzer Strich auf dem Rücken*	*-*
Körper-Form:	*gedrungen, „dicker“*	*zierlicher, „dünner“*
Form des Schwanzes	*abgerundetes Schwanzende*	*spitz endender Schwanz*
Farbe des Schwanzes	*2 bis 8 schwarze Schwanzringe*	*keine oder nur selten Schwanzringe*

3.Male in das Bild, wie der Schwanz der Wildkatze aussieht:



Die Wildkatze ist kein *Haustier* _____!

STATION 2- LEBENSRAUM

1.Wie viele Tiere erkennst Du? Trage die **Anzahl** in die Kästchen ein:

[0] Schlange	[1] Vogel
[2] Wildkatze	[0] Reh
[1] Fuchs	[0] Wildschwein

2. Bringe die Satzteile in die richtige Reihenfolge:

[2] ist die Wildkatze im Wald gut getarnt
[4] und sich gut verstecken
[3] und kann sich unbemerkt an ihre Beute anschleichen
[1] Weil ihr Fell so unauffällig ist,

3. Findest Du den Begriff, der alle Wörter zusammenfasst? Schreibe ihn in die Zeichnung:

Reisighaufen
Umgefallene Bäume
Steinhaufen
Baumhöhlen
Gebüsche

4. In einem **naturnahen** Wald findet die Wildkatze alles, was sie braucht.

Deshalb ist dieser Wald ihr *Lebensraum*.

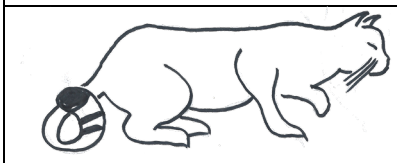
STATION 3- VERHALTEN

1. Die Wildkatze kann aus dem Stand sehr weit springen. Wie weit schaffst Du es? Trage ein:

so weit springe ich: _____

so weit springt die Wildkatze: _____

2. Wie jagt die Wildkatze? Ordne die Puzzleteile und fülle dann die Tabelle aus:

So sieht die Wildkatze aus:	**Das macht die Wildkatze:**	**Das kann die Wildkatze, weil sie…**
	*Anschleichen*	*gut getarnt ist*
	*Lauern*	*sich gut verstecken kann*
	*Springen*	*weit springen kann*
	*Beute fassen*	*spitze Zähne und scharfe Krallen hat*

3. Sortiere die Buchstaben:

Die Wildkatze ist ein ICSCHLEH (*Schleich*)- Jäger

und frisst MESUÄ (*Mäuse*).

4. Wem gehören diese Spuren? Trage ein:

Spur		Tier
A		*Katze / Wildkatze*
B		*Hund*

5. Fülle die Lücken aus:

Die Wildkatze hat *scharfe* Krallen. Wenn sie läuft, hat sie die Krallen immer *eingezogen*, deshalb sieht man sie *nicht* auf der Spur.

WARUM GEHT DIE WILDKATZE NICHT IN DIE ANDEREN WÄLDER?

Wir wissen jetzt, wo sich die Wildkatze *aufhält/ wohlfühlt*.

Wenn aber zwischen zwei *Wäldern/ Lebensräumen*

Stellen sind, die sie nicht überqueren kann, dann bleibt sie, wo sie ist.

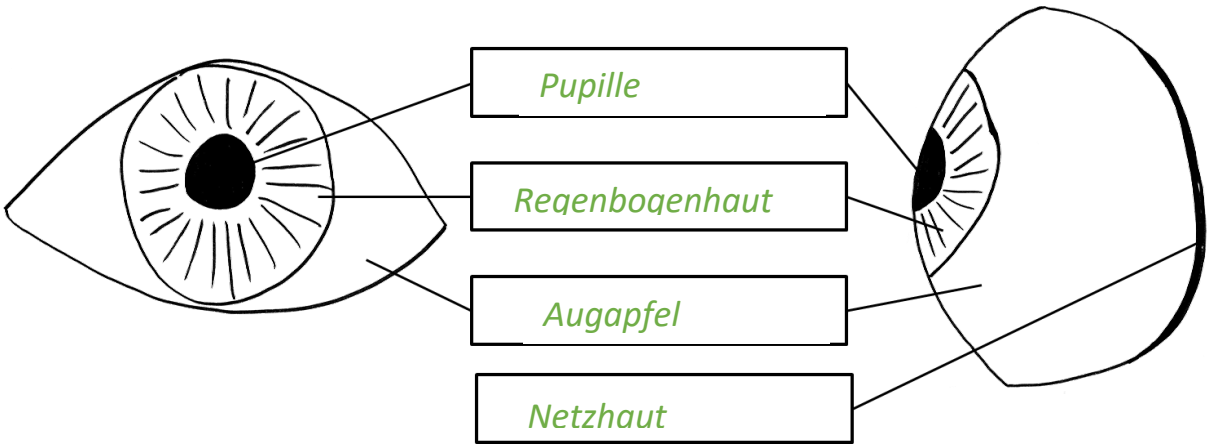
Damit die Wildkatze *wieder* in Deutschland leben kann, planen Menschen in Deutschland *Grünbrücken* für die Wildkatzen, damit sie von einem Lebensraum in den anderen laufen können.

Wenn Du Lust bekommen hast, der Wildkatze zu helfen, kannst Du in einer Naturschutzgruppe mitmachen!

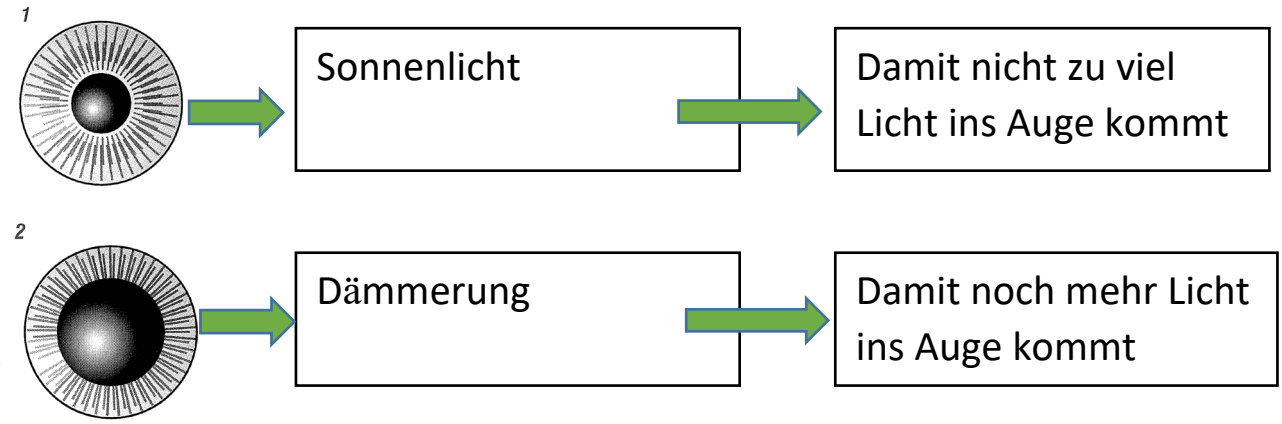
DAS AUGE

Um herauszufinden, warum Wildkatzen in der Dämmerung besser sehen können als Menschen, müssen wir unsere Augen und die der Wildkatze genauer erforschen.

1.Beschrifte: Pupille, Regenbogenhaut, Augapfel, Netzhaut



2. Ordne mit Pfeilen zu, wie sich die Pupille des Menschen verändert:



3. Fülle die Lücken aus:

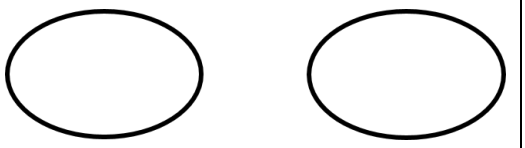
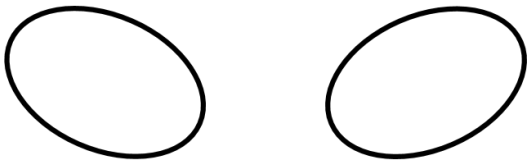
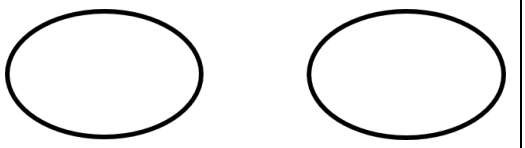
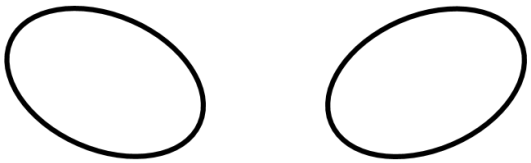
Die Pupille ist ein *Loch* im Auge, durch das *Licht* ins Auge fällt.

Dieses *Licht* braucht das Auge zum *Sehen*.

Wenn es ganz dunkel ist, sieht der Mensch *nichts*.

DAS AUGE

4.Wir kennen nun unsere Pupillen. Wie unterscheiden sie sich von denen der Wildkatze? Zeichne die Pupillen ein:

	Mensch	Wildkatze
Sonnenlicht		
Dämmerung		

5. Fülle den Lückentext aus:

Die Pupillen der Wildkatze werden in der Dämmerung noch *größer* _____ als die des Menschen, deshalb kommt mehr *Licht* _____ hinein und die Wildkatzen können in der Dämmerung *besser* _____ sehen als die Menschen. Wenn es ganz dunkel ist, sehen auch Wildkatzen *nichts* _____.

Die Regenbogenhaut verändert die *Größe/ Form* _____ der Pupille. Sie macht die Pupille also *größer* _____ und *kleiner* _____. Zum Farbensehen brauchen Menschen und Wildkatzen die Regenbogenhaut *nicht* _____.

8.2.2 Workstation materials wildcat

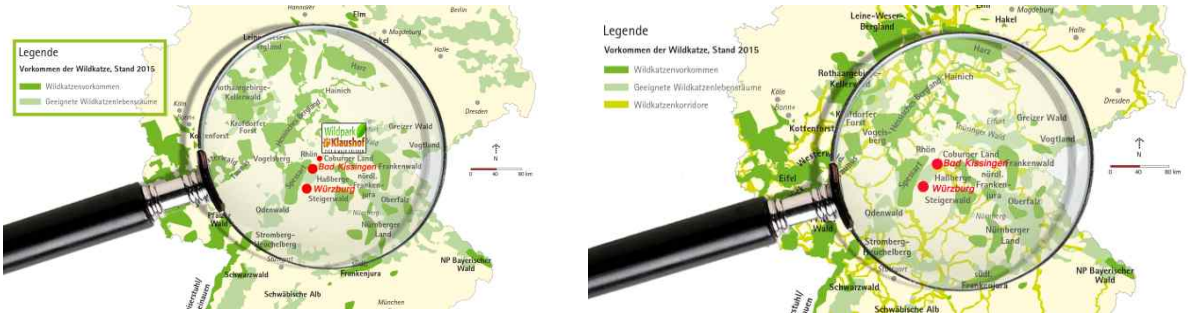


Figure 6: Wildcat habitats in Germany. Left: without corridors, right: with corridors.
(The maps can be found on www.bund.net, they were adapted by Simone Körber)

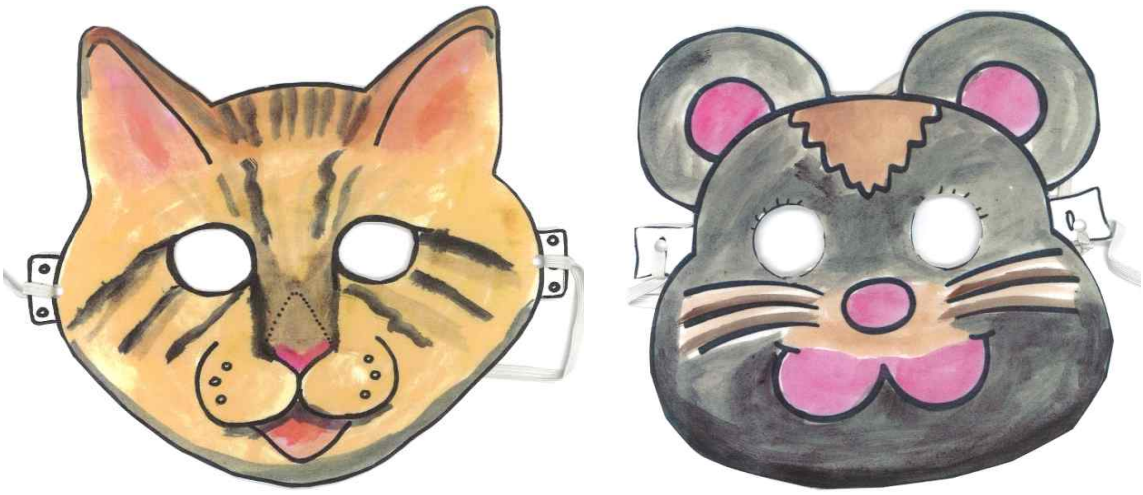


Figure 7: Masks. Left: Wildcat, right: mouse (The masks were drawn by Ruth Freudinger)

Stationsplan

Bearbeite die **Stationen mit deiner Gruppe genau in der Reihenfolge**, wie sie hier steht!
Wenn du eine Station bearbeitet hast, kannst du hier ein Kreuzchen machen.
Kreuze zusätzlich an, ob du **Hilfe** gebraucht hast!

Diese Stationen habe ich schon bearbeitet:

☐	Station 1: Hauskatze = Wildkatze?	mit Hilfe?	☐
☐	Station 2: Meister der Tarnung	mit Hilfe?	☐
☐	Station 3: Was frisst die Wildkatze?	mit Hilfe?	☐
☐	Station 4: Echt bissig!	mit Hilfe?	☐

Pfoten

Ein Abdruck gehört dem Hund, der andere Abdruck gehört der Wildkatze und der Hauskatze. Sie haben den gleichen Pfotenabdruck. Die Wildkatze braucht ihre scharfen Krallen nur zum Beute fassen, nicht zum Laufen. Sie kann ihre Krallen einziehen. Der Hund braucht seine Krallen auch zum Laufen, da er sich damit beim Rennen gut abdrücken kann.

8.2.3 Workstation materials vision

Figure 8: Eye models. Left: cat's eye with reflective tape, right: human eye (picture taken by Sabine Glaab)

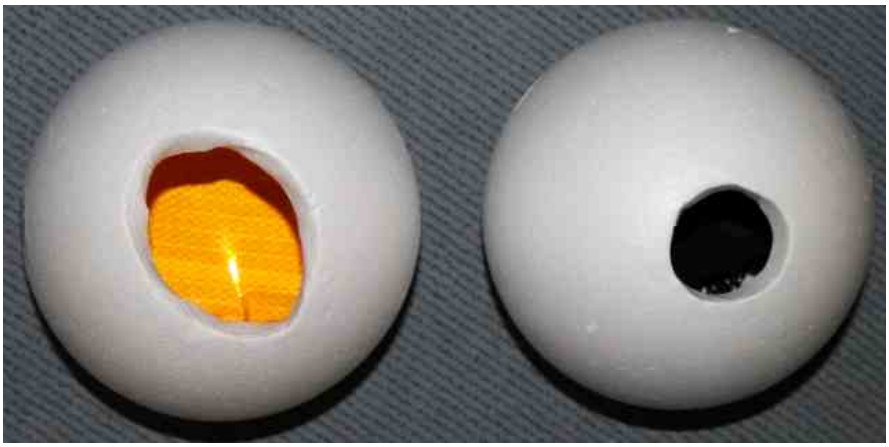


Figure 9: Eye models with flash fotography (picture taken by Sabine Glaab)

8.3 Schedules (Artikulationsschema)

8.3.1 Intervention I (wildcat)

The schedule was used for all teaching approaches. All steps were used as shown in the schedule for the teacher-centered instruction. For guided as well as the stronger student-centered approach, the beginning through step 2.2 as well as steps 2.5 through the end did not differ from the teacher-centered instruction. The middle part was omitted altogether for the stronger student-centered approach. For "guided learning at workstations" the middle part stressed student's self-acting work as described in the text.

Zeit	Art. Stufe	Unterrichtsverlauf	U-Mittel
9:00	Busparkplatz	Klären der Regeln: Ruhezeichen Durchgehen bis zum Grünen Klassenzimmer	
9:20	Grünes Klassenzimm.	Ausgabe der Namensschilder, Klemmbretter und Arbeitshefte	
9:30	I.Hinführung 1.1Motivation (im Gehege)	Abklären: Ruhe im Wildkatzengehege Beobachten der Wildkatze im Gehege während der Fütterung	originale Natur-begegnung
	1.2Problem-begegnung (gegenüber der Stopf-Präparate)	Wildkatze-Verbreitung und potentielle Lebensräume in Deutschland Stummer Impuls, SuS betrachten die Karte Was seht ihr hier? S: Das ist eine Landkarte von Deutschland Da sind grüne Flecken drauf,… L: Liest Du bitte vor, was dieses Grün bedeutet? S: Wildkatzenvorkommen L: Wisst ihr, was das bedeutet? S: Da gibt es die Wildkatze L: Liest Du bitte vor, was das helle Grün bedeutet? S: Geeignete Wildkatzenlebensräume L: Wisst ihr, was das bedeutet? S: Da könnte die WK leben L: Genau. Überall, wo es grün ist, kann die WK leben. Und was ist mit den vielen weißen Stellen? S: Da kann sie nicht leben	Landkarte: Verbreitung ganz Deutschland Landkarte: Ganz Deutschland mit Lupe Landkarte: gezoomter Ausschnitt
	1.3Problem-findung	L: Die WK kommt nur an den dunkelgrünen Stellen vor und könnte nur in den hellgrünen leben. Nirgends sonst. Könnt ihr euch vorstellen, wie unsere Frage heute lautet? S: Warum kommt die Wildkatze nur an diesen Stellen vor?	Landkarte
	1.4 Zielangabe	L: Genau. Wir wollen wissen, was an diesen Stellen so besonders ist, so dass die WK nur dort vorkommt. Habt ihr schon Ideen, woran das liegen könnte?	
	II Erarbeitung 2.1 Zielgerichtete Vermutungs-bildung	Freie SÄ: Sie finden nur dort Nahrung, haben dort keine Feinde, Sie fühlen sich wohler, bleiben immer da, wo sie geboren sind. L sammelt die Äußerungen. hält sie fest	Whiteboard, Edding
		L: Wie können wir nun herausfinden, ob unsere Vermutungen stimmen?	
		S: Wir können die Wildkatze beobachten etc. L: Ich habe euch ja erzählt, dass ich ein Forscher bin. Wie würde ein Forscher herausfinden, warum die WK nur dort vorkommt?	

		S: der würde sie untersuchen, sie beobachten,… L: Und wir wollen heute alle Wildkatzenforscher sein und es herausbekommen.	
	2.2Lösungs-planung	L: Zum Glück sind wir hier im Wildpark in einem solchen Wald, in dem die Wildkatze vorkommt. Hier können wir forschen. Was müssen wir alles wissen, um unsere Frage zu beantworten?	
		(1) Wir müssen sie erkennen können (von der Hauskatze unterscheiden) Station 1- ERKENNEN „wie sie aussieht“ (2) Wir müssen wissen, was sie zum Leben braucht Station2- LEBENSRAUM „Was sie braucht“ (3) Wir müssen wissen, wie sie lebt Station 3- VERHALTEN „Wie sie lebt“ L hält die Stationen fest, werden später abgehakt	Laminierte Stations-karten, Edding
09:40	2.3Feinziele 1. Feinziel: Erkennen	Betrachten der Stopfpräparate im Glaskasten	Stopfpräp.
		Arbeitsauftrag: Betrachtet die beiden Katzen	
		L: Hebt Kärtchen Wildkatze und Hauskatze in die Höhe Welches ist die Wildkatze, welches die Hauskatze?	Lam. Kärtchen
		S: die mit dem geringelten Schwanz ist die WK etc.	
		L: heftet Kärtchen unter die entsprechenden Bilder am Flipchart, im Laufe der Erarbeitung werden fertige Kärtchen und Kärtchen, die mit den Aussagen der SuS beschriftet wurden, an die Tabelle geheftet. Die SuS übertragen die Merkmale in ihr Arbeitsheft L: Welche Merkmale sind euch aufgefallen? S: Ohren, Schwanz, Fell etc. L: Fangen wir mal mit dem Fell an. Wie ist das bei der WK? S: grau, braun, ocker, beige, schwarz etc. L: Und bei der Hauskatze S: grau, schwarz, bunt L: also immer unterschiedlich, oder? Und das von der WK? S: immer gleich! L: Genau L: heftet Kärtchen an: Farbe des Fells L: Jetzt denkt mal daran, wie die WK die Mäuse gefressen hat, wie hat sie das gemacht? S: Sie hat sich umgedreht L: Ist euch etwas auf dem Rücken aufgefallen? S: ein schwarzer Strich L: Hat die Hauskatze den auch? S: nein. L: Was sagt ihr denn zum allgemeinen Aussehen. S: die WK ist größer L: genau L: Was können wir über den Schwanz sagen? Stellt euch vor, ihr seht eine Hauskatze, die die selbe Farbe hat wie die Wildkatze. Ist dann der Schwanz auch gleich? S: der Schwanz ist buschig L: Und der von der Hauskatze? S: dünn, spitz, etc. L: schaut euch mal das Ende des WK-Schwanzes an. Was fällt auch da auf? S: der hat Streifen L: genau. Und ganz am Ende? S: ist er schwarz L: Malt den Schwanz der WK in die Zeichnung im Forscherheft.	Flipchart mit Tabelle, Lam. Kärtchen Arbeitsheft Karte Farbe des Fells Beschriftung Karte mit Farbe Beschriftung Karte Besonders fällt auf Schwarzer Strich Körperform Form des Schwanzes Farbe des Schwanzes

		L: Wir wissen jetzt, wie wir die Wildkatze und die Hauskatze unterscheiden. Die Hauskatze ist ein….. S: Haustier L: Die Wildkatze ist….. S: kein Haustier! L: Fülle die Lücke im Forscherheft aus	Arbeitsheft
	Feinziel-sicherung 1	L: Wer liest noch einmal die Unterschiede vor? S:…. L: Die erste Station haben wir schon, hakt Station 1 ab. Wir gehen zur nächsten Station. Ich bin die Erste. Ihr habt Überholverbot.	laminierte Karte „Station 1“
10:00	2.Feinziel Lebensraum	Lebensraum der WK mit versteckten Tieren L: Lies den ersten Arbeitsauftrag vor L: Bitte suche leise und sage nicht vor	Tarnungs-Station
		S: suchen, tragen Anzahl ein	AH
		L: Lies bitte Deine Lösung vor Gemeinsame Lösung: 1 Fuchs, 1 Vogel, 2 WK	
		L: Warum sieht man die WK so schlecht? S: Weil sie gut versteckt ist. L: Könnt ihr den Arbeitsauftrag 2 schon in die richtige Reihenfolge bringen? L: Was bedeutet „getarnt“? S: Sie kann sich gut verstecken	AH
		L: Wo kann sich die WK denn hier gut verstecken?	
	Feinziel-sicherung Verstecke	S: Hinter den Steinen, in hohlen Bäumen, unter Reisighaufen, hinter umgefallen Bäumen, im Gebüsch L: dann kannst Du sicher schon die Aufgabe 3 beantworten. Welcher Begriff ist gesucht? S: Verstecke. S: Schüler tragen „Verstecke“ ins AH ein	AH
		L: Ein Wald voller Verstecke ist ein naturnaher Wald. L: Lies bitte die Nummer 4 vor S: In einem naturnahen Wald findet die WK alles, was sie braucht, deshalb ist dieser Wald ihr… S: Lebensraum	AH
		L: Was muss es in ihrem Lebensraum noch geben? L: Das kann sich auch gut verstecken S: Nahrung L: Genau! Wollen wir mal schauen, ob wir auf dem Weg Nahrung für die WK finden?!	
	(Station Drehelemente Beute) Feinziel-sicherung Lebensraum	Drehelemente L: Was denkt ihr, was frisst die WK am meisten hier im Wald? S: Mäuse. L: Super! Jetzt haben wir schon die zweite Station abgehakt, den Lebensraum der WK. Wer kann noch einmal zusammenfassen, was die WK braucht? S: Verstecke, Mäuse	Nahrungs-station
10:15	Station Balancieren und Springen	Springen, Balancieren L: Wie weit schafft ihr es, aus dem Stand zu springen? Jeder hat nur einen Versuch! Merkt euch eure Weite und die der WK	Station Balancieren, Springen Maßband
	Station Gebiss	L: Wer kann mir das Gebiss der WK beschreiben? L: Sehen alle Zähne gleich aus? L: Welche Form haben die Zähne? S: Spitze Zähne, unterschiedliche Zähne	Station Gebiss
10:30	PAUSE Grün. Klass.	Trinken, Essen, Beruhigen (Karten und Whiteboard holen!)	

10:45	3. Feinziel	L:Was haben wir vor der Pause alles gelernt? S: Die WK braucht Verstecke, Frisst Mäuse S: Die WK hat scharfe Zähne S: Die WK kann gut springen L: Wofür braucht sie das alles? S: Zum Jagen! L: Kann sich schon jemand vorstellen, wie die WK jagt? S: Sie schleicht sich an S: Sie rennt hinter den Mäusen her L: Ich habe euch ein Puzzle mitgebracht, wie die WK jagt. Könnt ihr das zusammenlegen? S: Puzzlen L: So sieht die WK aus. Was macht sie? S: Sich anschleichen L: Warum kann Sie das gut? S: weil sie gut getarnt ist Dito: Lauern, Springen, Beute Fassen	Puzzle Filztafel
	Feinziel-sicherung 3	L überträgt Puzzle an Filztafel S übertragen Tabelle ins AH	laminierte Kärtchen, AH
		L: Wer fertig ist, kann schon mit der Nummer 3 anfangen. Sortiere die Buchstaben S: Die WK ist ein Schleich-Jäger und frisst Mäuse	
		L: Schaut euch die Spuren bei der Nummer 4 an. Was denkt ihr, wem gehören sie? S: A Hauskatze, B Wildkatze S: A Hund, B Wildkatze o.ä. L: ich gebe euch einen Tipp. Eines ist die Wildkatze, eines ein Hund S: Vermuten L: Braucht die WK ihre Krallen zum Laufen? S: nein, nur zum Beute fassen L: Und der Hund? S: Der muss seine Nahrung hetzen, also gut rennen können L: Mit den Krallen kann der Hund sich gut abdrücken beim Rennen. Muss die WK auch Rennen, um zu Jagen? S: nein, sie schleicht sich ja an L: Also, was denkt ihr, welche Spur gehört zur WK, welche zum Hund? S: A= Wildkatze B= Hund. L: genau. Lies bitte die Nummer 5 vor. Wer weiß, was in die Lücken gehört? S: Die Wildkatze hat scharfe Krallen. Wenn Sie läuft, hat sie die Krallen immer eingezogen, deshalb sieht man sie nicht auf der Spur L: Prima. Jetzt haben wir schon die letzte Station abgehakt, was wir alles über die WK wissen wollten Hakt Station 3 Verhalten ab	Arbeitsheft Laminierte Karte
		Jetzt wollen wir spielen, wie die WK jagt. L verteilt Masken Wildkatze und Maus L: Ihr zwei macht das mal bitte vor, alle schauen zu Zwei Schüler spielen vor, die anderen kommentieren. L: War das ein gutes Anschleichen, Lauern etc.? L: Rennt die Katze der Maus hinterher? S: Nein, sie schleicht sich an. L: Sehr gut. Jetzt dürfen alle das Jagen ausprobieren S: Spielen Jagd auf dem Platz vorm Grünen Klassenzimmer	Masken

11:15	2.5 Überprüfung der Vermutungen (Grünes Klassenz.)	Whiteboard mit Vermutungen der Schüler wird geholt, Die abgehakten Stationenkarten werden an die Filztafel geheftet L: Was können wir jetzt über unsere Vermutungen sagen? Richtiges wird abgehakt, falsches durchgestrichen L: Wisst ihr jetzt, warum die WK nur in den grünen Flecken auf der Landkarte leben kann? S: Weil sie nur dort Verstecke, Nahrung etc. findet	Whiteboard Filztafel Whiteboard Landkarte
	III Vertiefung	Landkarte Verbreitung mit Lupe L: Also. Wir wissen jetzt, warum die WK in den grünen Gebieten lebt. Aber warum lebt sie nicht in den hellgrünen?	
		S: Sie kommt nicht über die Straßen etc. S: Sie bleibt dort, wo sie geboren ist S: sie hat Angst vor Feinden S: sie hat Angst vor Hunden L: Das sind alles gute Ideen, aber das richtige war noch nicht dabei. Lasst uns das mal nachbauen. L legt Spieleteppich mit der bunten Seite nach unten auf den Boden vor dem Grünen Klassenzimmer	
		L: ich brauche vier Kinder hier auf dieser Seite und vier auf der anderen Seite S: stellen sich im Viereck auf und halten Absperrband fest. Das Absperrband wird mit Steinen am Boden fixiert	Teppich mit Straßen und Häusern Band
		L: Jetzt wollen wir hier einmal aufbauen, was die WK alles braucht. S bauen Reisighaufen, umgefallene Bäume, Steinhaufen, laminierte Bilder Mäuse in eines der abgesteckten Gebiete. L: hier geht es der WK gut, hier lebt sie L legt laminiertes Bild der WK in das Viereck L: Welche Farbe hat dieses Gebiet auf unserer Karte? S: Grün L: Jetzt stellen wir uns vor, hier drüben ist ein hellgrünes Gebiet. Was heißt das? S: da könnte die WK leben L: Also wie muss es dort aussehen? S: wie da drüben S bauen wieder Reisighaufen etc. wie oben nur ohne Wildkatzenbild L dreht Teppich um. L: Jetzt stellen wir uns vor, zwischen den zwei Gebieten sind Straßen, Häuser, Felder (legt grünen Teppich dazu) S: Sie kann nicht rüber, weil sie sonst überfahren wird, nicht getarnt ist, keine Mäuse findet etc. L: Ganz genau. Also warum kann die WK nicht in die geeigneten Gebiete? Ruft einen Schüler auf, der noch nichts gesagt hat. S: wiederholt Gründe.	Steine Äste Zweige Bild Maus Bild Wildkatze Oder Plüsch-WK Grüner Teppich

		L: Und jetzt möchte ich von euch wissen, was wir Menschen tun können, um der WK zu helfen, diese Stellen zu überwinden. S: Wir müssen es so machen, wie sie es gerne mag L: und wie ist das? S: Verstecke, Mäuse L: Wir können das tatsächlich. Wir können einen Übergang schaffen, in dem sich die WK wohlfühlt. Wie können wir das machen? S: wir können Bäume pflanzen, Verstecke machen L: Genau. Wisst ihr, wer das macht? S: Umweltschutzgruppen, Naturschutzgruppe etc. L: richtig. Hier seht ihr, wie das dann aussehen kann L: Wir wollen uns noch mal hinsetzen und den Lückentext ausfüllen	Modell Landkarte mit Korridoren Bild Grünbrücke
	IV Gesamt-sicherung	L: Wir wissen, wie wir die WK erkennen. Wisst ihr es noch? S: Fell, Schwanz etc. L: Wir wissen, was die WK braucht S: Verstecke, Mäuse L: Wir wissen, wie die WK jagt S: Anschleichen, Lauern etc. L: Lies den Lückentext vor S: Wir wissen jetzt, wo sich die WK wohlfühlt. Wenn aber zwischen zwei Lebensräumen Stellen sind, die sie nicht überqueren kann….Damit die WK überall in D leben kann, planen Menschen in D Korridore/ Wege/ Übergänge….	Station 1 Karte Station 2 Karte Station 3 Karte
11:40		Concept Map Nachtest: Wissenstest und Motivationstest	
12:00	Wildpark Eing. bereich	Spaziergang durch den Wildpark, Tiere streicheln und füttern, Spielplatzbesuch	
12:30	Grünes Kl.	Mittagspause	

8.3.2 Intervention II (vision)

Zeit	Art. Stufe	Unterrichtsverlauf	U-Mittel
	Grobziel:	Warum sehen Katzen besser in der Dämmerung als der Mensch	
13:00	I.Hinführung 1.1Motivation (Guckkästen)	Guckkästen S blicken durch die Guckkästen	Guckkästen Gedrückt halten!!
	1.2Problem-begegnung	L: Was habt ihr denn gesehen? S: Maus war schwierig zu sehen. L: und beim anderen Kasten (Katze)?	
	1.3Problem-findung	S: Die Katze kann die Maus besser sehen L: Das haben im Fragebogen viele von euch schon gewusst. Jetzt wollen wir noch wissen, WARUM das so ist. Wie lautet also unsere Frage?	Whiteboard mitnehmen!
	1.4 Problemfrage	S: Warum sieht die Katze besser in der Dämmerung als der Mensch?	
	II Erarbeitung 2.1 Zielgerichtete Vermutungs-bildung	Freie SÄ: Das ist ein Nachtsichtgerät, da ist irgendwo Licht, das ist wie bei dem Auge von der Katze etc. L sammelt die Äußerungen. hält sie fest	 Whiteboard
	2.2Lösungsplanung	L: Zum Glück sind wir ja immer noch Wildkatzenforscher. Also wollen wir weiterforschen. Was müssen wir denn herausfinden?	
		Wie das Auge von der Katze funktioniert Wie unser Auge funktioniert Was anders ist L: Genau. Damit wollen wir jetzt anfangen	
	2.3Feinziele 1.Feinziel: Auge des Menschen-Beschriften Pupille, Regenbogenhaut, Netzhaut,	S kennen die Bauteile des menschlichen Auges: Pupille, Regenbogenhaut, Netzhaut S betrachten Auge des Nebenmannes L: Was seht ihr alles im Auge? S: Regenbogenhaut, Pupille, Augapfel L: Heftet Kärtchen an die Tafel Beschriftung mit Kärtchen L: eine Struktur habt ihr nicht gesehen. S: die Netzhaut! L: Die ist ganz hier hinten im Auge	 Schüler-selbst-versuch Filztafel Laminierte Kärtchen Augenmodell
	Feinziel-sicherung 1	S: Übertragen die Beschriftungen ins Arbeitsheft	Arbeitsheft
	2.Feinziel Pupille	Jetzt hältst Du Dir die Augen zu, lässt die Augen dabei aber offen. Nimm ganz schnell die Hände weg, wenn Dein Partner schaut. Was passiert mit der Pupille?	Selbst-versuch
		S: Selbstversuch, Vermuten L: Lies den Arbeitsauftrag 2 vor. S: Ordne mit Pfeilen zu,…. L: Wer weiß, wie es richtig ist? Gemeinsames Verbessern der Pfeile L: Jetzt wollen wir genau erforschen, was die Pupille ist. Habt ihr eine Idee? S: ein Fleck, das Schwarze im Auge etc. L: Könnt ihr euch vorstellen, dass die Pupille ein Loch ist? S: NEIN. L: Schaut mal her: Ich nehme unser Augenmodell mit der Netzhaut, dieses Mal die Vorderseite. L hält Pupillenloch hoch. S: Da kann man doch durchgucken!	AH Augenmodell Pupille

		L: stimmt. Aber in unserem Auge gibt es noch mehr Schichten. Eine davon ist dunkel. L klebt schwarze Folie ins Augenmodell, schraubt Hälften aufeinander, hält es hoch S: Jetzt ist es schwarz! L: Die Pupille ist wirklich ein Loch! Und warum? S: weil da das Licht durchgeht. L: Genau. Sonst geht das Licht nirgendwo durch. Nur an der Pupille.	
	SV: Sehen in der Dunkelheit.	L: Viele von euch haben angegeben, dass wir im Dunkeln sehen können. Haltet euch noch mal alle die Hände vor die Augen, so dass es ganz dunkel ist. Seht ihr jetzt noch etwas? S: nein. L: Gewöhnt ihr euch an die Dunkelheit? S: Nein. L: Genau. Wenn garkein Licht da ist, sehen wir nichts. Weil wir das Licht zum Sehen brauchen. S: Aber ich sehe im Dunkeln. L: Woran könnte das dann liegen? Straßenlampe, Mond, Licht aus anderem Haus /Zimmer etc.	
	Feinziel-sicherung 2	L: Lies den Arbeitsauftrag Nummer 3. S: Fülle die Lücken aus L: Wir lesen gemeinsam S: Die Pupille ist ein Loch im Auge, durch das Licht ins Auge fällt. Dieses Licht braucht das Auge zum Sehen. Wenn es ganz dunkel ist, sieht der Mensch nichts.	Arbeitsheft
	3. Feinziel: Regenbogen-haut ändert Größe der Pupille, Katze hat größere Pupille	L: Wir sind jetzt im Forscherheft bei der Nummer vier. Wer weiß noch, wie unsere Pupillen im Sonnenlicht und in der Dämmerung aussehen? S: kleiner Kreis, großer Kreis L: Sehr gut. Malt das schon einmal ein. Wisst ihr auch, wie die Pupillen der Katze aussehen? S: Striche im Hellen und rund in der Dämmerung L: werden die Pupillen der Wildkatze in der Dämmerung auch größer? S: Ja. L: warum? S: Damit mehr Licht hineinkommt. L: Denkt ihr, dass die Pupillen der Menschen und Katzen in der Dämmerung dann so aussehen? S vermuten ja, nein, größer, kleiner L: wir wissen ja, dass die Katzen besser in der Dämmerung sehen als die Menschen, also was denkt ihr? S: größer L: Genau. Die Pupillen der Wildkatze werden in der Dämmerung NOCH größer als die des Menschen. Malt das in euer Forscherheft. L: Lies den Arbeitsauftrag 5 Gemeinsames Ausfüllen des Lückentexts Pupille der Wildkatze in der Dämmerung. L: Die Pupillen können also größer und kleiner werden. Aber wie geht das, wenn die Pupille doch ein Loch ist? S: das außenrum muss die Pupille verändern L: Was ist außenrum? S: Die Regenbogenhaut L: Sehr gut. Die Regenbogenhaut macht die Pupille größer und kleiner. Weiter im Lückentext Gemeinsames Ausfüllen des Lückentexts bis „Zum Farbensehen brauchen Menschen und Wildkatzen die Regenbogenhaut……“	Arbeitsheft Laminierte Karte Pupillen der Katze Laminierte Karte Provokation Arbeitsheft

	SV Farben Sehen	Viele von euch haben gedacht, man braucht die Regenbogenhaut, um Farben zu sehen.	
		Dann müsste jemand mit grünen Augen ja nur grün sehen und jemand mit blauen Augen nur blau. Ist das so? L hält die laminierten Karten hoch S: NEEEIIN L: genau, wir sehen alle Farben. Die Regenbogenhaut hat mit dem Farbensehen nichts zu tun. Was ist ihre Aufgabe? S: Sie macht die Pupille größer und kleiner L: Richtig. Was kommt also in die letzte Lücke? S: „Zum Farbensehen brauchen Menschen und Wildkatzen die Regenbogenhaut nicht“.	Bildkarten blau, grün, braun
	Feinziel 3 **SV Augen der Katze leuchten**	Viele von euch haben geschrieben, dass die Katze besser sieht, weil ihre Augen im Dunkeln leuchten. Ist das so? Bild von Scheinwerferaugenkatze L hält das Bild hoch S: quatsch, das ist nicht so! L: Wie ist es denn? S: die Augen reflektieren /leuchten nur, wenn man sie anstrahlt etc. L: Genau. So sieht die Katze aus, wenn man sie im Dunkeln anstrahlt. Ihre Augen leuchten nicht, sie reflektieren! So kann die Katze das Licht, das durch die Pupille kommt, doppelt nutzen	63 von 450 Bildkarte Scheinwerfer Bildkarte Reflektor-augen
		L nimmt das Augenmodell des Auges der Katze mit der Reflektorschicht und der Netzhaut darauf. L: wenn man bei der Katze hinter die Netzhaut schaut (nimmt Netzhaut heraus), ist dort eine Reflektorschicht. L baut das Auge wieder zusammen und leuchtet mit der Taschenlampe durch die Pupille.	Modell Auge Katze
	Überprüfung d. Vermutung.	L holt Whiteboard mit Vermutungen. Richtige werden abgehakt, falsche durchgestrichen.	
14:00	IV Gesamt-sicherung	L: Jetzt wollen wir noch einmal alles zusammenfassen, was wir gelernt haben. S: Katze sieht besser in der Dämmerung, weil Pupille größer wird und weil Auge das Licht reflektiert S: Pupille ist ein Loch, Regenbogenhaut verändert Größe der Pupille, im Dunkeln sehen Menschen und Wildkatzen nichts, weil wir alle Licht zum Sehen brauchen.	
14:10		Nachtest Schülervorstellungen	
14:30		Pause	
14:45		Nachtest 2-MEV	
15:00		Aufräumen, auf den Rückweg machen, wenn früher fertig→Otterfütterung bzw. Luchsfütterung anschauen	

9. List of publications

All following articles were published / submitted in the course of this dissertation:

Glaab, S., & Heyne, T. (2018). Green classroom vs. classroom - Influence of teaching approaches, learning settings and state emotions on environmental values of primary school children. *Applied Environmental Education and Communication 0* (0), 1-12. doi:10.1080/1533015X.2018.1450169

Most of this article was written by the candidate (60-70 %), all experimental procedures and data analysis were conducted by the candidate. Interpretation of data was conducted in a team effort.

Glaab, S., & Heyne, T. (2017). Confront and cluster-How different groups of primary school children respond to instruction towards conceptual change at an out-of-school learning setting. *World Journal of Educational Research 4* (3), 417-429. doi: 10.22158/wjer.v4n3p417

Most of this article was written by the candidate (60-70 %), all experimental procedures and data analysis were conducted by the candidate. Interpretation of data was conducted in a team effort.

Glaab, S., Körber, S., & Heyne, T. (2018). Ist die Wildkatze noch zu retten? *Schulmagazin 5-10 6*, 39-46.

Most of this article was written by the candidate (ca. 70 %), all experimental procedures and data analysis were conducted by the candidate.

Glaab, S., & Heyne, T. (submitted). Learning at workstations for primary school children in an out-of-school learning setting- a recipe for disaster? *Applied Environmental Education and Communication.*

Most of this article was written by the candidate (60-70 %), all experimental procedures and data analysis were conducted by the candidate. Interpretation of data was conducted in a team effort.

10. Authors´ contributions

Description of the specific contributions of the PhD-candidate to publications with several co-authors and confirmation by the co-authors.

PhD- student: Sabine Glaab, Fachgruppe Didaktik Biologie, Fakultät Biologie

Title of the publication: Glaab, S., & Heyne, T. (2018). Green classroom vs. classroom - Influence of teaching approaches, learning settings and state emotions on environmental values of primary school children. Applied Environmental Education and Communication 0 (0), 1-12. doi:10.1080/1533015X.2018.1450169

Name of Co-Author: Dr. Thomas Heyne

Publication details	**Description of the own contribution**
Writing of the article Which parts of the article have been written to which extent by the candidate?	Most of the article was written by the candidate (60-70 %)
Performed research Which experimental procedures have been conducted by the candidate?	All experimental procedures have been conducted by the candidate
Conceptual design of the research To which extent did the candidate contribute to the conceptional design of the research project?	50%
Data analysis To which extent did the candidate contribute to the data analysis?	All data analysis was conducted by the candidate and proofread by the Co-Author. Interpretation of data was conducted in a team effort.
Overall contribution of the candidate (in%)	70 %

Confirmation by co-authors:

Name Co-author	**Signature**	**Date**
Thomas Heyne		23. Juli 2018

Title of the publication: Glaab, S., & Heyne, T. (submitted). Learning at workstations for primary school children in an out-of-school learning setting- a recipe for disaster? *Applied Environmental Education and Communication.*

Names of Co-Author: Thomas Heyne

Publication details	**Description of the own contribution**
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Overall contribution of the candidate (in%)	70 %

Confirmation by co-authors:

Name Co-author	**Signature**	**Date**
Thomas Heyne		23.Juli 2018

Title of the publication: Glaab, S., & Heyne, T. (2017). Confront and cluster-How different groups of primary school children respond to instruction towards conceptual change at an out-of-school learning setting. *World Journal of Educational Research 4* (3), 417-429. doi: 10.22158/wjer.v4n3p417

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Confirmation by co-authors:

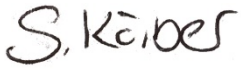
Name Co-author	**Signature**	**Date**
Thomas Heyne		23.Juli 2018

Title of the publication: Glaab, S., Körber, S., & Heyne, T. (2018). Ist die Wildkatze noch zu retten? *Schulmagazin 5-10 6*, 39-46.

Names of Co-Authors: Simone Körber, Thomas Heyne

Publication details	**Description of the own contribution**
Writing of the article Which parts of the article have been written to which extent by the candidate?	Most of the article was written by the candidate (ca. 70%)
Performed research Which experimental procedures have been conducted by the candidate?	All experimental procedures have been conducted by the candidate
Conceptual design of the research To which extent did the candidate contribute to the conceptional design of the research project?	
Data analysis To which extent did the candidate contribute to the data analysis?	
Overall contribution of the candidate (in%)	70 %

Confirmation by co-authors:

Name Co-author	**Signature**	**Date**
Simone Körber		5.7.18
Thomas Heyne		23.Juli 2018

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Eidesstattliche Erklärung

Eidesstattliche Erklärungen nach §7 Abs. 2 Satz 3, 4, 5 der Promotionsordnung der Fakultät für Biologie

Eidesstattliche Erklärung

Hiermit erkläre ich an Eides statt, die Dissertation: „Das grüne Klassenzimmer am Wildpark: Umwelteinstellungen, Unterrichtsformen und Conceptual change in der Primarstufe am Beispiel der europäischen Wildkatze“, eigenständig, d. h. insbesondere selbständig und ohne Hilfe eines kommerziellen Promotionsberaters, angefertigt und keine anderen, als die von mir angegebenen Quellen und Hilfsmittel verwendet zu haben.

Ich erkläre außerdem, dass die Dissertation weder in gleicher noch in ähnlicher Form bereits in einem anderen Prüfungsverfahren vorgelegen hat.

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Affidavit

I hereby declare that my thesis entitled: „ Green classroom at the wildlife park:
Aspects of environmental, instructional and conceptual education of primary school children concerning the European wildcat.” is the result of my own work. I did not receive any help or support from commercial consultants. All sources and / or materials applied are listed and specified in the thesis.

Furthermore I verify that the thesis has not been submitted as part of another examination process neither in identical nor in similar form.

Besides I declare that if I do not hold the copyright for figures and paragraphs, I obtained it from the rights holder and that paragraphs and figures have been marked according to law or for figures taken from the internet the hyperlink has been added accordingly.

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