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Supported by Stories

Exploration of a story-based learning design in schools and at the Danish science centre Experimentarium

Doctoral Dissertation 2012

Mai Murmann

Juli 2012

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Supported by Stories

This thesis is dedicated to my mother,
Anne Murmann,
who told me a bed time story
every night
my entire childhood

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Overview of Contents

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Min historie

Det er en floskel, men de sidste tre år og skabelsen af denne ph.d.-afhandling har i sandhed været en rejse. Som videnskabsjournalist med en baggrund i biologi har jeg i mange år pakket min rygsæk med naturvidenskabelig viden og skriveredskaber. Jeg har iagttaget det naturvidenskabelige landskab og forstår dets demografi og topografi. Jeg kender dets sprog og de regler, som de indfødte levede efter. Det er en velkendt kultur, og det er trygt.

Alligevel har jeg altid haft udlængsel, og det var den, der bragte mig ind i museumsdidaktikkens forjættede land. Jeg emigrerede, kan man sige, og det gav mig et kulturchok. For jeg flyttede til et land med flydende grænser, et land hvor intet var sikkert, og alt var til debat, et land, hvor jeg ikke talte sproget, og hvor jeg måtte starte helt fra bunden for at opbygge en identitet. Jeg måtte lære ord som "ontologi" og "epistemologi" og lærte, at konstruktivisme var bedre end transmissionslæring, selvom det var alt, hvad jeg havde kendt til. Tit og ofte undrede jeg mig over, hvad man mente, når man talte om "diskurser". Der var bjerge af litteratur at bestige og bundløse diskussioner at dykke ned i.

I dag er jeg så småt ved at være integreret. Der er stadig ting, jeg ikke forstår, og en svag accent, når jeg taler det indfødte sprog. Jeg kan også nogle gange tage fejl, når jeg navigerer i de kulturelle koder. Men når jeg I skrivende stund sidder og kigger på de 300 sider, som min afhandling har sneget sig op på, er jeg som en anden Christoffer Columbus: Jeg har opdaget nyt land, og det ser lovende ud!

English translation of *Min historie*:

My story

The last three years and the creation of this thesis has truly been a journey. As a science journalist with a background within the academic field of biology, my backpack has been filled with knowledge of science and with writing utensils. I have observed the landscape of science, and I understand its demography and topography. I speak the language, and I know the culture of the natives. I am safe here.

Still, my mind has always been wandering, and it brought me to the promised land of Science Museum Education. I migrated, you might say, and I experienced a virtual culture shock. I reached a land with dynamic borders. A land where nothing had an absolute truth and anything could be debated. A land where I did not speak the language and where I had to build a new identity from scratch. I had to learn words like *ontology* and *epistemology*, and I learned that *constructivism* was better than *transmission learning* even though that was previously all I had ever known. I often wondered what we were talking about when we used the word *discourse*. There were mountains of literature to climb and an endless amount of discussions to dive into.

Today, I am almost integrated. There are still things that I do not understand, and I have a slightly odd accent when I speak the language. I still misinterpret the cultural codes I am navigating in every now and then. But sitting here with my 300-page thesis looking back at the last three years, I feel like Christopher Columbus: I have discovered new land—and it looks promising.

Acknowledgments

Thank you very much to the staff at Experimentarium for always being open-minded toward my questions and curiosity and for being available, involved, and enthusiastic about it. Especially, I would like to thank Joakim Bækgård, Sara Tougaard, and Ane Ethelberg for a good cooperation on the project and for numerous theoretical and practical discussions as well as filled chocolates and good friendships. Especially thank you to Sara and Ane for numerous brainstorms and discussions at the end of my journey.

I would also like to thank Chief of Experimentarium Research Department, Morten Busch, and Director, Asger Høeg, for having established this initiative on demonstrating how theory and practice *can* work together in science education at Experimentarium. Thank you to Per Velk, project manager, of the SENSES exhibition, for taking me in on the project and letting me dissect every little thought regarding its design. And thank you to Gitte Husmer, graphic designer, for the good advice regarding the layout and for designing the front page of this thesis.

Also a warm thank you to the people at the Department of Science Education. Thank you to my supervisor, Bob Evans, for believing in my crooked mind-set, for supporting me in my ideas, and for the good pieces of advice and reflections. Especially, I would like to thank Bjørn Johannsen for the academic discussions, the practical help, and the assistance with easing the navigation between my two institutions.

Thank you also to Gerd Christensen, associate professor in psychology, for the important insight into the field of learning theory.

Thank you to Professor Justin Dillon for establishing a number of contact relations with British museums, such as the Natural History Museum and the Science Museum in London. Thank you to these institutions for giving me an introduction to the field of museum education research. Especially, thank you to Sue Cavell at Techniquest in Cardiff for an insightful week on the topic.

Last but not least, thank you to my family and my friends. As my dear friend Maria Louise once said,

"Research to you is like being the first one to step in newly fallen snow."

Thank you for understanding the thrill and excitement I feel, for being proud of me, and for supporting me when I was stuck in the snow.

Abstract

In the project, *Supported by Stories—An Exploration of a Story-based Learning Activity at Schools and at the Danish Science Centre Experimentarium*, I explore how students use fictive stories as tools for learning. The primary focus is the nature of the story when it is applied to a learning setting. The insights collected in this project imply that the story carries certain properties like structure and motivation that support students during learning activities. However, students also perceive the story differently from traditional storytelling when it becomes educational.

The project is created in the Danish program of industrial PhDs, where a business organisation and a university corporate to make research that is applicable to the practical reality of the particular business in question—in my case the Experimentarium. Hence, the aim of the project is to explore the considerations regarding the design of the stories for science centre staff, teachers, and other parties who design school materials. This purpose is executed by the use of a methodology called Design Research in which practitioners and researchers cooperate to develop new learning designs that are inspired by prior experience and pedagogical and psychological theory.

In the project, I describe how I created a story-based learning activity called *The Emperor Who Only Believed His Own Eyes*. The design should scaffold students in learning activities about the natural senses in schools and at an interactive exhibition called SENSES at the Danish science centre, Experimentarium. Through this design, I explore how a story interacts with existing learning activities.

To inform the design of the story, I used a theoretical framework. In this framework, I put forward a number of properties that make

stories useful as cognitive tools for learning. I position the story as a tool for learning in Activity Theory and outline how certain structural and epistemological features of the story qualify it as a cognitive tool that supports students' immersion, understanding, and motivation for learning activities. Based on these theoretical assumptions and the practical knowledge of designers and teachers at Experimentarium, the design of *The Emperor Who Only Believed His Own Eyes* was created.

Empirical studies revealed that *The Emperor Who Only Believed His Own Eyes* provide a social, cognitive, tertiary tool, which students and teachers may use as a common reference. The internalised story represents a "narrative micro-world," which students can use for interpreting the educational activities.

However, the story is not omnipresent but provides a frame and a memory tool, which students and teachers may use as a common reference, when it is needed. The story inhabits a certain "nature" when it is used in learning activities. This relates to a number of parameters, such as the teacher being the gatekeeper of the story and mediating the acknowledgment of the story as a tool and the culture of the Danish science subject "nature/technology." To students the story is part of a controlled way of playing in which they still take directions from the teacher. Students often keep a slight emotional distance to the story and only immerse completely into it in their own imagination. However, despite the influence of educational elements, the story provides a number of qualities known from psychology and literary theory, such as immersion, motivation, agency, and structures for cognitive guidance, and supports the design of cohesive and meaningful educational activities.

The thesis ends with a short list of recommendations for future designs.

Danish Summary

I denne afhandling undersøger jeg, hvordan elever kan bruge fiktive historier i naturfagsundervisningen på skoler og science centre. Det gør jeg ved at designe et narrativt skoleforløb kaldet "Kejseren der troede sine egne øjne" og undersøge, hvordan eleverne forholder sig til historien som et læringsredskab i naturfag.

I hovedtræk viser afhandlingen elevernes internalisering og eksternalisering af et historie-baseret undervisningsforløb. Min forskning viser, at historien har en særlig "natur" i undervisningshenseender, hvor de eksisterende strukturer fra undervisningsmiljøet påvirker elevernes opfattelse af den som redskab. Derfor har eleverne ofte en distance til historien, og den er primært i brug, når den introduceres af læreren. Historien udgør en slags "kontrolleret leg", der binder undervisningen sammen, og gør den meningsfuld, motiverende og bidrager til indlevelse i undervisningen.

Et erhvervsbaseret projekt

Projektet "*Supported by stories*" er skabt som en del af en erhvervsPhD, som er et samarbejde mellem en forskningsinstitution og en virksomhed fra det private erhvervsliv, hvor intentionen er at skabe praksisnære forskningsresultater. I dette projekt forholder jeg mig derfor som udgangspunkt til den praksis, Experimentarium har omkring udviklingen af skolematerialer. Formålet er at udforske, hvordan designere hos science center kan lave historie-baserede skoleforløb, hvor historien fungerer som læringsredskab og er bindeled mellem aktiviteter på skolen og aktiviteter på museet.

Relevans – hvorfor og for hvem?

Historier er tidligere blevet etableret som gode undervisningsredskaber i skolen, som støtter og motiverer eleverne. I mine studier har jeg dog ikke fundet litteratur, som

udforsker, hvordan eleverne forholder sig til historiens komponenter og iboende egenskaber, når den skal fungere som primært læringsredskab i naturfag.

Afhandlingen placerer sig derfor i diskussionen af, hvordan vi gør videnskab lettere tilgængeligt for elever i alderen 9-12 år. Projektet tager afsæt i science center-besøget, men opbygger præ- og postaktiviteter på skolen og retter sig mod de problemer, som eleverne har i forhold til at være fokuserede og motiverede, når de lærer naturvidenskab i de to kontekster.

De to kontekster kæmper med hver deres problemer: I skolen kritiseres naturvidenskaben for at være dogmatisk og steril og for at have mistet sin kontekst. På science centeret mister eleverne overblikket og overvældes af indtryk, når de slippes fri i en udstilling og glemmer de naturvidenskabelige målsætninger. Afhandlingen undersøger, hvordan en historie kan understøtte eleverne i disse problemer, og hvordan eleverne bruger denne understøttelse som et redskab i deres læring.

Designbaseret forskning

Projektet er bygget op som et designbaseret forskningsprojekt. I design forskning fremhæves samarbejdet mellem forskere og praktikere i udvikling af læringsdesign. Tanken er, at forskere og praktikere sammen skal skabe et design, der er informeret af både praktikerens virkelighed og af forskerens teoretiske indsigter i pædagogik og didaktik. Dermed bliver det muligt at forandre allerede eksisterende læringsdesign og undersøge, hvordan problemer og udfordringer kan løses inden for en teoretisk ramme.

Den teoretiske ramme repræsenterer en slags "*proto-teori*", som løbende udvikles gennem processen. Ideelt set udgøres denne proces af iterationer af design, analyse og re-design, hvor forskeren og designeren hele tiden forholder sig til den komplekse "*lærings-økologi*", som designet fungerer som en del af.

Målet er at skabe ny teori om, hvordan læringsdesignet fungerer i praksis ved at udforske designet og evaluere det i forhold til den opsatte proto-teori. De udviklede teorier anses dog som relativt simple, fordi de altid er knyttet til det aktuelle design og den kontekst, designet er foregået i. I dette projekt benyttes en særlig triangulær model af Skovmose og Borba til at lede designprocessen. Modellen fremhæver tre situationer.

I den første situation, kaldet den *Aktuelle Situation*, identificerer man problemerne i den eksisterende læringsaktivitet. Dernæst skaber man en *Forestillet Situation*, hvor man opbygger en slags ideverden, der illustrerer, hvordan den Aktuelle Situation kan ændre sig ved implementering af nye pædagogiske og didaktiske løsninger; man forestiller sig, hvordan ens proto-teori virker i praksis. Ud fra disse to situationer skaber man til sidst den *Arrangerede Situation*, som er det egentlige design, og som er det, man undersøger og videreudvikler sin proto-teori ud fra.

De tre situationer skabes ud fra tre processer; *Pædagogisk Forestilling*, *Praktisk Organisering og Undersøgende Meningsdannelse*. Særlig vigtig er *Undersøgende Meningsdannelse,* som er den afsluttende analyse af designet med henblik på at revidere proto-teorien. Man bruger derfor Undersøgende Meningsdannelse til – ikke blot at kigge på det egentlige design – men også til at undersøge, hvorvidt det ligner den Forestillede Situation, og dermed hvilke nuanceringer eller ændringer der skal ske.

Teoretisk rammeværk

Som det fremgår, er en af de væsentligste drivkræfter i udviklingen af det nye læringsdesign proto-teori. Derfor indledes designprocessen med en fremlæggelse af det teoretiske rammeværk bag projektet, som munder ud i en proto-teori for elevernes brug af et historie-design som et redskab.

For at placere historien som læringsredskab i en læringsaktivitet anskues designet fra et virksomhedsteoretisk perspektiv.

Virksomhedsteori angiver, at al læring sker gennem aktivitet, og at fysiske og kognitive redskaber spiller en stor rolle i menneskelig aktivitet. Historien positioneres derfor som et redskab i læringsaktiviteter. Læringsaktiviteter beskrives gennem en triangulær model om "*aktivitets-systemer*", hvor redskaber medierer menneskelig aktivitet såvel individuelt som socialt.

Derefter diskuteres det, hvordan redskaber kan fungere i læringshenseender til at stilladsere eleverne ved at mediere elevernes handlinger, så de hele tiden befinder sig i zonen for deres nærmeste udvikling. Her defineres stilladsering som "*noget der understøtter eleverne i deres læringsaktivitet*", og der redegøres for, hvordan dette kan foregå gennem både mennesker, fysiske redskaber og kognitive redskaber – såsom historier. Første del af proto-teorien er derfor, at *man kan iscenesætte en historie som et kognitivt redskab i en læringsaktivitet.*

Jeg forsøger derefter at etablere narrativer som kognitive redskaber ved at påpege sammenhængen mellem narrative strukturer og narrativer som epistemologisk redskab. Her bruges særligt tre teoretikere Bruner, Mandler og Polkinghorne, som alle tre påpeger sammenhængen mellem de narrative og de kognitive strukturer. Anden del af proto-teorien er altså, at historien kan fungere som *et kognitivt redskab gennem et strukturelt design.*

Til slut gennemgår jeg, hvilke egenskaber narrativet kan antages at have, når det placeres i en læringsaktivitet. Her redegør jeg først for, hvordan historien kan antages at fungere som et velkendt redskab i kraft af dens sociokulturelle status som kommunikationsmiddel. Fordi vi som mennesker vokser op med historier, og deres strukturer er udviklet gennem årtusinder, har vi en grundlæggende forståelse af deres funktion.

Dernæst forholder jeg mig til, hvordan historien fungerer som kognitivt redskab ved at placere det inden for teoretikeren Wartofskys tre kategorier af redskaber. Jeg definerer historier som

tertiære redskaber, som skaber imaginære verdener, som man kan bruge til at fortolke den faktiske verden med. Derudover forholder jeg mig til historiens emotionelle egenskaber, som også kan være anvendelige i læringsaktiviteter. Det angives, hvordan historien gennem dens strukturelle opbygning skaber *motivation*, og hvordan den gennem indlevelse i karakterer og hændelser kan skabe *indlevelse,* og at disse to egenskaber kan bidrage til, at eleverne benytter historien som et tertiært redskab. Til sidst angiver virksomhedsteorien, at historien vil blive påvirket af den kontekst, den er placeret i og af elevens personlige erfaringer. Tredje del af proto-teorien er derfor, *at en historie kan fungere som tertiært redskab, der medierer forståelse, indlevelse og motivation, men som også påvirkes af den kontekst den bruges i og af elevernes personlige oplevelser.*

Design af en historie

I den følgende del af afhandlingen redegør jeg for designfasen af det historie-baserede skolemateriale "*Kejseren der troede sine egne øjne*" ved brug af den triangulære design model. Jeg indleder derfor afsnittet med at beskrive den *Aktuelle Situation* og de problemer, som historien skal bidrage til at løse.

Fordi skolematerialet er opbygget med præ- og post-aktiviteter på skolen, der skal understøtte besøget på Experimentarium, indleder jeg afsnittet med at beskrive Experimentarium og Natur/Teknik i folkeskolen, og hvilke problemer og mål begge institutioner har i forhold til at få eleverne til at engagere sig i naturvidenskabelige læringsaktiviteter. På baggrund af dette opstiller jeg en række problemer og udfordringer, som historien skal løse ved at sætte fokus på begrebslæring inden for emnet sanser og forståelse af fænomener i interaktive udstillinger samt at bidrage til udvikling af elevernes kompetencer inden for naturvidenskabelige metoder, sprog og tankegange.

Dernæst forestiller jeg mig en løsning af disse problemer gennem en historie i den *Forestillede Situation*. Som udgangspunkt for dette brugte jeg min proto-teori om historien som et tertiært værktøj og

opstiller derigennem tre aktivitetssystemer. De to første systemer er henholdsvis skolen og science centerets læringsøkologier og de mål, værtøjer, regler, arbejdsdelinger og fællesskaber, de har. Det tredje system er historiens aktivitetssystem, som udgør et slags imaginært univers, der kan bruges til at fortolke de to andre aktivitetssystemer.

På basis af den *Aktuelle Situation* og den *Forestillede Situation* beskriver jeg hernæst, hvordan disse to situationer skaber det konkrete design "*Kejseren der troede sine egne øjne*" og indarbejder mere praktiske overvejelser og konkrete udfordringer fra den sanse-udstilling, som skolematerialet skal dække. Jeg gennemgår, hvordan de strukturelle komponenter i historien om Kejseren og dyrene er organiseret, og hvordan dette er intenderet til at skabe et narrativt aktivitetssystem, der kan virke som et kognitivt redskab for eleverne. I materialet er den overordnede struktur for designet derfor lavet ud fra både læringsteoretiske og narrative overvejelser, som er afstemt med hinanden gennem en proces, jeg kalder *"Narrativ begrundelse"*.

Forskningsspørgsmål

Baseret på min proto-teori og mit design opstiller jeg tre forskningsspørgsmål, som forholder sig til historien som læringsredskab. De to første koncentrerer sig om henholdsvis individets interaktion med historien som redskab og læringsøkologiens indflydelse på individets opfattelse af redskabet. Det sidste spørgsmål forholder sig til det aktuelle design af "*Kejseren der troede sine egne øjne*", og hvordan dette design understøtter eleverne og læringsaktiviteten.

Empiri og analyse

De empiriske studier af designet er lavet på syv skoler fra klassetrinnene 3.-6. klasse. Data består af observationer fra hele forløbet samt optagelser med videobriller på Experimentarium, lydoptagelser, billeder af elevernes produkter samt interview med lærere og elever efter forløbets afslutning. Derudover gennemførte

jeg interview med både lærere og elever, efter forløbet var slut samt et endeligt interview med lærerne en måned efter, jeg havde afsluttet mine første analyser. Interviewene med eleverne var semi-strukturerede gruppeinterview, der skulle få eleverne til at tale frit om deres brug og opfattelse af historien som et redskab.

Observationer og interview blev analyseret via en metode kaldet "*Tematisk analyse*". I metoden identificeres, analyseres og findes et mønster – såkaldte "Temaer" – i data. I mit projekt er metoden baseret på en fænomenologisk-inspireret epistemologi, hvor jeg lægger vægt på elevernes personlige erfaringer med historien som redskab. Desuden er min tilgang til analysen teori-dreven, idet jeg undersøger mine data ud fra min proto-teori og de deraf følgende forskningsspørgsmål.

Resultater og diskussion

I mine resultater præsenterer jeg syv forskellige temaer, som alle ligger under mine tre forskningsspørgsmål, og som jeg forholder mig til gennem min proto-teori.

I spørgsmålet om interaktionen mellem læringsøkologiens, historie-designet og eleverne viser mine analyser, at læreren fungerer som gatekeeper for historien og er det medie, den lever igennem. Derfor har læreren stor indflydelse på eleverne brug af historien. Desuden påvirkes elevernes opfattelse af historien af den naturfaglige kultur i Natur/Teknik. Både lærere og elever har en forventning om, hvilke metoder der bruges i faget, og historiens format opfattes i højere grad som tilhørende en dansktime. Sidst men ikke mindst betyder den naturfaglig kontekst, at eleverne har en hvis emotionel distance til historien. Undervisningen tvinger dem til at zappe ind og ud af historien, og derfor er elevernes indlevelse i historien primært dikteret af læreren og bliver til en slags "kontrolleret leg".

I spørgsmålet om elevernes interaktion med historien viser mine analyser, at historien bidrager med både emotionelle og

strukturelle retningslinjer, som skaber en sammenhæng i undervisningen. Historien skaber motivation, indlevelse og en følelse af handlekraft. Eleverne knytter sig meget til karaktererne i historien og føler, at historien giver dem et meningsfyldt mål, som de gerne vil opfylde. Samtidig fungerer historien som et kollektivt huske-redskab og en ramme, som giver lærere og elever en fælles reference før, under og efter forløbet.

Det tredje og sidste spørgsmål går helt tæt på designet af *"Kejseren der troede sine egne øjne"* og fremhæver et stort problem ved designet i forhold til at støtte elevernes læring. Designet fungerer glimrende som ramme for undervisningen, men historien fejler i forhold til at nedbryde læringsmålene og give elever og lærere de retningslinjer, de har behov for, for at løse de narrative mål. Problemet findes særligt på Experimentarium, hvor historien blot leder eleverne hen til opstillingerne, men ikke forklarer, hvordan de bruger opstillingen. Desuden problematiseres det, at flere lærere er ubekendte med designets metoder og derfor har vanskeligt ved at bruge historien som formidler af metoderne.

Sidst i afhandlingen gives der en række retningslinjer for fremtidige design af historie-baserede aktiviteter baseret på erfaringerne fra dette projekt.

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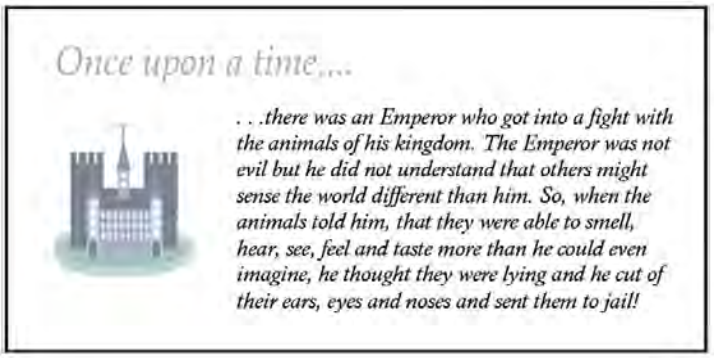
1 Introduction

The introduction to this thesis is about the design of story-based scaffolds and the exploration of stories as tools for learning. Arguments are put forth to show how these topics are relevant in science education. Lastly, this introduction provides the reader with an outline of the remaining chapters of this thesis.

Purpose



Thus begins the story about *the Emperor Who Only Believes His Own Eyes*. Through this story, students must engage in science learning and inquiries about human and animal senses in school and in science exhibitions. In this thesis, I explore how students use this story as a tool for learning.

The aim of the project behind this thesis was to

- **design a story-based learning activity and to explore how students use the story as a tool for learning in educational activities at schools and science centres.**

The intention of my project, *Supported by Stories*, is to explore the design of *The Emperor Who Only Believed His Own Eyes* and through this develop a new theoretically based model of the properties and the contextual interpretations that students assign to stories as tools for learning science.

I will refer to the story as *The Emperor* in the rest of the thesis. The entire story and the school material can be found in the Appendix D, page 239.

It is no coincidence that this design has been created as a story. Most people love a good story. *I* love a good story. As humans, we grow up listening to stories, we tell our own stories, and we use stories to communicate with each other and to understand the world. As the following quote states:

Narrative [1] *is the dirt path that leads us through the impenetrable forest, so we move forward and don't feel lost. (Scanlan, 2003)*

The question is: how can a story like *The Emperor* guide students through the impenetrable forest of the scientific paradigm to help them understand science in schools and science centres without the sense of feeling lost?

[1] The terms "narrative" and "story" may be used interchangeably.

The use of narratives in this thesis

The main feature of this thesis is the exploration of stories as learning tools through a design perspective. A design perspective on research promotes great focus on the process of design and the use of theory is, to a great extent, related to this process. Hence, the exploration of the design, *The Emperor*, creates a two-dimensional perspective on my research: first theoretical and practical reflections regarding the actual design, and second an exploration of students' epistemological use of the design.

The use of narrative in this thesis

The two-sided perspective on research in this thesis implies that I am concerned with stories at two levels: as a designed, fictive, literary story on one hand and as an epistemological tool for learning on the other.

Narrative as formal structure (Texts) Making sense of stories	*Narrative as epistemological tool* (A way of thinking) Stories as sense making

The first level in this research is related to the design of a strong and convincing story that scaffolds students. The story structures must be crafted in a way that makes sense to students and interact with other educational elements from the learning activity.

The second level, the epistemological properties of the story, is related to the story as a cognitive tool that should enable students to understand and interpret their learning activities.

Ideally these two levels should complement each other: by crafting *The Emperor* with classical story structures in mind, these structures should support students cognitively in their learning

activities. Throughout the thesis, I will explain *why* stories have this potential as a tool for learning and *how* this potential is effectuated in the practical reality of science learning activities.

A practical perspective on research

The design of *The Emperor* is created and explored from a very practical perspective. It is done as part of an industrial PhD program created in a cooperation between University of Copenhagen and Experimentarium, a Danish science centre, in an exhibition called SENSES about human and animal senses. The intention is to create a theoretical base in order to support the design practice of the Experimentarium staff when they develop learning materials for students at aged nine to twelve.

To clarify, an "industrial PhD program" entails that a business or organisation work closely together with a university in order to support and enhance the relationship between theory and practice. As a PhD student, I must play a part and be present in both worlds and negotiate between the needs and demands of these two distinct realities. On one hand, I have to consider the practical reality of a business that has to produce certain products and make deliveries. On the other hand, I have to accommodate the theoretical knowledge and the discussions of the research community at the university.

Hence, this project is anchored in the practical reality found at the Experimentarium. However, it is informed by learning theory and narrative theory found in the academic community of the university. The aim is to create research that informs and improves the practice of science centre staff, teachers, and other practitioners when they design story-based learning activities.

Why this thesis is significant

The use of stories is significant in the perspective of making learning interesting to students. This is especially important in education in natural science, where a tradition of eliminating contextual narratives exists.

The missing stories of science

Historically, stories have been a way of collecting, carrying, and passing on knowledge and experience (Mandler, 1977). However, with the birth of the scientific society this culture changed.

The scientific community is characterised by giving emphasis to the generalisation of knowledge and logic, by pursuing the precise repetition of scientific experiments, and by talking in a language that consists of multi-semiotic codes, graphs, symbols, and diagrams. Instead of belonging to a narrative domain, knowledge is logical and instrumental. Consequently, the stories of science often lose their temporality, particularity, and context and are therefore left behind (Bruner, 1996).

This approach has, to a great extent, been adopted by science education. Several studies indicate that a traditional picture of science has been prevalent among teachers and school materials for a long time (Gauld, 1982; Gallagher, 1991; Barnett and Hodson, 2001). Despite several reforms within the last decades, the science education found in school systems is locked in a traditional, academic, positivist approach to science (Andersen et al., 2003). In school, science is presented as providing students with objective truths, and science utilises a language, which is strongly rooted in a scientific tradition and context (Lemke, 1990; Lindahl, 2003). This is also the case in science centre exhibits that are initiated by this scientific paradigm. In these types of exhibits, the dominant mode of dissemination is often hands-on inquiry with a single-voiced authoritative explanation (Quistgaard and Kahr-Højland, 2010).

This academic approach to science has been widely criticised. Students supposedly feel alienated toward the natural sciences because they have to view science as nothing more than a collection of facts and laws with no personal relevance (Wang and Marsh, 2002). Science is criticised as being dogmatic, authoritarian, and impersonal, and it is often described as much harder to understand than it really is (Lemke, 1990).

American psychologist, Jerome Bruner (Bruner, 1996), has articulated the missing stories of science in a theory of human modes of thinking. He defines two primary means of thought: *paradigmatic* and *narrative*. The paradigmatic mode is in its nature logic, scientific, and based on reasoning. The narrative mode is sequential, action-oriented, detail-driven, and influenced by feelings and emotions.

According to Bruner, the narrative mode is the default mode of thinking. In our everyday lives this is how we organise our thoughts. We discuss previous events to understand ourselves and to plan for the future—we schedule appointments, we dream, and we make promises. We listen to stories throughout our lives and learn how to index them according to themes, topics, goals, protagonists, and actions (Lemke, 1990; Horsdal, 2000). As humans, and in our personal lives, we find it hard to discard stories and neglect temporality, particularity, and context.

Yet according to Bruner, schools traditionally favour the paradigmatic mode and consider the narratives of subjects, such as singing, drama, fiction, and theatre as decorative forms of art (Bruner, 1996). However, stories are gradually being reintroduced into science education as a part of an increasing interest in narratives.

Humanising science through narratives

Western society is paying increased attention to the potential of the narrative mode as a means of communication. Narratives are used in sociology, human psychology, and philosophy and for practical and economic purposes found in, for example, commercials and presentations of business strategies.

In education, a number of researchers have also found narratives to be useful for learning science (Slater, 2002; Klopfer and Squire, 2008; Kahr-Højland, 2010). Researchers claim that narratives could *humanise* science education by taking into account the human elements of science and consequently help create a more detailed index than abstract knowledge, usually presented in science education (Wang and Marsh, 2002). It is stated that students find it easier to memorise the familiar cognitive schemas of narrative content and form than to memorise traditional discourse genres, such as expository and argumentative texts, where the structure is often unknown. The close correspondence to everyday experience of situations and episodes also make narratives a very natural mechanism of comprehension (Graesser et al., 2002). Additionally, students benefit from stories in their learning environment because they provide an opportunity for reflection, evaluation, illustration, exemplification, and inquiry (Conle, 2003) and enhance interest, memory, and understanding (Norris et al., 2005).

In general, stories are regarded as having a much greater impact than the abstract principles we find in science (Schank and Berman, 2006). However, these changes, which are argued for in the formal school system, have largely remained a feature in the debate and literature concerned with the revolution of science education (Quistgaard and Kahr-Højland, 2010).

Addressing the lack of stories in science

This thesis makes a contribution to the growing field of introducing the narrative mode of thinking into science education. As the prior section describes, stories have previously been established as excellent tools for learning that support students and consequently foster a greater motivation for students. Nevertheless, in my literature reviews, I have found very little that explores the story from the students' perspective when narratives are the primary tools for learning science. How does the context of learning science affect the traditional perception of stories? And how do the structural and emotional properties of stories affect students when they are used in schools and science centres?

My intent is to contribute to the establishment of the use of narratives and stories in the field of science learning. By reintroducing the story format into science learning, it may be possible to expand our understanding of how stories support and engage students in learning and consequently contribute to students' interest in science.

Outline

This thesis consists of twelve chapters and four *picturamas*. The *picturamas* are found in the interstices of relevant sections, and they serve to illustrate the practical reality that this thesis represents. The pictures were taken in the course of the project, and they illustrate the story, the SENSES exhibition, at Experimentarium. They also illustrate how students use the story in school and at the exhibition.

The chapters evolve from being introductory (Chapter 1) to consideration of the methodology that creates the foundation of the project, namely, Design Research (Chapter 2). They then move on to consider the theoretical framework of Narrative Theory and Activity Theory (Chapters 3–5) before they describe the execution of the Design Phase (Chapter 6). They then establishe the Research Questions (Chapter 7) based on the design and the theoretical framework, before moving to the Empirical Phase, and the Analytic Phase (Chapter 8–9). Lastly, they presents the Findings (Chapter 10), which are discussed and summarised, at the end of the thesis (Chapter 11–12).

Chapter 1: The introduction of this thesis is concerned with the design of story-based scaffolds and with the exploration of stories as tools for learning. Arguments are here put forth to illustrate how these topics are relevant in science education.

Chapter 2: This chapter describes the considerations behind the Design Research as a research paradigm and outlines the framework of a design methodology called Critical Research. The methodology considers both practical and theoretical concerns regarding a particular design, and it implements a proto-theory of more ideal designs to inform the design process.

Chapter 3: This chapter is the first of three chapters concerned with this paper's theoretical framework. It reviews Activity Theory as a philosophical framework for studying student praxis and learning in order to position narrative as a tool for learning. The chapter describes how Activity Theory adds focus to the mediating tools used during learning activities.

Chapter 4: This chapter is the second part of the theoretical framework. It considers how narratives can be used for learning purposes due to its inherent formal structures and properties as an epistemological tool. It does this by considering how narrative structures and narratives as a cognitive tool are intertwined.

Chapter 5: This chapter is the final part of the theoretical framework. It explores how a story can be used as a tool in learning activity by reviewing the sociocultural, cognitive, and emotional properties of stories.

Chapter 6: This chapter outlines the three situations that informed the design, the Current Situation, the Imagined Situation, and the Arranged Situation. The chapter characterises schools and Experimentarium and highlights certain problematic features regarding learning in these institutions and proposes how narrative structures may support these features in the design of the story about *The Emperor*.

Chapter 7: This chapter outlines the research questions of the thesis by reviewing the theoretical and practical assumptions that lie behind the design of the story *The Emperor*.

Chapter 8: This chapter outlines the areas of interest for empirical studies and it describes how school classes were selected for the study and the considerations about data-collection techniques as well as the actual data collection.

Chapter 9: This chapter outlines the use of thematic analysis of interviews, sound bites, and observations to extract knowledge about students' use of the story as a tool. It highlights the use of a phenomenological-inspired approach and demonstrates how the analysis was done in five theoretical steps.

Chapter 10: In this chapter I present the findings of my analysis. Through quotes and examples from observations, the chapter describes three superior themes: the story as a tool for learning, interactions between the story and the learning environments, and evaluation of the design of *The Emperor*.

Chapter 11: In this discussion I interpret the findings in relations to the proto-theory to create a basis for a new theory-based model of story-based designs. I also consider the design of *The Emperor* and how the experiences made in this design may be considered in future designs.

Chapter 12: In this final chapter of the thesis, a new model for story-based learning designs is presented and recommendations for future guidelines are made.

2 Design Research

The following chapter outlines the considerations behind Design Research as a research paradigm and outlines the framework of the design methodology called Critical Research. This methodology considers both practical and theoretical concerns regarding a design and implements proto-theory of more ideal designs to inform the design process.

The basics of *Design Research*

I will start this journey by describing my research within the last three years by outlining the methodology of Design Research. Design Research is the foundation of this project with a special focus on a triangular framework called *Critical Research*.

Design Research is an emerging field, which only dates back to early, 1990s. American researchers made *Design experiments* in pedagogies and learning. Based on prior research, they created, tested, and improved educational designs (Collins et al., 2004). The following section considers the basic concepts of Design Research.

Design Research explores "what could be"

Design Research is empirical research that investigates changes and improvements of theory-driven designs to develop a new theory. The purpose is to explore not only the "what is" but also the "what could be" by integrating new designs into old learning activities (Skovsmose and Borba, 2004).

Design Research was created as an alternative to the summative approach of traditional research (Collins et al., 2004; Skovsmose and Borba, 2004). It was criticised for only evaluating whatever happens right now. Even though it was possible to make suggestions for improvements, traditional research could not tell if the implementation would be successful.

In opposition to this, the nature of Design Research is formative and focuses on how things could be changed or improved. It is conducted during the development or improvement of an educational design, such as tools, activity structures, institutions, scaffolds, and curricula (Cobb et al., 2003). As the theory develops and informs the iterations of this design process, it is possible to consider the changes of the learning activity. The aim is to explore

new forms of learning in specific settings but with a broad theoretical goal that frames selected aspects of the invented learning activity (Cobb et al., 2003).

Cooperation between researcher and practitioner

In the exploration of these new learning formats, Design Research emphasises strong cooperation between researchers and practitioners. It combines pedagogical theory with practical experience from previous educational designs in order to incorporate the knowledge and workflow of designers.

The so-called *Osmotic Model*, can illustrate the cooperation between researchers and practitioners. This model shows the fluctuation between designing tools and the development of theoretical insights (Ejersbo et al., 2007). See Figure 1.

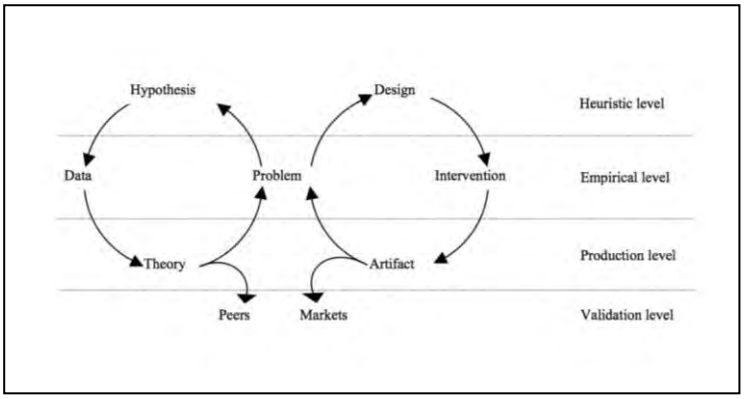


Figure 1: The Osmotic Model. The left circle mimics the process of doing educational research, and the right circle mimics a production cycle. The integration of these two processes drives the design and the development of theory (Ejersbo et al., 2007).

In the Osmotic Model Ejersbo et al. (2007) describe how the left circle mimics the traditional way of doing educational research. Here, the main "customers" are peers. The right circle mimics a

production cycle, but compared to normal industrial production, the participation of users and consequently of feedback is much stronger. The model starts off with the common "problem" in the centre and ideally performs iterative synchronous circle movements in both directions.

The model works on four levels: *the heuristic level, the empirical level, the production level, and the validation level*.

The *empirical level* is where it all starts in that it identifies the problems or situations to be changed. Through experiments, observations, verifications etcetera, the empirical level tells us what can be known and what is unknown. The second level is the *heuristic level*. Here, researchers and practitioners combine their practical experience and hypothesis into a design prior to re-entering the empirical phase in order to collect data and possibly make changes and/or improvements. This shift from design to intervention shows the circular, iterative process of Design Research. Here there may be infinite loops of design–intervention–redesign before moving on to the *production level.* This actually demonstrates two important aspects of design experiments: *expectations* and *reflections*.

The expectations are the *"proto-theories*" on how to improve a learning process through design and what tools to utilise when doing so. The reflections are done whenever these hypotheses are tested. Expectations and reflections feed into the iterative process when using the design in practice. This helps shape the explanatory framework and specifies the expectations during the next iteration (Cobb et al., 2003).

After a certain number of iterations, expectations, and evaluations, the research moves on to the *production level* of the design, and here the broader theoretical perspective is extracted into theory. The design is organised and synthesised before it

finally enters the *validation level,* where the markets and peers judge the outcome (Ejersbo et al., 2007).

In this project I use Critical Research to execute the empirical and heuristic level of the osmotic model. I will return to this later in this chapter.

The learning ecology *of Design Research*

An important aspect of Design Research is paying attention to the complexity of learning activities during the iterations, evaluations, and developments of theory. Research cannot only document success or failure but must also focus on interactions that refine our understanding of the issues involved (Collective, 2003). It is important to consider that there are many aspects even though the researcher may not pay attention to all of them (Collins et al., 2004).

Hence, designs created are considered as a part of a *learning ecology*—a complex interacting system of multiple elements, types, and levels, e.g., the story design in this thesis was implemented in the complex learning ecology of school-science centre activities. This draws attention to multiple parameters rather than a single collection of activities, or a single list of separate elements that influence learning (Cobb et al., 2003).

Ideally, Design Research should result in a greater understanding of the learning ecology. It explores how the design supports learning by designing the elements of the learning ecology and anticipating how these elements function together. Through changes in the design, it is also possible to see the influence on the learning ecology and the actions of the participants thereby creating new designs and new theory (Cobb et al., 2003).

A development of humble theories

The purpose of Design Research is not to just empirically tune *what works* in certain learning ecologies. The purpose of Design Research is to develop a class of theories about the design and about the processes of learning that the Design Research supports. Still, these theories are quite humble as Design Research emphasises a close connection with the context of the educational design.

In Design Research, the outcome of the research should be connected to the process and to the actual learning activity in order for it to create a generalised theory, which guides future design processes. This creates an intermediate theoretical scope located between two accounts: one narrow account of a specific system, such as a particular school or a particular science centre, and a broad account that does not orientate design to a specific incident. Hence, Design Research theories are humble, contextual, and accountable to the activities of the design (Cobb et al., 2003).

The characteristics of the methodology of Design Research are summed up in Table 1 (Cobb et al., 2003; Collective, 2003; Collins et al., 2004; Kahr-Højland, 2010)

The specifics of *Critical Research*

As described in the previous section, Design Research is informed by practical knowledge, theory, and proto-theories. The story designed for this thesis was informed by the theoretical framework introduced in Chapters 3, 4, and 5 on narrative theory and Activity Theory and the knowledge of school teachers and Experimentarium staff.

Characteristics of Design Research	
A practical purpose	The purpose of Design Research is to develop a class of theories about the process of learning and actual designs to communicate relevant implications to practitioners and other educational designers
Intertwining practice and theory	The practical design and the theories of learning are intertwined by doing research in authentic settings influenced by both researchers and practitioners
Iterations	The research is iterative and takes place through continuous cycles of design, enactment, analysis, and redesign that shape the explanatory framework.
Paying attention to complexity	Design Research pays attention to the interactions and the complexity of learning activity and cannot merely document success or failure.
Development of humble theories	Design Research theories are humble, contextual, and accountable to the activities. They are located between a narrow account of a particular design and a broad theoretical account.

Table 1: The table shows five characteristics of Design Research (Cobb et al., 2003; Collective, 2003; Collins et al., 2004; Kahr-Højland, 2010)

To guide this design process and test my proto-theories of the potential of stories as learning tools, I used the triangular model of the Critical Research of Skovsmose et al., which originates from Critical Theory and Action Research. It was invented in the classroom in critical math education as a democratic, philosophical, and socioscientific alternative to classic research in mathematics (Skovsmose et al., 2000).

Conducting Critical Research means considering what could have taken place and imagining new alternatives by paying special attention to a hypothetical situation although still considering what is actually happening (Skovsmose and Borba, 2004). The triangular model organises these parameters into three situations and three processes, which I will describe in the following sections. See Figure 2.

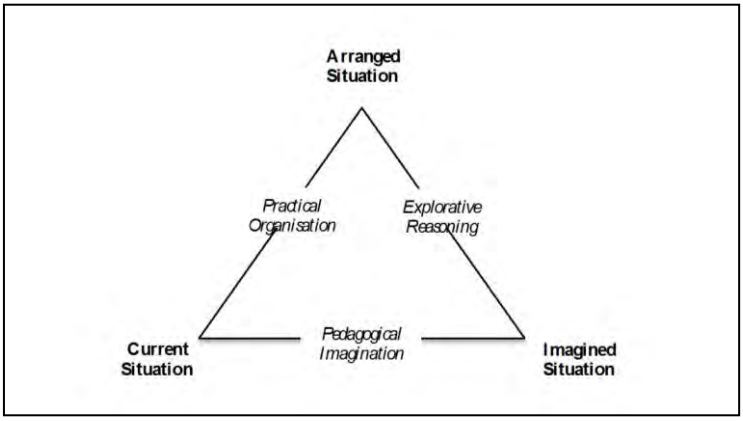


Figure 2: The triangular model of Critical Research indicates the three situations of the design phase and the processes that mediate between them. The *Imagined Situation* describes how the *Current Situation* is visualised to be better and the *Arranged Situation* integrates these two situations into the actual design.

Three situations

The *Current Situation* in the triangular model is the situation found prior to the educational experiments taking place. This situation contains problematic features that researchers must pay special attention to. According to Skovsmose et al. (2004), this is the situation that traditional research encompasses.

The Current Situation can be imagined to be different and this alternative vision is called an *Imagined Situation*. Introducing an Imagined Situation expands the research perspective and makes it

possible to consider what may be. It is an imagined incorporation of "proto-theory" into the existing situation (Cobb et al., 2003; Collective, 2003). The Imagined Situation is an idealised situation that describes how certain changes in the existing learning environment may change the learning activity. This situation is partial and volatile and it only exists as a conception established by different proto-theories and ideas (Skovsmose and Borba, 2004).

Even though this Imagined Situation does not really exist, it creates a basis for designing an *Arranged Situation*. The Arranged Situation differs from the Imagined Situation by being limited by different kinds of structural and practical constraints, but it has been arranged with the Imagined Situation in mind. The Arranged Situation is also an alternative to the Current Situation but it is very different from the Imagined Situation. The Arranged Situation is the actual design of a new learning environment in which the problems and the imagined solutions from the Current Situation and the Imagined Situation have been implemented. It emerges from a negotiation between the researchers and the practitioners (Skovsmose and Borba, 2004).

In this way, three different situations become a part of the research perspective. By adding a narrative design informed by theory and practice, I used this triangulation in my project to intervene with the already existing learning environment in schools and at the Experimentarium. As a tool to create and analyse the situations behind this design, I used three processes from the triangular model to explain the relations between the current, the imagined, and the Arranged Situation.

Three processes

The processes of the triangular model are called *Pedagogical Imagination, Explorative Reasoning,* and *Practical Organisation.*

Pedagogical Imagination is the relationship between the Current Situation and the Imagined Situation and has the Current Situation as the point of departure. It is in this process of imagining and conceptualising that things can be done differently from the current educational situation.

By Pedagogical Imagination, the designer imagines how the Current Situation can be turned into the Imagined Situation thereby formulating the processes necessary for the Imagined Situation to take place. It may express a historical and an anthropological sensitivity by acknowledging what has happened before and what else has been done, e.g., by cooperating with practitioners, such as science centre staff or teachers as well as students or other parties involved.

But in reality the educational context constrains the Pedagogical Imagination. Thus, when using the Current Situation as the point of departure, Practical Organisation is necessary to establish an Arranged Situation that simulates the Imagined Situation. The Practical Organisation represents a pragmatic version of the Pedagogical Imagination in order to describe the necessary planning activities for creating an Arranged Situation (Skovsmose and Borba, 2004). Whereas Practical Organisation and Pedagogical Imagination represent the considerations behind the design, we have to introduce a third process for analysing the outcomes. As we cannot expect an Arranged Situation and an Imagined Situation to be identical, Explorative Reasoning is an important analytical process in terms of analysing the empirical data generated from the design product (Skovsmose and Borba, 2004).

Explorative Reasoning is an analytical process used to reconsider the Imagined Situation based on the experiences from the Arranged Situation. But this is not simply a way to generalise from data extracted from the Arranged Situation. Even though the data are linked to, and limited by, the Arranged Situation a part of

the analysis is concerned with the Imagined Situation. By looking through the data from the Arranged Situation, it is possible to draw conclusions about the Imagined Situation and in this way the Arranged Situation turns into a window through which we might be better able to grasp and qualify the Imagined Situation. It does not only have an effect on the changes of the design and the learning activity but it also changes the Pedagogical Imagination and informs new designs or new iterations of the design (Skovsmose and Borba, 2004).

To sum up, the osmotic model and the triangular model of Critical Research provide an opportunity for creating a design that considers both imagined and actual perspectives of a learning activity. This creates an opportunity to incorporate proto-theories of story-based learning into a design and explore these intentions while also exploring the actual situation.

The next three chapters outline the theoretical basis that constitutes the proto-theory used in this thesis.

3 Narrative from the Perspective of Activity Theory

This chapter is the first of three chapters of the theoretical framework of this thesis. It reviews Activity Theory as a philosophical framework for studying student praxis and learning in order to position narrative as a tool for learning. The chapter describes how Activity Theory gives focus to mediating tools during learning activities, and how these tools may scaffold students during learning activities.

Learning through activity

In this chapter and the succeeding two, I will outline the theoretical framework of my project, and through this describe the proto-theory that has informed the design of *The Emperor*.

I will begin by positioning stories as tools in the philosophical framework of Activity Theory. Activity Theory gives emphasis to tools in learning activities because tools are carriers of history, experience, knowledge, and skills. Hereby they provide a theoretical scope for considering stories as scaffolds and tools for learning.

What does "activity" mean?

Before I elaborate on the concept of narratives as tools for learning, we need to look into the philosophical framework of Activity Theory. There are many variations and interpretations of this theory that was originally developed from cultural theory by Vygotsky (1978)—inspired by Marxism—and further established by Leontjev (1978), Luria, and a number of modern theorists (Vygotski and Cole, 1978).

In general, "Activity Theory" is a theory of learning and development. *Activity* means all activity done by individuals, whether it is of a physical, emotional, or mental character. According to Activity Theory, the individual understands and constructs itself and attempts to understand the world through activity. Thus, activity is essential for learning.

The theory emphasises the social, historical, and cultural nature of consciousness and thinking. Unlike classic constructivism (like early Piaget), Activity Theory does not just focus on cognition and the interplay of physical and mental development. However, the social aspects of Activity Theory do not replace cognitive learning theory but should rather be seen as a supplement to this. The

social-interactive dimension means that Activity Theory considers cognition and memory as situated in certain kinds of communication, certain activity patterns, and in cultural and social relations. It establishes a dialectic relationship between the individual and the sociocultural context. It is through interaction with the outer world that the inner structures of the individual develop and learn (Broström, 2005).

The research objective within the cultural-historical paradigm is to understand the relationship between human inner structures, the social parameters (culturally and historically conditioned), and the actions of the individual (Broström, 2005).

The meditational triangle of Activity Systems

To understand what constitutes an activity, it can be helpful to use the concept of an "Activity System."

The core of Activity Systems is a triangle of a subject striving for an object mediated by a tool. We can call this *The Mediational Triangle* of activity. This is illustrated in Figure 3.

Mediation is defined as the situation, where humans purposely place tools between themselves and the environment they interact with in order to modify it and gain certain benefits. For example a farmer ploughs his soil to gain more crops, or we use language to mediate between the inner and the outer world. In the mediational triangle, the transformation of the object into an outcome motivates the existence of the activity (Kuutti, 1996).

The parameter of the mediational triangle can be described as follows:

A *subject* can be both an individual and a group of persons involved with the same activity. They strive for an *object* that may

have different forms. To reach this object they use mediational *tools*, and consequently achieve a certain *outcome*.

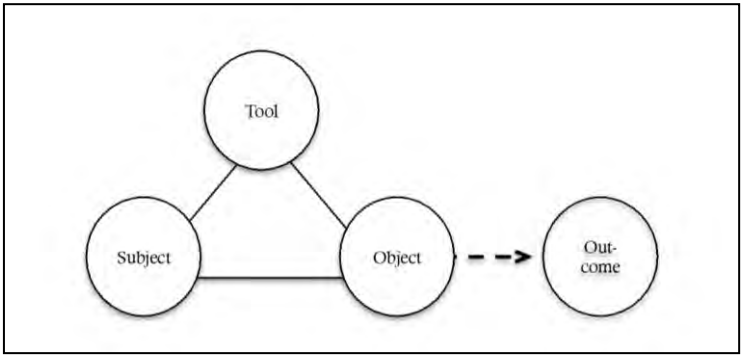


Figure 3: The basic mediational triangle. The model shows how an activity consists of a subject striving for an object mediated by a tool in order to achieve a certain outcome.

The object can be a physical or material or it can be a more or less tangible thing, such as a plan or a common idea. The object may also undergo changes during the process that constitutes any given activity. Like the object the mediating tool can be physical and psychological. It may be a book or a calculator or a language, culture, or a way of thinking (Kuutti, 1996).

I will discuss the tool in greater detail in the next section. At first we need to consider how the mediational triangle can be elaborated to contain more social aspects of Activity Theory. The social aspect is important in this project as the story-based learning activities involve classes of students who are influenced by each other and the learning environment.

To understand why the social dimension is important, we can use an example by Leontjev (1978).

Leontjev describes how primitive hunters divide into two separate groups when they want to catch the game: catchers and bush beaters. The goal of the bush beaters is to frighten the game toward the catchers. However, this is in stark contrast with the goal of catching the game to get food and clothes. But since the activity is joined with a catcher, it makes perfect sense. The activity of the bush beater can only be understood as part of the larger system of the hunting activity (Leontjev et al., 1981). The example demonstrates how the social parameters and the context influence the actions of an individual.

Engestrøm (1987) demonstrated this relationship—between individual and social parameters of an activity—in an extended Activity System. Based on Leontjev's analysis of the social dimension, he introduces three parameters: *community, rules,* and *division of labor* (Engestrøm, 1987). The extended Activity System can be seen in Figure 4.

Engestrøm (1987) describes how a community arises whenever an activity has a social dimension, e.g., when several people share the same object. Within this community, rules regulate actions and interactions. Rules cover both explicit and implicit norms, conventions, and social relations within a community. On the other hand, the members of the community also need to make a division of labor, which influences the power and status. Division of labor refers to the explicit and implicit organisation of a community related to turning the object into the outcome (Engestrøm, 1987; Kuutti, 1996; Kaptelinin et al., 1999).

All together, the abovementioned parameters create a dynamic network with six nodes, and each node influences the others. Tools mediate the relationship between subject and object, the relationship between subject and community is mediated by rules, and the division of labor mediates the relationship between object and community (Engestrøm, 1987).

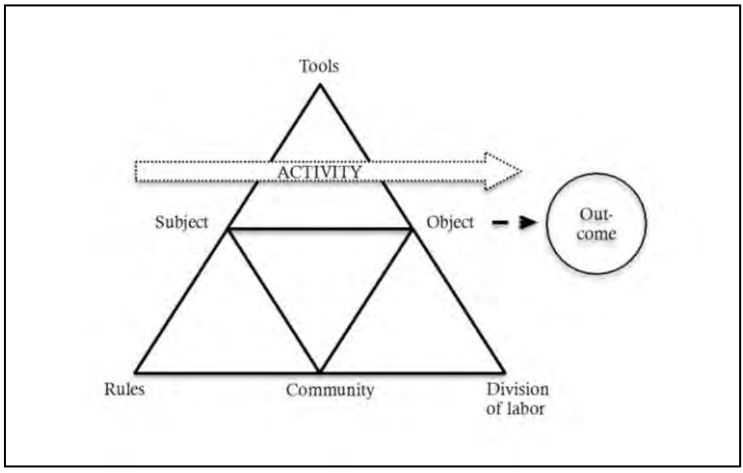


Figure 4: The triangular model (Engestrøm, 1987). The model shows how the activity of a subject is placed in a social context of a community guided by rules and a division of labor.

I will emphasise two important aspects of Activity Systems. First, Activity Systems are always situated. They are grounded in historicity and culture and thus an activity cannot be understood or analysed outside the context in which it occurs (Engestrøm, 1987). Second, the somewhat rigid appearance of the triangular model is only for the sake of simplicity. Activities are not static or rigid entities; they are under continuous change, and they develop at all levels; new operations are formed as participants' skills increase, and the scope of new actions is enlarged, invented, and adapted. Each activity has a history of its own, where parts of activities often stay embedded in new activities. A historical analysis of this development is often needed to understand the Current Situation (Kuutti, 1996).

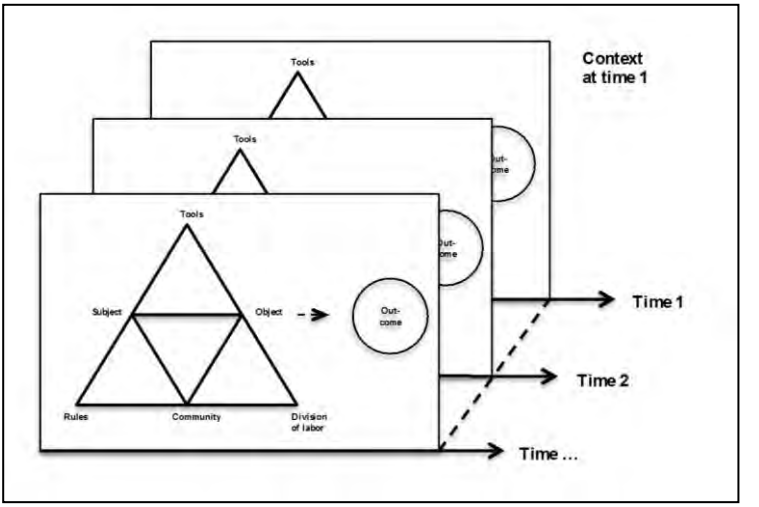


Figure 5: The Context model (Kaenampornpan and O'Neill, 2004) representing the history of the Activity System. The model shows how activities are placed in a specific context that develops through time.

The *context model* by (Kaenampornpan and O'Neill, 2004) illustrates these two features of Activity System in Figure 5 through a representation of history that considers time and context. This model emphasises that time is a crucially important part of context—not just the current time but also the past and the future. The past contributes with an element of historicity to the context, and the future enables a prediction of users' actions from the current context (Kaenampornpan and O'Neill, 2004).

Hence, Activity Theory provides a philosophical framework for studying human praxis and learning through a perspective, where learning takes place through active participation and individual and sociocultural parameters are linked together (Kuutti, 1996). Hence, when analysing human activity we must explore more than just the kind of activity people engage in. We must examine *who* is engaging and what their goals and intentions are, what they achieve through the activity in terms of objects and products, the

rules and norms of the activity, and the larger community in which the activity occurs (Jonassen and Rohrer-Murphy, 1999).

The importance of tools for learning

Having established what constitutes an activity I move to consider the importance of tools in activities in regard to learning.

The tool *affects the activity*

The human use of tools is an essential parameter in Activity Theory. Tools distinguish the human psyche and its development from animals. Our ability to use tools represents a unique mode to process and understand the world. This may be illustrated by the use of a spoon. When we use a spoon, we acquire a skill in using the spoon, we learn the word *spoon*, and we understand the cultural history of the spoon (Leontjev, 1977). The spoon mediates a number of activities and through the embodiment of history, experience, knowledge, and skills it provides a means for the individual to engage in culture and develop psychologically (Broström, 2005).

However, the tool is both enabling *and* limiting: it empowers the subject with the historically collected experiences and skills, but it also restricts the interaction to the single perspective of that particular tool. Other potential features may stay invisible to the subject (Kuutti, 1996). At the same time, as humans, we influence the development and understanding of these tools and consequently a dialectic relationship is established between the tool and human development (Lindquist, 2004). However, in order to understand tools as a potential learning tool we need to consider how learning happens according to Activity Theory.

Learning through actions, operations, and internalisation

As mentioned in the beginning of this chapter, learning occurs during activity. Thus, we can consider learning by looking at the constant change in the Activity System.

Activities can essentially be broken down into *actions* and *operations*. Each activity is a result of a series of actions directed toward an object. Actions are the individual and independent units with their own objectives within the activity. Actions can be decomposed into sequences of operations, that is, certain functions or routines that are already incorporated and therefore occur relatively unconsciously. The activity, actions, and operations are each related to motives, goals, and conditions under which the activity is performed (Broström, 2005; Nussbaumer, 2011).

This can be illustrated through the act of driving a car: while driving you make use of a number of operations, such as changing gears and using the wipers. At some point you have learned how to change gears, going from third to fourth gear by lifting the foot off the accelerator, pressing down the clutch, and moving the gear lever. Once the action of shifting gears is operational it becomes a routine (Kuutti, 1996).

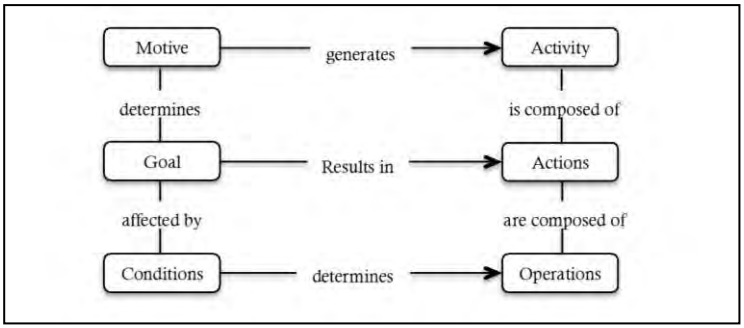


Figure 6: Activities broken down to actions and operations (Nussbaumer, 2011)

In activities new operations are constantly created on the basis of past actions as participants' abilities increase, which in turn create entirely new actions. This means that the level of an activity depends on who is undertaking it. The act of driving a car can be an activity for someone who is learning how to drive and the driving teacher. It can be an action for an experienced driver or an operation for a skilled taxi driver who knows exactly how to navigate the streets. It depends where the learner is in the process of learning.

In learning situations, when a student acts, experiments, or conducts other tasks she makes this activity her own. This is called *internalisation* of the outside world. It is through this active process that the psychological structures for learning are created. However, the process of internalisation does not stand alone. It fosters an *externalisation* process in which the individual starts expressing herself about internalised aspects. Through externalisation students begin to understand their own conception of the newly gained knowledge, and they become able to view it from a distance (Broström, 2005).

Vygotsky believes that these higher mental functions develop twice. The first time it happens is with the interpsychological functioning, which is a part of social activity and action. The second time these mental functions are established is when the child starts using these functions individually for internal thinking. This is called an intrapsychic function (Vygotsky, 1982). But children cannot establish this internalisation by themselves. They must get help from more knowledgeable others in the form of teachers, parents, educators, and peers (Broström, 2005).

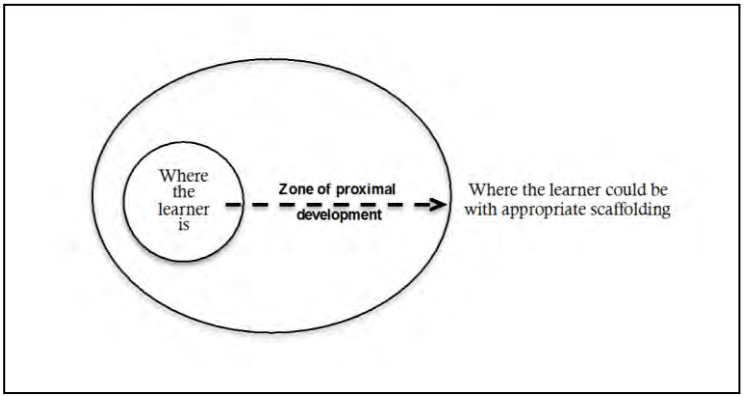


Figure 7: The Zone of Proximal Development

This coincides with what Vygotsky calls *The Zone of Proximal Development* (see Figure 7). In the zone of proximal development a more capable companion, teacher, or parent mediate between what the learner already knows and what the learning potential is (Vygotsky, 1982).

Scaffolding learning

The introduction of the zone of proximal development in terms of *learning something* brings us back to considering tools for learning.

Mediation and *the zone of proximal development* were relaunched in psychology by Wood et al. (1976) by the term *scaffolding*. Originally, the term was closely related to the zone of proximal development and was used to describe the support given by a more knowledgeable individual in a one-on-one tutorial interaction and implied the presence of a more knowledgeable other (Sherin et al., 2004).

However, since this first launch of the concept several researchers who study learning and human interactions have adopted the concept. It has been looked upon from various perspectives,

transformed, and generalised (Sherin et al., 2004) and is used for various purposes.

This expands the definition of the term and makes it possible to consider complex systems, such as classroom learning and complex activity structures (Davis and Miyake, 2004). Today, scaffolds may also be representations and physical artefacts that serve as cognitive tools that mediate action (Wertsch, 1991).

A *scaffold* is something that supports the student during his or her learning activities. Wood et al. emphasise how scaffolding includes a number of functions. These functions are recruitment of interest in a task, reducing the degree of freedom available to the learner, direction maintenance, frustration control, demonstration, accentuating relevant features of the task, and modelling solutions to the task (Wood et al., 1976).

Today, research in educational software increasingly pays attention to scaffolding by cognitive learning tools (Kuutti, 1996; Reiser, 2004; Dobson et al., 2005; Uden, 2007; Conole, 2008; Dobson and Ha, 2008). Reiser proposes that cognitive tools should help learners overcome challenges in the learning environments through *structuring* and *problematising* (Reiser, 2004).

Through *structuring* the scaffold can provide students with stimuli that support their reflection and articulation, guide them and break down the task. This should create curiosity and interest in understanding or resolving an issue and focus students' attention on aspects that need resolution. By *problematising* certain issues, the scaffold should guide students in domains that will be productive for learning and help them think of a problem in a particular way. The scaffolding should provoke students to *rock the boat* (Sherin et al., 2004).

Reiser emphasises that even though a scaffold can be a cognitive tool we cannot simply consider itas inside the head of learners.

The tool works within a specific system and cannot be considered without exploring other aspects of this system. Learners have certain expectations toward learning situated in a school culture. It also matters what other resources are available to support the tool in terms of teacher support and information resources (Sherin et al., 2004). Hence, cognitive tools are situated and affected by other aspects of the learning activity.

Hence, cognitive tools embody culture, history, experience, and skills. These tools can be used as scaffolds for learning by supporting the learner in establishing and developing inner cognitive structures that the learner could not gain by herself. The tool scaffolds the learner by giving structure and highlighting important parameters of the activity. Consequently, in this project the aim is to design a narrative scaffold that acts as a cognitive tool for learning. The scaffold should help structure problem solving and problematising subject matter thereby provoking learners to pay attention to issues they might not otherwise address.

In the next chapter I will describe why I imagine narratives to constitute a cognitive tool for learning.

4 Narrative Structure as a Cognitive Tool

This chapter is the second part of three about the theoretical framework of this thesis. It considers how narratives can be used for learning purposes due to their inherent formal structures and properties as epistemological tools. It does this by considering how narrative structures and narratives as a cognitive tool are intertwined.

The concept of "narrative"

This second chapter of the theoretical framework considers what qualifies stories as cognitive tools for learning science.

The idea of using stories to scaffold student learning in this project is related to the cultural status of narrative. Narrative is considered our main form of communication and has been studied and represented in a number of disciplines, such as education, sociology, human psychology, philosophy, history, fiction, film, and others. It is our main form of discourse and present in the life of children from a very young age (Chatman, 1978; Avraamidou and Osborne, 2009).

Since the term *narrative* has been used for a number of purposes a wide range of definitions of this term exist.

For general purposes in semiotics and literary theory, a *narrative* is a story or part of a story (Ricoeur and Thompson, 1981). It may be spoken, written, or imagined, and it can be viewed from one or even several perspectives. The American dictionary of English language defines *narrative* as "*a constructive format . . . that describes a sequence of fictional or non-fictional events*" (Pickett, 2000).

In philosophy and various clinical fields, a narrative can refer to aspects of human psychology. Here, a narrative is a mental and an epistemological tool for the construction of meaning, memory, and identity.

In this thesis I understand the concept of narratives in terms of both the literary construct of "a story" and as an epistemological tool similar to the view of the American psychologists Jerome Bruner, Jean Mandler, and Donald Polkinghorne. They share a common theory that there is a clear-cut connection between the structures of a story and the narrative as an epistemological tool.

They combine insights from structural narratology with psychological and cognitive aspects of narratives.

To understand the story as a scaffold and a tool for learning, I will review the epistemological and structural properties of stories in the following sections.

The story as an epistemological tool

To understand the bridge between structure and cognition I will start by describing the epistemological properties of narratives.

Stories show significant features as mental tools when meaning is being constructed. For example if we have to describe a wonderful day at work to our husbands or friends, we tell how lovely it was that all deliveries were made on time, that one of our colleagues treated us for lunch, or that we were promoted. We carefully select the things that went right and emphasise the events of the day that characterised it as a wonderful day. We create a story about our day.

When we create a narrative, we make interpretations of our experiences and of our surroundings in order to organise them in a meaningful way. A Danish professor in Education Marianne Horsdal defines this process as "the explanation-value of the story" (Horsdal, 2000).

Due to these attributes humans constantly use narrative as means of communication and explanation. We use them to organise events by telling about them, by keeping track of the knowledge by verbally recreating the process we went through to get the knowledge, and by using it in a social way to tell others about our life and experiences (Miller et al., 1990).

The American psychologist, Jerome Bruner argues that human beings are born with certain mental schemas that we also apply to

stories. We use these schemas in order to help ourselves to organise our experiences and as something we can rely on whenever we need to. He claims that stories are organised representations of human experiences that cool down the chaos that arises when actions, emotions, and thinking are mixed together (Bruner, 1986; Bruner, 1991; Bruner, 1996).

According to Bruner stories accomplish this by creating an action that implements problem, temporality, and solution. When we tell a story, not all details from our reality can be present. We have to make selections, create hierarchies, and make a sequence. We create beginnings and endings to ensure coherence and in order to understand the world. It supports us when we try to remember the past and when we seek to Figure out where to go in the future.

Bruner actually takes the notion of narrative even further by arguing that narratives are more than just a means of communication. Bruner believes that we live in narratives and that our immediate experience of a world is constructed in narrative:

"We live in a sea of stories, and like the fish who will be the last to discover water, we have our own difficulties grasping what it is like to swim in stories."

As such, the story is omnipresent and represents a certain form of discourse that connects separate episodes and creates meaningful events. They provide a macrostructure that contributes to both local and global coherence thereby organising human thought and activity (Plowman, 2005). In that way, stories are extremely powerful as a means of communication but simultaneously they provide a sense of calmness as they restore the "inner peace" by providing explanations (Kahr-Højland, 2010).

Hence, people use stories cognitively to provide themselves with a familiar structure that helps shaping the construction of meaning.

The inherent structures of stories

Several researchers in cognitive psychology have explored the connection between stories and human cognition. They argue that the strengths of stories as epistemological tools are found in their compository structures (Mandler and Johnson, 1977; Polkinghorne, 1988; Bruner, 1991). According to these researchers, narratives are not simply particular accounts fitted to specific occasions, but follow a number of universally structured principles (Bruner, 1996).

An American professor of cognitive science, Jean Mandler, proposed that story structures and epistemological properties of narratives are intertwined through a kind of narrative evolution. The certain "traits" and components of stories are very recognisable to people, presumably because they existed long before people invented writing.

Mandler and Johnson (1977) suggest that the structures and forms of fairy tales, folktales, fables, and myths have been advanced through generations of traditional storytelling. Since people could not write down their stories, those structures that were the easiest to remember survived. Today, the stories we tell are perfectly aligned with the way we think and understand our world. Because of their familiarity they carry certain expectations for temporality and causal relations (Mandler and Johnson, 1977).

Hence, let us consider some of these compository structures and how they relate to cognition.

Components of the story

The structures of stories were given considerable attention in literary theory in the early twentieth century, and especially those of fictive stories, such as folktales and fairy tales are well understood. Several researchers have tried to pin point the

necessary components and structures for creating meaningful stories. Researchers in science education Avraamidou and Osborne (Avraamidou and Osborne, 2009) reviewed three of these different structural analysis of narratives provided by literary theorist Toolan (Toolan, 2001), Norris (Norris et al., 2005), and Chatman (Chatman, 1978) and established a list of seven necessary components in a narrative.

- *Purpose*
- *Events*
- *Structure*
- *Time*
- *Agency*
- *Narrator*
- *Reader*

Avraamidou and Osborne argue that as well as being useful in classic literature these components can also be useful when using stories for science learning (Avraamidou and Osborne, 2009). Each of these components plays a special part in the entire story.

The story has a *purpose*, to help us understand the world and help the reader to invent new entities and concepts of the narrated world. It is also characterised by having a chain or sequence of *events* that are connected to each other and arranged into an identifiable *structure*, such as beginning, middle, and end, where events are related temporally. By doing this, narratives also establish a sense of *time* that integrate past and future. The agents (human and nonhuman ones) cause and experience events and give a sense of *agency* that moves the story forward.

Avraamidou and Osborne also emphasise the *narrator* and the *reader* as important components of narrative. These can be more or less directly included in the narrative. The narrator can be either a real character or, alternatively, a sense of a narrator. The reader

can be directed in the text or must at least interpret the text as narrative.

By emphasising these components, Avraamidou and Osborne stress the important features of narratives that are normally not accentuated in traditional expository texts in science education, such as causality, intentionality, and temporality. They argue that the purpose of narratives is not merely to help us understand the human world but also to understand the natural world. Science is, they say, about developing causal explanations of the material world, and these causes can be accentuated by the use of narrative components.

Story grammar

Our understanding of the narrative components can be expanded through the concept of story grammar. Mandler and Thorndyke created a so-called *Story Grammar* (Mandler and Johnson, 1977; Thorndyke, 1977; Mandler, 1984) to explore why stories seems to provide a way to organise human knowledge.

Mandler introduces the concepts of *story grammar* and *story schema* (Mandler, 1984).

A *story schema* is a hypothesised mental structure consisting of sets of expectations concerning the way in which stories proceed. According to Mandler, humans have mental story schemas in terms of certain expectations to stories because of their specific structures and components. For example we recognise the structures of fairy tales and folktales.

Story grammar, on the other hand, is a rule system devised for the purpose of describing the regularities found in stories. The rules of this system describe the components of which stories are composed and the ordering of these components (Mandler, 1984).

Two commonly used models illustrate the concept of story grammar in classic storytelling by organising the structural components into more superior structures: the *Actantial model* and the *Hollywood model*. See Figures 8 and 9.

The *Actantial model* was developed in, 1966 by semiotican A. J. Greimas (Larsen, 2003). The model analyses traditional actions in a story and describes how the agents of the story relate to each other. The model considers four agents: subject, object, helpers, and opponents.

If we analyse a traditional story, like a fairy tale, by using the Actantial model, we recognise a number of agents. In a fairy tale the subject is often the hero of the story who strives for a particular object, e.g., freeing a princess or an enchanted animal. However, if he could easily achieve this objective, the story would most likely appear as boring to the reader. Therefore, along the way he meets different helpers and opponents, such as evil Emperors, lack of knowledge, dragons, good servants, helpful insights, and enchanted swords. The model arranges the agents of the story in relation to each other to make the story interesting and meaningful.

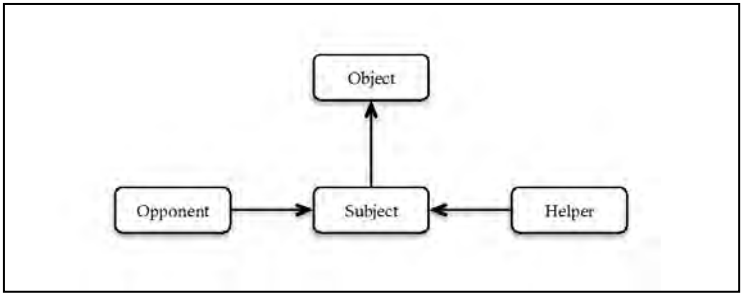


Figure 8: The actantial model (Larsen, 2003). The model shows the relationship among agents by describing what a subject is striving for, and the object as influenced by helpers and opponents.

The second classic model, the *Hollywood model* complements the Actantial model by outlining the subject's way to the object. It describes the typical phases in traditional storytelling and ensures a way of building tension as the hero strives for his object.

This model begins with a prelude that captures the viewer and outlines the general premise of the story to be told. Then a presentation of the agents and an escalation of the conflict follow. When the story reaches its "point of no return," the entire scenario of the conflict is set and the readers' attention is caught to such a degree that she needs to get to the end. Then the conflict escalates even further toward the climax of the story in which the hero achieves the goals. Finally, the story fades out in order for the reader to say goodbye (Larsen, 2003).

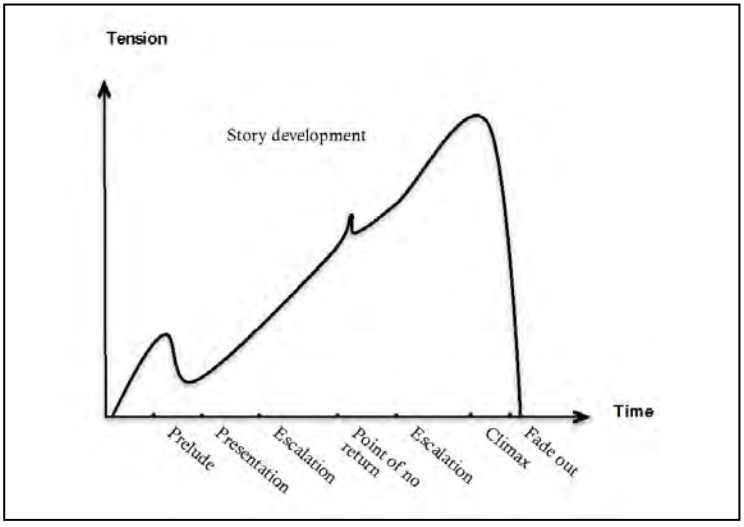


Figure 9: The Hollywood model (Larsen, 2003). The model shows the phases of a classic story through time, and how this affects the development of tension in the story.

Traditional storytelling often follows the classical story grammar described in the Actantial model and the Hollywood model. The

models act as templates for the design of new stories, thereby using the well-established structures to increase the interest of readers, and their understanding of the story. Hence, let us consider how these story structures relate to the epistemological properties of narrative.

Bridging narrative structures and cognition

American Professor in psychology Donald Polkinghorne paid attention to one particular structure in stories that we use to create the mental organisation of story components. He highlights one specific structure that draws all of these components together. The "mother" of narrative components: *the plot* (Polkinghorne, 1988).

A plot is a type of conceptual scheme that creates contextual meaning between individual events in a story. It draws events and actions together into an organised whole to make people understand and retell the events and choices of their lives (Polkinghorne, 1988). Plots create meaningful stories by:

1. *marking the beginning, the middle, and the end of the story, thereby defining the boundaries of the story*
2. *giving criteria for the selection of events to be included in the story*
3. *creating a sense of temporality by organising events into an unfolding movement culminating in a conclusion*
4. *explicating how events are meaningful and contributes to the story as a unified whole (Polkinghorne, 1995)*

By emphasising the plot, Polkinghorne demonstrated the organising effect of stories that provides a way for creating meaning in an otherwise chaotic world. The plot demonstrates the bridge between structure and cognition.

The importance of contextual meaning between organisation of story events (plot) and how these are important for human

thinking can be illustrated by considering a particular organisation of a story: the beginning, the middle, and the end. When we read a story, the beginning tells us what to expect and turn our attention onto specific elements of the story thereby creating curiosity. The middle elaborates on the beginning and unfolds the story by creating tension and expectations, and the end provides us with some kind of morale and resolves the tension.

By establishing these structures, the story tells the reader what to remember and what to expect. It emphasises what is important to notice and what is not. It also provides the reader with a framework for remembering what has happened before, thereby giving the reader a résumé of prior actions that might help them predict future actions. Lastly, it informs the reader of when a part of a story is over and when it can be stored and remembered as well as which parts are not completed and must be remembered until more information has been gathered (Mandler and Johnson, 1977).

Hence, the structural components "beginning," "middle," and "end" demonstrate how story structures may act as tools for construction of meaning by organising knowledge and highlighting what is important. It supports the thesis of stories matching the cognitive structures of the brain that lead to human experiences being organised into temporally meaningful episodes.

Hence, story structures provide a recognisable story grammar, which gives us certain expectations and helps us interpret the reality of the story. Consequently, similar mental story schemas are assumed to be relevant in the story design developed for this project to create a cognitive tool for learning.

5 Aligning Narrative Properties with Learning

This chapter is the third, and last part, of the theoretical framework of this thesis. It explores how a story can be used as a tool in a learning activity by reviewing the sociocultural, cognitive, and emotional properties of stories.

Defining the properties of narratives as cognitive tools

In this third and last part of the theoretical framework I explore which properties a story could supply as a tool in a learning activity from the perspective of Activity Theory and Narrative theory. I do this by considering the cognitive properties of stories and how sociocultural parameters and the context influences the interpretation of the story as a tool.

The sociocultural status of narratives

The term "cognitive tool" describes any device or technique that focuses on students analytical processes, provides support, and gives directions for the practices of the learners. Cognitive tools mediate the students' understanding of the external world and this in turn shapes their intentions and actions (Sherin et al., 2004).

My understanding of narrative as a cognitive tool for learning is based on the assumption that students already know the narrative structure and content and consistently use them in an attempt to understand and retell their experiences.

This relates to the sociocultural status of narratives as cognitive tools. The form and narrative components have been formulated through a kind of narrative evolution that we keep in our cognitive structures (Mandler and Johnson, 1977). One might therefore argue that the countless stories we have heard take stories from an interpsychological position to an intrapsychic position. In the same way as a spoon and other tools, stories embody culture, history, experience, and skills and therefore can be considered as a tool to be used in human activity. Thus, preknowledge about story structures and awareness of their connections matters in order for the readers to understand the story. Therefore, narratives are already a familiar tool for them, which students can use for interpretation (Norris et al., 2005).

Hence, by introducing the story to the classroom or science centres, students get a familiar structure to help them cope with all the unfamiliar elements that comes with learning a new topic, developing skills, and physically navigating in learning environments.

The story as a tertiary tool

The comprehension of how the story could act as a cognitive tool can be described by a theory by philosopher Marx Wartofsky who works within Activity Theory. He has proposed three different levels of tools: *primary*, *secondary,* and *tertiary* ones (Wartofsky, 1979).

Wartofsky's first level considers those tools that are directly used in production, such as words, texts, and networks. The second level considers representations of primary tools, such as recipes, traditional beliefs, and norms.

The third, and most important level in this thesis, is a class of tools that Wartofsky calls *Imaginary Worlds*. These *Tertiary tools* are mental representations of the external world. They can affect the way we see the actual world and change the current praxis. These tools are used when we interpret art, in processes of change, and in perception of an environment. Wartofsky describes this latter level by an example of how a hunter interprets his environment. When the hunter is in the forest hunting, he has a mental representation of the forest's environment. The environment changes when he hears a snap of a twig, or when he hears a bird taking flight (Daniels, 2001). His mental tool helps interpreting the world and becomes a vehicle for operating in the environment (Norman, 1991).

Wartofsky's idea of tertiary level tools illustrates how cognitive tools may change a task in fundamental ways and affect how

people engage in the tasks they perform. I propose that interactive stories may be useful as tools for learning by acting as tertiary cognitive tools for interpreting an environment.

Promotion of motivation and immersion

This assumption that stories might act as tertiary tools relates to the structural and emotional properties of stories that encourage people to engage in the story. It relates to an assumption that stories promote motivation and immersion.

In the previous chapter I established narratives as cognitive tools based on structural properties. However, Bruner has pointed out that good stories are not just effective because of their structure but also because they involve the reader emotionally.

According to Bruner, stories have two interrelated dimensions. One is *The landscape of action*, which is related to the plot-structure of the story where agents, purposes, events, and time constitute the action of the story (Bruner, 1986).

"The landscape of action" is the primary driver of our curiosity and motivation for reading the story because we meet the story between recognition and identification and difference and uncertainty. Because of its form the story represents something known and familiar; but because we do not know how it will evolve before it is realised, it also represents something unknown (Horsdal, 2000). Hence, the story challenges us and stimulates our curiosity. It motivates us to read more and follow along from the very beginning to the very end.

The second element is called *The landscape of consciousness*. It outlines the mental state of the characters and how they think or feel (Bruner, 1986). Through "The landscape of consciousness" readers identify themselves with the story and the characters. In return they get engaged with the story. Oatley states that when reading and interpreting a story, people feel certain emotions

depending on their connection to the characters and their own emotional memories (Oatley, 1995). This emotional engagement in the story may even provide the reader with a sense of being immersed in a story or transported to another time and place. We become absorbed in the narrative universe (Bruner, 1986).

According to Green et al. (2004) readers can be so absorbed in the story that they surrender to the story and the cognitive processes step into the background. The reader enters the world of the story as an active character and offers his thoughts and actions as a medium in which the history can be played out. The story becomes a cognitive vehicle that allows us to gain experience in the physical and social environments of the story (Kahr-Højland, 2010). Bruner calls this "Suspension of disbelief."

"Suspension of disbelief" is a temporary acceptance of something incredible or unbelievable that we are willing to accept because we want to make coherence in the story. For example we are willing to follow Alice into her wonderland and enter the story at its premises (Horsdal, 2000). If the immersion is strong enough, the reader forgets the actual time and place and lives in the fantasy universe created by the story (Biocca, 2002).

Hence, stories are able to create motivation and stimulate curiosity by placing us in a zone between known and unknown actions. It may also foster an emotional engagement in the story, at times so strong, that readers are immersed into the universe of the story. When using the story as a tool for learning we might be able to use these emotional aspects, such as empathy, curiosity, motivation, and immersion to engage students in the learning activity. These features might encourage students to enter the "imagined world" of stories and use this familiar world to organise and interpret activities in the physical world.

The situated story

Even though the story offers an alternative universe, students are still situated in the physical reality of a school or a science centre. Hence, the enrolling of stories to Activity Theory and constituting them as tertiary tools also means that we have to consider the social and personal context of the story. It matters who reads them—where and why.

American researchers in narrative psychology Graesser, Olde, and Klettke proposed that context and experience matter when interpreting a story whether the narrative is presented in radio, television, film, theater, or literature (Graesser et al., 2002). They call this *The situation model*. They base this idea on three theoretical assumptions on how people seek meaning (Graesser et al., 1994). The assumptions are *readers' goals, coherence*, and *explanation.*

The first point considers the goal of reading a text. A reader interprets a text depending on the purpose of reading the text. It emphasises that if the goal is learning, the content of the text is read differently than if the goal is purely for entertainment purposes. The second point considers how learners create coherence between passages when reading the text. The individual reader tries to make sense of the text both locally and globally. Local coherence refers to shorter sequences within the narrative, whereas global coherence refers to how the entire narrative matches constitute themselves in a genre - similar to what Mandler calls story schemas. The last one describes how the reader tries to understand the events in the story through her own experience and theories on psychology and causal effects. This is done to explain the intentions of the characters in the story and why things happen.

According to these assumptions, readers assign more meaning to the story than the actual content of the story implies. Graesser et al. (2002) describe it as the "*mental micro world of what the story is about."* The actual outcome is the reader's representation of the world described in the story. The reader's way of understanding the text is thus grounded in the personal and social context of students who use their previous experiences with narratives and learning activities to interpret the story world. We might consider similar parameters when applying interactive narratives to a learning context. Hence, when considering the story as a cognitive tool for learning we must assume that students use the context and their own experiences and emotions to make their own interpretations of the story.

Hence, stories have certain properties that presumably may be useful in a learning activity. Due to stories' sociocultural status they are familiar cognitive tools that students can easily use. Their status as a cognitive tool can be defined as tertiary level tools, where they act as imaginary worlds that help students interpret their learning activity. The use of the story as a tertiary tool may be improved by the emotional properties of stories that foster motivation and immersion. However, students' perception of the story is influenced by the personal and social context of the students, and this again influences the properties of the story.

The prototheory for narrative as a cognitive tool for learning

In the last three chapters I have used the insights from Activity Theory and narrative theory to ague how stories might be useful as tools for learning. As a result of these chapters I have created three fundamental assumptions that constitute the prototheory that guides the design and analysis of *The Emperor*. The three theoretical assumptions of the prototheory are as follows:

1. *A story can be used as a tertiary cognitive tool in a learning activity and provide structure and direction.*
2. *The connection between story structure and cognition provide a gateway to design narratives that act as cognitive tool for learning*
3. *When using a story as a cognitive tool for learning the story provides a number of properties, such as familiarity, understanding, interpretation, immersion, and motivation. However, these properties are influenced by the context and students personal experiences.*

6 Design Phase: Designing the Story

This chapter outlines the three situations that informed the design, the Current Situation, the Imagined Situation, and the Arranged Situation. It characterises schools and Experimentarium and highlights certain problematic features regarding learning in these institutions and proposes how narrative structures may support these features in the design of the story about The Emperor.

Applying Design Research to a story-based learning activity

Having described the methodology of Design Research and my prototheory I move to consider the actual design process. In this chapter I describe how I used the triangular model of Critical Research in the design of *The Emperor*.

Organisation of the design process

The intention of the design phase is to create the strongest possible story design by analysing the existing learning activity and imagining how a story scaffolds certain parameters of this situation. From an Activity Theory perspective this involves understanding the cultural and historic factors that have resulted in these Activity Systems (or what Design Researchers calls the "learning ecology") and identifying which parameters need alignment, are inadequate or in opposition and then work to resolve these matters.

On a practical level, this was done in cooperation with a project manager and manuscript writer who handled the more concrete parts of the design. To ensure that our considerations were also aligned with the needs of science education in third to sixth grade we were in an ongoing dialogue with three teachers from different schools in Copenhagen. My position as a researcher was to ensure the connection between the practical considerations, the educational perspectives and the story. The design itself is a result of this cooperation, but this section primarily describes my method as a Design Researcher and outlines my considerations of the triangular model of Critical Research, as shown in Figure 10:

1. **The Current Situation:** analysis of the current learning activities and the related problems to explore *what* the story should scaffold.

2. **The Imagined Situation:** using prototheory and Pedagogical Imagination to imagining how a story may solve the problems of the Current Situation by acting as a scaffold in science learning activities.

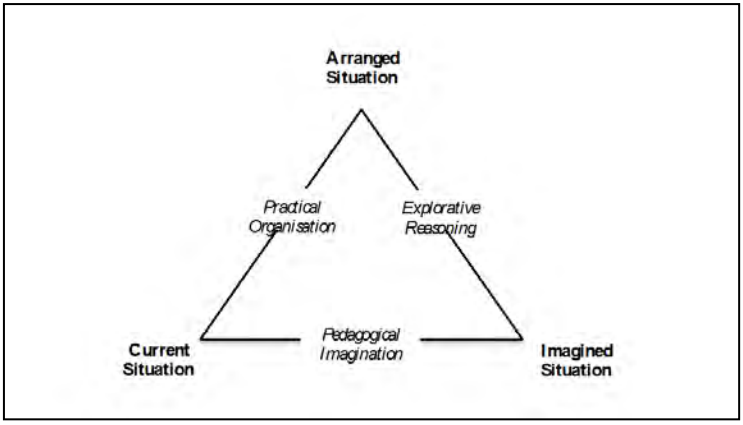


Figure 10: The triangular model of Critical Research.

3. **The Arranged Situation:** design of *The Emperor* through Practical Organisation.

The intention of creating these situations is to let the current and Imagined Situation inform the actual design of *The Emperor* in the Arranged Situation. This makes it possible to consider if the story changes the Current Situation, if the story works as a tool in the way it was intended to in the Imagined Situation, and to evaluate the actual design of the Arranged Situation. These insights create the basis for new theory on story-based learning of science.

Defining the learning activity

Before I describe the three situations, we need to look into the format of the story design and the learning activities it should scaffold.

As directed by Experimentarium management, the story design is executed as a school material. At Experimentarium school materials are text-based folders, audio recordings, websites, or videos that support teachers and students in their visit. Sometimes the materials are exclusively to be used at Experimentarium, and sometimes they incorporate pre- and postvisit activities at the school. In the particular case of the SENSES exhibition we decided to create a text-based exercise book that integrates the visit to Experimentarium to a series of activities in schools. This design makes it possible to explore how students use the story as a tool in these two different contexts and whether the story is able to create a bridge between them. Consequently, we consider the visit to Experimentarium as a resource for learning and this makes it necessary to design a story that scaffolds the Activity System of both schools and science centres and the problems related to learning science in both institutions.

The Current Situation: identification of a point of departure

First step in the design phase is the establishment of the Current Situation at schools and science centres. This should inform the design process and serve as a tool for the interpretation of empirical data when we put the design to use. Hence, in the following sections I will describe the characteristics of Experimentarium and the Danish school subject *nature/technology* (in Danish: *Natur/Teknik*, in the following I will refer to it as *N/T*) and highlight some problems related to these settings that must be considered in the design of a story-based learning activity. In

terms of Design Research this is also a description of the current learning ecology in which the story should be implemented.

Experimentarium and the SENSES exhibition

To describe the problems related to students visiting science centres I will start by describing what characterises Experimentarium as a classic science centre.

The history of science centres usually begins in, 1969. This year the first American science centre—*The Exploratorium*—was created. The science centre originated as a result of the Sputnik-shock. The subsequent space race between the Soviet Union and the United States created a need to strengthen the understanding of Science and Technology in the American population. As a result the Exploratorium, and many other science centres after this—including Experimentarium—followed (Pedretti, 2002). A new paradigm in the organisation of museum exhibits began.

The idea of science centres was to create hands-on exhibits in which visitors could explore freely and create their own knowledge about science. The science centres wanted to show the public "the wonders of science" by presenting a "forest of scientific phenomena" for visitors to interact with (Oppenheimer, 1968) to increase the interest and understanding of science. Hence, science centres were typically concerned with presenting universal abstract laws, principles, and phenomena and visitors are presented with theses phenomena through exhibits, where they should manipulate, read, push, pull, and in general use their senses (Pedretti, 2002). Science centres would offer "a decontexualised scattering of interactive exhibits, which can be thought of as exploring stations of ideas" (McManus, 1992).

These science centres emphasised *constructivism.* In constructivism an active and involved individual is considered essential during the process of cognitive development and learning. Visitors should

be allowed to explore interactive exhibits without any structural guidance but their own curiosity (Oppenheimer, 1968).

In, 1991 Experimentarium was created in this image of science centres, and it was strongly inspired by guidelines from Exploratorium. Experimentarium is, in many ways, still a classic science centre that emphasises the experiment and the scientific phenomena, even though it has changed throughout the years. The purpose of Experimentarium is to

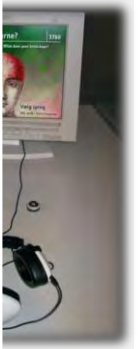
- *increase public interest in science and engineering and promote knowledge of methods and results in science especially for the younger population*

Pictu-rama

Experimentarium

Experimentarium is a classic science centre that aim to inform people about science and technology. The core value of Experimentarium is to make visitors experiment.

The science centre is situated in an old brewery hall in Copenhagen and holds all the permanent exhibits.



All exhibits are located in a big hall, only divided by partial walls. The walls split the exhibition into thematic clusters about scientific topics such as the body, various forms of energy and geological phenomena.

Box 1: The uniqueness of Experimentarium

Experimentarium opened in, 1991 strongly inspired by classic science centres, such as Exploratorium in San Francisco. The cornerstone of early Experimentarium was authentic experiment with open-ended hands-on exhibits explaining scientific phenomena, such as light, color, and force.

But visitors expressed a lack of understanding of the open experiments and Experimentarium had to revise the original concept. Instead the way to "the hearts" of the visitors went through their understanding of themselves as human beings. Today most special exhibits are centered on the human body and more classical physics and technology are left out.

Additionally an increasing number of school classes were using the centre as an excursion point. Hence, exhibit designers had to pay attention to the curriculum of the school. Rather than being primarily a place for adults and families, Experimentarium became a place for learning and a new concept was born: The themed exhibition.

The semiannual themed exhibitions about spies, the brain, or extreme adaptations and climate changed Experimentarium and made it more diverse. The need for funding meant that selected themes were dependent on the interest of external parties and not all topics could be equally represented. The science centre also had to rely on varying scenography to link exhibits to each other through design, color, shape, and placement.

Today, it is difficult to define the essence of Experimentarium. Rather than being *one* place Experimentarium continuously changes depending on the themes, the scenography, the schools, the funding and who manages the project. But still the employees can agree on one thing: the core-values of the early Experimentarium are the same. The natural sciences, the

interactive exhibits and the body-on experiences are the heart and soul of the place.

I have tried to capture the characteristics of Experimentarium today through a short historical flashback in Box 1. The text is based on my casual observations at Experimentarium and interviews with two project managers and the director of Experimentarium, Asger Høgh.

The focus on learning about scientific phenomena is especially prevalent in the exhibition considered in this project: *the SENSES exhibition.* The exhibition is the product of a cooperation between Experimentarium and the Royal Belgian Institute of Natural Sciences in Brussels and the Dutch national natural history museum, Naturalis. It is created with both families and schools in mind and especially minded at children age six to twelve. According to the sketch report, which described the vision and considerations behind the exhibition the core message of the SENSES exhibition is as follows:

- *"Our senses detect information (in stimuli) from the environment (and make us act appropriately). Some stimuli we can detect very well, for some stimuli our senses are limited and some stimuli we cannot sense at all while animals can sense them."*

The sketch report further states

- *"The core message of the SENSES exhibition is translated into interactive exhibits so visitors will experience all the different stimuli present in the environment and learn that humans do not "use" them all to get information from the environment"*

The sketch report describes a scenography, where the exhibition is divided into seven areas. Five areas demonstrate the classic senses of smell, taste, sight, touch, and hearing. Two areas demonstrate the more exotic senses of magnetism and thermoreception. The areas are defined by different surface textures of the exhibits, such as wool, fake snakeskin, and wood. In order to emphasise the role of the animals they are represented in the exhibition as stuffed animals, moving , and photos.

According to project manager, Per Velk, the core message is established in dialog with the partners from the Dutch and Belgian museums. These museums emphasise scientific concepts and phenomena to a slightly higher degree than Experimentarium, and hence the core message put even greater emphasise on scientific phenomena than Experimentarium typically does. Visitors should learn about concepts like thermoreception, understand the phenomenon of sense receptors in their skin and realise how light influences their ability to see, etc. They should experience various stimuli and see the difference between their own senses and the senses of animals.

In conclusion, the core values of Experimentarium and the SENSES exhibition are still the scientific experiment, and they still emphasise visitors' free exploration of scientific phenomena. Consequently, as an institution for learning Experimentarium can still be considered a "classic" science centre in which exhibitions are constructed according to constructivist guidelines. This is the reality that must be considered in the design of exhibition-related learning activities at Experimentarium.

The lack of "minds on" in science centres

A huge problem in classic science centres in terms of school visitors are keeping students engaged in the task of learning. It is difficult to keep students focused on the scientific phenomena illustrated by the exhibits. In a study by Sørensen and Kofod

(2004) on how teachers plan visits to Experimentarium this exact problem is described as follows:

"Daniel and Thomas are having fun whispering to each other from a far distance through the great white parabolas. It takes 35 seconds. Then the boys run to the geyser and press the button to make the water come . . . However, it takes too long and Thomas drags Daniel to the exhibition with the soap bubbles. It is fun to create the biggest bubble. It takes 25 seconds. Thomas leaves. He has discovered a free seat in the rowing machines. He stays there for a few minutes to receive the juice you get, if you roe for long enough. He gets up and notices the music hopscotch diagram. Daniel joins him. They want to try, but two girls are dancing a melody, and they let it go. Instead they try the skeleton bicycle. It looks fun in the mirror. It takes 14 seconds, then they discover something new . . ."

As Sørensen and Kofod state, this behavior is quite common when schools visit Experimentarium and is a general problem in science centres. Science centres emphasise a great degree of play, freedom, and individual choice that seems to conflict with a high degree of cognitive engagement with exhibit content. The physical environment is flooded with competing stimuli that distract students and prevent them from focusing on the learning objectives and in contrast to the formal environment of the school, where responses are explicitly described students must make their own choices in these informal environments for learning (Bitgood, 2002). As a result students often run from one exhibit to the next doing random button pressing, and the average holding time is often less than thirty seconds (Paris, 1997; Sørensen and Kofod, 2004). As stated in an attack on the science centre movement in the journal *Nature,*

"When education and entertainments are brought together under the same roof, education seems to be the looser" (Shortland, 1987).

Science centres like Experimentarium seems to be challenged in terms of educational learning due to the playful elements of the exhibitions. I will try and interpret this problem of the behavior of

students described above from Goffman's (1961) dramatic analysis of context.

According to Goffman, people play different parts depending on their context—when we visit a supermarket we become customers, when we go to work we are employees, and when we are at home with our families we are parents. Depending on our context, we behave and act in certain ways and follow specific rules (Goffman, 1961). Applied to a science centre, it seems as if students play the part they have during playtime or at a funfair when they are at a science centre. They interpret the interactive exhibits as a playground rather than a place for learning. There is something in the context of a science centre that encourages students to play rather than engage in cognitive learning by working with the scientific messages of the exhibits. I will describe this further by using Activity System in the Imagined Situation.

The interpretation of science centres as a place for fun rather than learning creates a big problem in school visits. The ambition regarding educational visits to Experimentarium is to make students have "minds on" rather than just "hands on" in the exhibition. Hence, the challenge is to show students the phenomena of science in the exhibition through reflection and not just activity (Hein, 1994; Kahr-Højland, 2010).

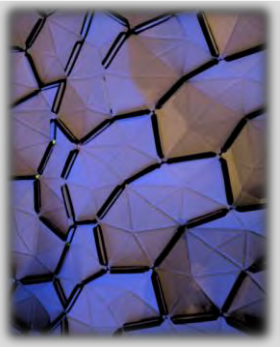
In this project I consider three factors that influence how students interact with exhibitions.

First of all, the very idea of making an open environment for exploration of science seems to contradict students' interest in the exhibition content. The lack of *structure* in science centre exhibitions inhibits cognitive engagement, as visitors feels overwhelmed, disorientated, and insufficient (Kahr-Højland, 2010).

Second, "the novelty-effect" of unfamiliar settings is considered as having severe impact on the behavior and learning of students. Studies have shown that students in new settings tend to focus on orienting themselves with space and navigating the exhibitions rather than giving focus to learning conceptual material (Falk et al., 1978).

Third, the lack of reflection in the way students interact with exhibits is to a large degree dependent on lack of preparation at school prior to the visit. In a study on fieldtrips to Experimentarium Helene Sørensen has identified how student's reflections upon exhibition content changes depending on the nature of the activities planned by the teacher, and the mediation of these activities during the visit (Sorensen and Kofod, 2004).

These three factors create the basis for my understanding of the problems of doing minds on activities in Experimentarium, and the parameters that I need to consider in my design.



The SENSES exhibit consists of 35 colourful, interactive exhibits. Each have a special surface made out of different fabrics such as cow skin, fake snakeskin, wool or wood. The surface tells you if you are in the area of hearing, vision, touch, smell or taste.

Pictu-rama

The SENSES exhibition

Among the exhibits are stuffed animals, aquariums with fishes - and even a living snake.

Nature/technology

In the project we also need to consider the activities at school. In Denmark the subject of science for students in grades 1–6 is called *nature/technology* (*N/T*). The subject does not stem from one particular academic discipline but should integrate topics from physics, biology, geography, and chemistry.

N/T was created in, 1994 to enhance interest in science and technology. Like the science centres, N/T is also a result of the Sputnik-shock, an increased interest in promoting science, which also spread to Denmark, created a number of initiatives from the, 1970s to the, 1990s. These new initiatives focused on changing the current praxis and on making science education closer to "real" science. Students should create their own experiments and understand certain science concepts, such as *organism, habitat, energy,* etc. Prior to these changes the subject biology had a more narrative tradition in which students heard stories about the fox, birds, and so on. N/T was introduced as a consequence of these initiatives and to create a broader understanding of science to help students understand the scientific and technological society (Veje, 2001).

The concept of "interest" is important and relates to two levels: on a societal level, there is a general belief that more students should be interested in the natural sciences to maintain a high level of scientific literacy and to ensure the recruitment of qualified labor in the fields of science and Technology. In an educational level, we think it is important that "science is for everybody," and when we teach science it should be a contribution to the education of all students and it should—at least to some extend—engage all students (Troelsen, 2005).

In the official report from the Danish Ministry of Education the purpose of N/T of students aged nine to twelve (which is the age relevant in this project) is described as follows:

- *The purpose for students in nature/technology is to gain insight in important phenomena and relations in science and to develop an understanding of the thinking, the language, and the concepts of nature and technology that are valuable in everyday life.*

The purpose further states that:

- *Education must be based on the pupils' own experiences, observations, surveys and experiments and help them develop practical skills, creativity and ability to cooperate . . . (Undervisningsministeriet, 2009)*

Hence, N/T at this level is mainly about introducing students to science and technology and developing a kind of scientific literacy and understanding of the language, the practice, the basic concepts and phenomena of science and technology. The aim is to evoke interest in science.

In order to achieve these goals the Ministry of Education has proposed that students should be instructed in ways that make it possible to engage in practical inquiry and give room for reflection, planning and evaluation. It is important to make the student aware of the process, they state, by asking questions like "What do we need to explore?" "How will we do that?" "What materials do we need?" "What do we expect to happen?" How can we use these results?" and "How can we communicate these results to others?"

These questions should be explored through open and closed activities. In closed activities students have little influence and are guided by the teacher. In open activities students have great influence and have to work based on their own experiences and abilities, and students have to formulate what they want to investigate, why, and how. This is also a way for the teacher to get

an understanding of what students know and what their interests are. Students should be trained in presenting the results of their own investigations and connecting their own practical work to theory. They should be able to draw conclusions and see new perspectives that can be applied to new activities (Undervisningsministeriet, 2009).

Hence, in N/T students are supposed to be engaged in the subject through their own interactions with the matter by investigating, experimenting, and formulating arguments. The process of learning is just as important as content learning. This is the reality that must be considered in the design of learning activities at schools.

Supporting students' inquiries

It is important to notice that while it is possible to make a more precise description of student behavior in activities at Experimentarium and the SENSES exhibition it is difficult to describe what exactly goes on in the classroom in N/T, and the specific problems teachers and students face, when they engage in N/T. Different school classes might experience different problems.

At the time of the design-phase, we decided to base our design on more general challenge on supporting students in the complex assignment of doing inquiries when they are active in the open elements of learning activities and must synthesise their own questions, investigations, and arguments. As an example of such an activity we used the framework of inquiry learning. In inquiry learning, students are taught to make hypotheses, conduct experiments, and participate in dialogs about science. Table 2 shows the principles in inquiry learning.

Additionally, we decided to address another problem, which is not directly related to the activities described in N/T but relates to

a challenge of making science personally relevant to students and to awaken interest.

Inquiry learning
Engaging scientific questions—that lead to empirical investigations and gathering of data to develop explanations.
Priority to evidence—which allows learners to develop and evaluate explanations that address scientific questions.
Explanations from evidence—formulated by learners to address scientific questions.
Evaluation of explanations—by checking the results with those proposed of the teacher.
Communicate and justify explanations—articulation of the question, procedures, evidence, explanations, and review of alternative explanations.

Table 2: Phases in inquiry learning (CSMEE (Centre for Science, Mathematics, and Engineering Education, 1996)

As described in the introduction science education today is criticised for being dogmatic, authoritarian, and impersonal and for making students view science as just a collection of facts and laws with little personal relevance (Wang and Marsh, 2002; Lindahl, 2003). Hence, a problem we also wanted to consider was how to make science meaningful and personally relevant.

Summary of problems at Experimentarium and schools

In the past sections I have described what characterises Experimentarium and N/T, and highlighted some problems in relation to these two settings. In summary the design should address the following problems.

- *Students find it hard to navigate science centre exhibits due to a lack of structure that makes them feel overwhelmed.*
- *The "novelty-effect" distracts students when they visit new exhibitions at science centres.*
- *Students are not focused on the scientific content of the exhibitions due to lack of scaffolding.*
- *Traditional perspectives of science in learning make students see science as not-personally relevant and uninteresting.*
- *Inquiry-based science learning creates complex processes that needs mediation.*

The aim is to make science interesting and relevant to students in schools and to make students engage cognitively in scientific content in science centre exhibits.

Having established what characterises activities in Experimentarium and "Nature and technology," I move to consider how a story might influence these parameters. The second step in the design process is to create an Imagined Situation.

The Imagined Situation: imagining the story as a scaffold

In the creation of the Imagined Situation, we have to put the prototheory to use in order to solve the problems mentioned in the previous section.

I have previously described my prototheory in the chapters on narrative theory and Activity Theory. In these chapters I described how I imagine the structures of the story-design to act as a cognitive tertiary tool that helps students interpret the activities in school and at the science centre. By providing a cognitive metastructure the tool should scaffold students during the learning activities. Based on these theoretical assumptions and the analysis

of the problems of the Current Situation, it is possible to imagine how things could be done differently.

I imagine that by designing learning activities with the familiar structure of stories students could engage in these stories and be equipped with tertiary cognitive tools during pre- and postvisit activities at school. The story should help make the scientific content and process personally relevant to students and help them structure the task of learning. Additionally, this should overcome the problem of students being insecure about how to use the exhibition for learning purposes and behaving as if they were on a playground when they visit the science centre. The story should supply students with means to interpret the activity differently by providing them with certain structures, goals, and motivation.

I will demonstrate the Imagined Situation of this project by considering the learning activity as Activity Systems in which the story acts as a scaffold and a tertiary tool by establishing a parallel narrative Activity System.

Imagining schools and science centres as Activity Systems

In this project I operate with three corresponding Activity Systems: one at school, one at the science centre, and one of the story designed to scaffold these two Activity Systems.

Initially, let us consider the two Activity Systems of the school and the science centre by looking at the five parameters of an Activity System that students face: the object, the tool, the community, the division of labor, and the rules.

When students engage in the learning activity in both institutions, they strive for an *object*. Ideally the objective is to engage in materials and exhibits on scientific phenomena, such as light and vision in order to acquire the intended outcome of learning about how our perception of light influences our ability to see colors.

That is, if the students share the same objective as the teacher and the curriculum. In order to achieve this objective, students interact with *tools*, such as the materials given by the teacher and by the exhibits at the science centre. These tools to a large extend define how students reach the objective, and this influences the final learning outcome of the activity.

As the activity is located at school and science centre, the teachers, the science centre staff, and the students themselves constitute a *community* of people who have the same or similar objectives. The activity within this community is governed by a set of *rules* that could be the ones of the school, the ones of the science centre, or even the ones that apply when students have playtime. The rules dictate what students should do and what they should not do to achieve the learning objective. Or if students do not get directions, their own implicit rules may count. There will also be a *division of labor* that could be stated by the teacher in terms of assignments during the visit or could come from the academic or social hierarchy of the students. These are the elements that the scaffold needs to cover. In Design Research terms, they are the existing learning ecologies in which the story-based learning design has to be implemented.

Imagining a story-based Activity System as a scaffold

The third Activity System, let us call it a "narrative Activity System", is the one we need to design in this project. It has a different nature than the other two. It is similar to what Wartofsky calls a tertiary tool in the way that it is intended to scaffold the activities at schools and science centres. It should provide a mental microworld to help students interpret the environments of the other two systems. Let us consider the five parameters of an Activity System from this narrative perspective as well.

First, I imagine that creating a narrative objective that corresponds with the learning objective will make students motivated and

focused at their tasks. As described by the Actantial model, a subject striving for an object is an essential component in classic stories, which creates the basis for establishing suspense and driving the story forward. By doing so the story provides students with a purpose for learning and makes it possible to make the learning objective of personal relevance to the student. This should help accommodate certain aspects of the curriculum.

Second, I imagine the story as a tool for the interpretation and use of other tools to reduce the novelty effect, such as the use of computers for finding information about a given topic or exploration of a scientific phenomenon through an exhibit. The story should establish these other tools as essential requisites for gaining the knowledge, skills, and language that are essential for reaching the objectives.

Besides these individual parameters social parameters in the story should support cooperation between the student and their interaction with the rest of the community to provide a clear set of guidelines for social interaction. I imagine that the story can define what constitutes the community by making it clear who is part of the community. If the learning activity demands group work the story supports this; if it demands interactions with teachers and science centre staff it supports that. Hence, students understand how the agents of the classroom and the science centre act upon each other and in relation to each other. This makes it clear to the students when to confer with peers, staff or teachers, or maybe even consider problems in relation to imaginary agents. This community could be navigated by a set of rules and division of labor dictated by the story. Intentionally this should assign certain roles to students in which they become helpers and heroes, which gives them a guideline for how to act and maybe provides them with different tasks in order to reach a common objective. It could also set up some rules for the exploration of the science centre, which would help the students decide which exhibits to go to and why.

Consequently, in this project, I wanted to equip students with a cognitive tool that will help them to structure their process of learning, make the scientific content personally relevant and interpret Experimentarium as a context for learning. Likewise, the tool should help connect the science centre visit to school activities and serve as a tool for overcoming the obstacles for learning science in this context as well. These reflections define the Imagined Situation of this project. However, we cannot tell *a priori* exactly how students apply the story to the learning activities at Experimentarium and "nature and technology," and hence I move to consider an actual design in the Arranged Situation.

The Arranged Situation: design of *The Emperor*

In the Arranged Situation, I move from an imagined design to the actual design of *The Emperor* - by using Practical Organisation. This should provide the strongest possible story-design and make it possible to explore how students use stories in Experimentarium and at schools under the given circumstances. The entire school material can be found in the Appendix D, page 222.

Implementing narrative structures into existing structures

The aim of the design phase is to create a design that fits into the existing learning ecology but changes it in a positive way. Hence, we have to implement the narrative structures into already existing structures of Experimentarium and N/T. This means considering the characteristics and problematic features of the SENSES exhibition and N/T. Hence, in the design phase we had to create a story-based school material that would fit the following goal:

- *To create a story-structure that motivates students for the learning activity by emphasising personal relevance and interest in the subject "senses," enhances students ability to reflect upon the scientific phenomena of the SENSES exhibition, support*

students in the process of scientific inquiry, experimenting, and in creating arguments about the topic senses, reduce the novelty effect by considering students' prior knowledge about senses, and orient students to the trip setting prior to the visit to SENSES.

To describe this design process I will start by outlining the final result of our consideration in Box 2 and in Figure 11.

Box 2: Outline of the educational considerations of the school material

The first part of *The Emperor* unfolds in the classroom, where the teacher reads the beginning of the story to the students. The story describes how the Emperor does not believe that others may perceive the world differently than he does, and he gets into a fight with his dog who claims to smell a bone buried in the garden that he cannot smell. He then discovers that numerous animals claim to sense the world differently than he does and he removes their ears, eyes, and noses and sends them to jail. To get help regaining their senses the animals decide to contact the kids at a nearby school and ask them for help.

The first part of the story establishes a sense of the narrative universe. The beginnings of the story help students tune their attention into specific elements of the story thereby creating curiosity.

The first part of the story also defines the learning objective: students have to gain knowledge about the senses to convince the Emperor that human beings and animals may perceive the world differently. The intended learning outcome of the activity is content learning about the senses as well as gaining inquiry skills from interacting with the exhibits and synthesising knowledge to inform the Emperor and the animals about the subject senses. Afterward an exchange of letters between students and animals

follows. The story establishes a community of six animals, dividing the labor by making smaller groups of students in charge of different animals. In that way each group gets their own microstory in which they have to defend an animal and learn about the lost sense of the animal. As the story evolves students have to follow certain rules and directions dictated by either the animals or the Emperor to reach their objective. The intention of the letters is to encourage students to consider and articulate their prior knowledge of the senses, and to reflect on their own process of synthesising knowledge and create arguments that might help free the animals.

In a final letter the animals tell students about a laboratory at Experimentarium, where the Emperor studies the animals' senses. Thus, students must select relevant exhibits to learn about the sense of their animal, thereby scaffolding students in their exploration of the interactive exhibit about the senses. The story is not present at Experimentarium neither as letters nor by physical representation. The design relies on students' memory of the story, as a means for students to navigate and interpret the exhibition. The exhibits at Experimentarium demonstrate how certain animals use their senses and give general information about the science of perception. Students should find and experiment with specific exhibits and extract useful knowledge to help their animal and realise that animals sense the world differently from humans due to both anatomical and sensorial differences.

Back at school students get the second part of the story. This bit explains how the Emperor has become even more upset with the animals and wants to fry them in his big black pot. Students can only save the animals if they defend them in court. Thus, the story climaxes, as students have to use their knowledge from Experimentarium to create arguments demonstrating that the Emperor is mistaken. If they do a good job, they get the final part of the story telling that the Emperor has been convinced and has

tried on the many different ears, eyes, and noses and discovered that it is quite true that animals sense differently than humans. This ends the story-based learning activity.

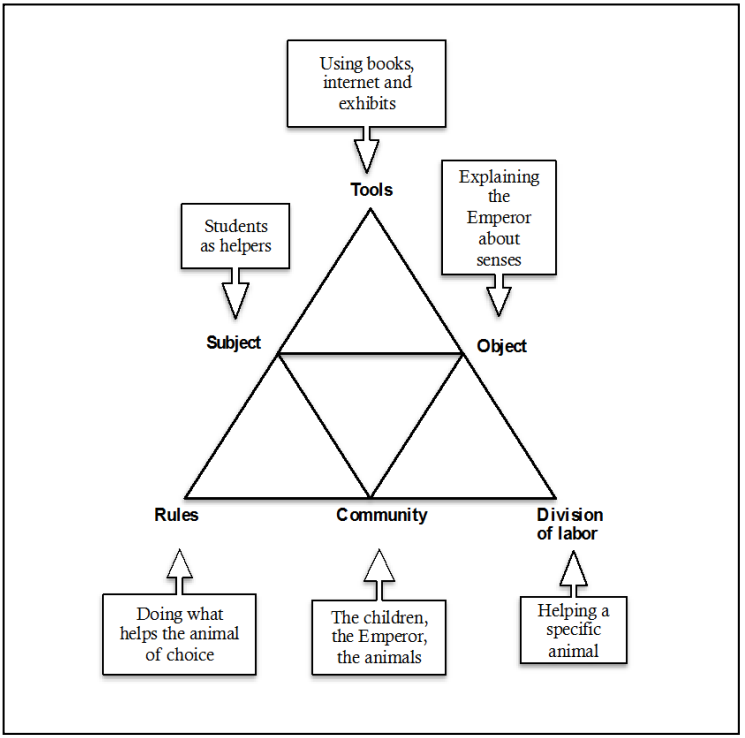


Figure 11: Outline of the tertiary Activity System of *The Emperor*. In this Activity System students are subjects in a world, where they have a clear objective to strive for; they should be able explain to the Emperor about the senses. If they are able to do this, they will achieve freedom for the animals of the story. To achieve this objective, they can use the materials and the exhibits provided by the story. The story constitutes a community of the students, the animals, the Emperor, and the teacher and a number of rules and a division of labor by giving students instructions on how to reach their objective and by dividing them into smaller groups with different responsibilities. Hence, the

story should highlight important issues of the learning activity while providing a familiar structure that is easy to navigate. The parameters of the activity should help students interpret the parameters of the learning ecologies at school and at Experimentarium.

Creation of narrative structures for cognitive guidance

I will start by describing the narrative structure of the design and how it implements the characteristics and needs of both schools and Experimentarium.

The Emperor is created in a way that follows structural guidelines from the grammar of stories. Hence, the temporality of a story defines the borders of time by creating a beginning and middle and an end in order to create tension and excitement (Larsen, 2003). By establishing the visit to Experimentarium as the *middle* of the story, school activities should act as *beginning* and *end.* This should create an understanding of the narrative universe and the topic *senses* before students enter the Experimentarium and make activities after the visit to review what they have learned during the visit.

Other narrative components are also placed strategically within the activities. I will describe how by going through the structural organisation of *The Emperor* outlined in Box 3.

This short resume of the story demonstrates how *The Emperor* follows the classic story schema of a fairy tale. This structure should make the design recognisable to students and make them aware of which components to expect within the story (Mandler and Johnson, 1977).

Additionally, the story creates tension and follows a classic story grammar by being divided into units of events, as described by the Hollywood model: the story begins with a prelude (lines 2–3) in which the Emperor and his temper are introduced. This ensures that the reader becomes aware of the forthcoming conflict. After

the prelude, the characters are further introduced (lines 3–4) and the conflict of the story is established (lines 5–6). This happens when the dog claims to be able to smell a bone, which the Emperor cannot smell.

Box 3: structural outline of *The Emperor*

1 The story describes an Emperor who does not believe that others may perceive the
2 world differently than he does. It starts by describing how he becomes furious
3 whenever someone claims to experience something that he cannot perceive. One day
4 his dog claims to be able to smell a bone buried in the garden that the Emperor
5 cannot smell. The Emperor becomes furious and decides that the dog is lying. He
6 punishes the dog by cutting off its nose and sending it to jail. But soon, he discovers
7 that all the animals in his kingdom are able to sense things he cannot and he removes
8 their ears, eyes, and noses. To get help regaining their senses, the animals decide to
9 contact the kids at a nearby school and ask them for help. This results in an exchange
10 of letters between students and animals. Students can choose to help the snake, the
11 rat, the bee, the scorpion, the dog, or the squid by explaining the Emperor about the
12 lost sense of the animal and how it differs from human senses. In a final letter the
13 animals invite students to visit a laboratory at Experimentarium, where the Emperor
14 studies the animals' senses. Here, students can test their hypothesis on animal and

15 human senses. As students come back from the laboratory, they realise that the
16 Emperor has decided to get rid of all the deceiving animals by frying them in his big
17 black pot. The animals can only be saved if students will defend them in a court
18 of law. Thus, the story climaxes, as students have to use their knowledge from
19 Experimentarium to create arguments demonstrating that the Emperor is mistaken.
20 A dramatic trial follows that ends when the Emperor is finally convinced. He now
21 tries on the many different ears, eyes, and noses and discovers that it is quite true that
22 animals do sense differently than humans.

The conflict escalates as the Emperor discovers that several of the animals claim to perceive the world differently than he does, which ultimately makes him cut off the instruments (noses, ears, etc.) of their senses and throws them all to jail (lines 6–8). The story reaches a point of no return as students are asked to engage in the story by writing letters in order to help out the animals and go to the Emperor's laboratory to plead their case (lines 9–15). The conflict escalates further once the students are back from the Emperor's laboratory. Here, they realise that the Emperor wants to fry the animals in his big black pot (lines 15–18).

Thus, the story climaxes as students engage in a trial against the Emperor by creating arguments for the animals' survival (lines 18–20). When they succeed in this, the story fades out with a happy ending in which the Emperor acknowledges that animals *do* sense the world differently than humans and consequently releases them from imprisonment (lines, 20–22).

The story also establishes a number of other classical, narrative components, such as temporality and agency. By establishing temporality, the story defines the borders of what students need to consider and what is to be expected. It provides a sense of where they are in time. Hence, when students hear about the middle of the story (where they go to the Emperor's laboratory) they should understand this in the light of the information they got in the beginning of the story.

The story also gives emphasis to agency by following the actantial model. The model outlines the objective of the story, the heroes, the opponents, and the helpers. The agents do something that moves the story forward. Clearly, the opponent of the story is the ill-tempered Emperor who has captured the animals. The objective of the story is to free the animals. Students are the subjects or the heroes able to achieve this goal. However, they have to defeat the Emperor to achieve this goal. To do that, they need the help of scientific knowledge about the senses.

As described by Polkinghorne (1988), a plot ties the events and agents of the Hollywood and the actantial model together. In *The Emperor* the plot is the task of finding a way to convince the Emperor that the animals are actually able to sense differently from human beings. The plot also defines the purpose of the story namely as emphasised by Avraamidou and Osborne (Chatman, 1978; Avraamidou and Osborne, 2009). In this story, the readers (students) are agents themselves and as such they can influence the story, as long as they stay true to the purpose of the story and make sure that their actions are aligned with the plot.
As these structures of the story are followed, it is hypothesised that the story aligns with our cognitive story schemas and hence can be introduced to a learning activity as an epistemological tool for learning. By highlighting these structures, the intention is for students to use the story as a way of organising and communicating their knowledge.

However, to make sense in a learning activity, the design of these structural story components must be integrated with the existing learning activities in schools and at the science centre. The next section describes how the story design is informed by the intended learning outcome and characteristics of these two institutions.

Integration of narrative structures and learning

N/T emphasises a process of learning where students work independently in *open activities* and are instructed by the teacher in more closed activities. As a consequence the Emperor is created with open and closed sequences in which the teacher read parts of the story to the class and students afterward use the structures from these closed sequences to explore the context and interact freely with each other in more open sequences in order to achieve the learning outcome. The "bubbles" in Figure 12 demonstrates how students can interact freely and are reconnected again by the story parts.

The intention is to use the open activities in the beginning of the program to reduce the novelty effect of the topic "senses" and the science centre setting. These activities consider students' prior knowledge of the topic before the visit, orient students to the trip setting prior to the visit, give students a measure of choice and control during the visit, and make students do group work to enhance motivation and academic discussions during the visit (DeWitt and Osborne, 2007).

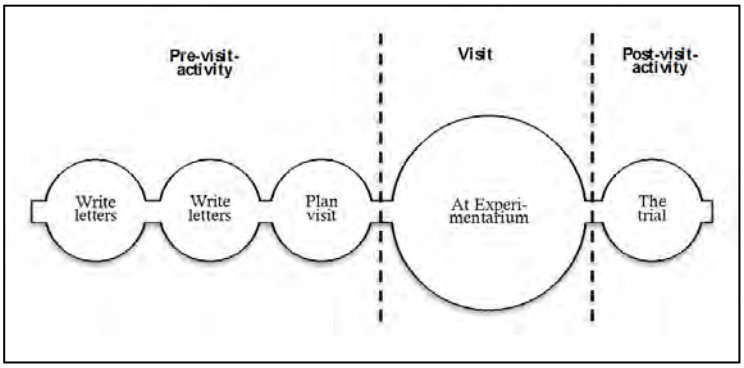


Figure 12: The "bubble" model outline of the open and closed bits of *The Emperor*. The model shows how students are free to explore the topic in open interactive "bubbles" of the story and follow the storyline in the linear parts of the story.

The "Bubble" model also aligns with the Hollywood model. I became aware of the potential of aligning story structure and didactical structure in an interview with game designer Christian Fonnesbech, whom I interviewed for an article about a narrative learning game (Murmann, 2009).

In a more informal part of the interview Christian Fonnesbech showed me an altered model of the Hollywood model, which illustrated how the elements of the learning activity needed to be aligned with the progression of tension in the story. Fonnesbech illustrated how learning elements could be placed strategically along the increasing line of tension. This is applied to Figure 13 and creates what you in computer terms call a "narrative backbone" with open interactive elements.

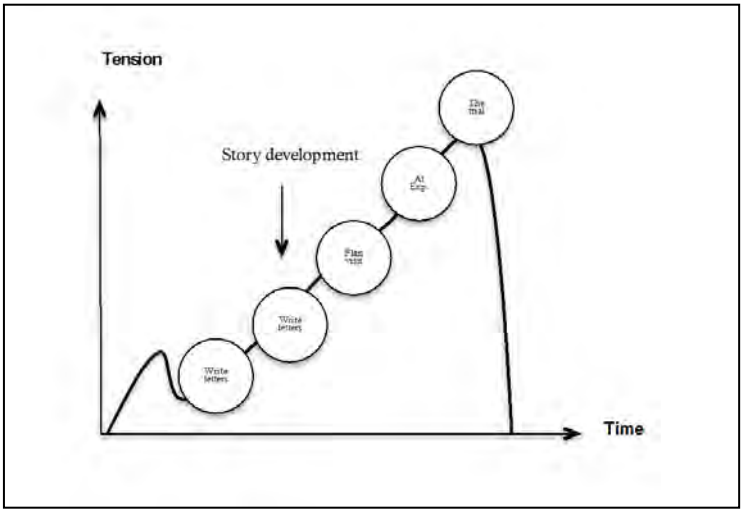


Figure 13: The Hollywood model applied to *The Emperor*. The Figure shows how the open interactive elements of learning are placed along the timeline of tension development.

In computer games this model integrates two different layers; what the story dictates and what users do. It does this by making intervening sections, giving a small part of the story before making the interactive universe available to the user.

These little story bits are called "cut-scenes" and are known from games like Resident Evil and Tomb Raider (Dickey, 2006). In these cut-scenes the user is told about relevant information that might inform their action in the following interactive part of the story, and this creates a level of control for the designers of the story.

However, the creation of interactive elements also provides students with "agency," which means that students are able to choose their own actions individually, which might influence their perception of the story. This may, according to Macfayden means that the story is only present as a background story. Students may

not think of the story at all but focus on the tasks initiated by the story. Only if they are in doubt of how to solve a certain task or are moving between tasks the story is present. The story matters regarding the choices they make, but it becomes a background item as soon as they engage in the task (Macfadyen et al., 2008). The idea of creating "cut-scenes" supports the original idea of intertwining story sequences with interactive sequences in the school material.

"Narrative reasoning"

Designing a story-based learning activity demands a delicate balance between the story structures and the educational elements in the learning activity. The main challenge in the design phase is to consider how the learning elements of the activity can be integrated with the narrative elements. This is a constant process of considering how these elements work together, if they are equally represented and if they make sense in relation to each other. In the design of *The Emperor* this is achieved (to some extend at least) by constantly aiming to provide students and teachers with what I call *narrative reasoning*.

"*Narrative reasoning*" means alignment of story structures and learning elements. Any goal or task should be grounded in both narrative structures and educational structures. This should prevent the story from being sugarcoated, where students either play along but learn nothing, or recognise that the playful nature of the activity is only sugarcoating and feel misguided and cheated. The rationale behind every bit of the learning activity should be story-based. As PhD in game design Rikke Magnussen says

"The story should create a "because" to the students questions on "why" they need to learn this" (Murmann, 2009).

Thus, when designing a story-based learning activity one should ensure that educational activities and the story do not run in two parallel tracks. In the *The Emperor* we do this by making students write letters about the senses to animals who need knowledge about the senses as a defense against the Emperor. This creates a connection between the story and the educational learning.

An especially big challenge is generating narrative reasoning regarding the learning objective of the story. Ideally the story should act as a tertiary cognitive tool and provide students with a meaningful context. To provide students with reasons to engage in the scientific content, we need to integrate the learning objective and the narrative objective. We need to construct "a narrative learning objective."

Narrative reasoning can be achieved by using the actantial model. As described previously the model describes how agents in a story relate to each other. Again, I am inspired by game design Christian Fonnesbech. He describes a common problem when designing narratives for learning.

When teachers set up narrative objectives, they often think that the learning objective equals the narrative objective. But whereas the learning objectives are what students need to learn, the narrative objective considers what motivates students for learning this specific objective. Traditional narrative objectives are often something that carries some kind of reward, like freeing the princess or winning half the kingdom. Most students do not consider gaining knowledge or competences about science rewarding if it is not used in a relevant context. However, these two objectives can be integrated through the actantial model.

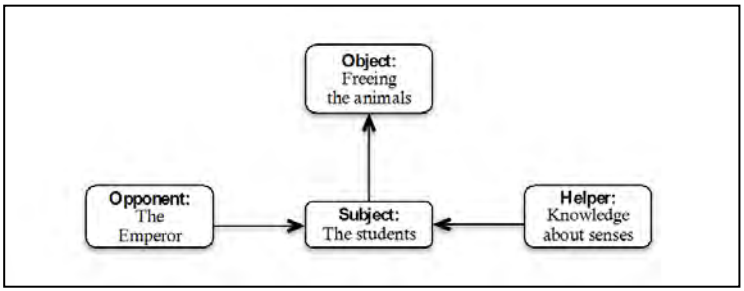


Figure 14: The actantial model applied to *The Emperor*. The model demonstrates how knowledge about the senses is considered a "helper" rather than an "objective"

In *The Emperor* the intended learning outcome is to increase understanding of scientific phenomena in the topic senses and to contribute to students understanding of scientific experimenting, thinking and language. Hence, the learning objectives are for example to *teach students to prepare an investigation from a question*. However, we use this learning objective as a "helper" rather than an objective itself. In order for students to "need" this "helper" we create the following narrative learning objective

- Save the animals and help them regain their senses by doing investigations that makes the Emperor realise that human and animals sense the world differently.

This should motivate students for making investigations and learning about the senses because it is the only way they can reach the objective of freeing the animals and helping them to regain their senses.

Another thing to consider regarding narrative reasoning is the physical context. New information from the story is related to what was already present in the learners' consciousness as described by the situation model (Graesser et al., 2002).

Thus, in *The Emperor* we aim to create narrative reasoning regarding physical context by incorporating the school environment into the story and letting students receive letters from the animals at school. We do not try to change the physical surroundings, but use them as settings for the story. A story universe can easily collapse if the school setting does not live up to the narrative description. Despite these considerations, the exhibition environment is described as the Emperor's laboratory in which the exhibits are laboratory equipment. This is done to make the story and the shift between the more formal environment of the school and the informal environment of the science centre exhibitions more coherent. Hence, this part relies very much on students being willing to "buy" this fantasy setting.
In the design of *The Emperor* several little adjustments were made throughout the design process, and I do not carry a record of all of them. The design of a story-based school material involves a constant moving back and forward between these elements to ensure that all parts of the activity is covered in regard to both learning and narrative.

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7 Research Questions

This chapter outlines the research questions of the thesis by reviewing the theoretical and practical assumptions that lie behind the design of the story The Emperor.

Defining the points of interest

My research questions are based on three points of interest.

- **The story as a tool for learning.**
- **The student as a subject engaging with the story.**
- **The learning ecologies of N/T and Experimentarium in which the student and the story are situated.**

In the following section I will shortly review these interests and their interactions and, on the basis of this outline, my research questions.

Main interests

The main interest of this project is the story as a tool, and my interest in students and the learning ecologies of N/T and Experimentarium is related to the use of this tool.

From the perspective of Activity Theory the story can be considered a mediator of activity, and a way to process and understand the world. In this perspective stories embodies experience, knowledge, and skills; it provides a means to engage in culture and develop psychologically. It can also be considered a cognitive scaffold that is both enabling and limiting. It empowers the individual with historically collected experiences and skills but it also restricts the user to only see certain perspectives of an activity. The tool as a scaffold is argued to be able to recruit interest, reduce frustration, demonstrate and model solutions to the task, to structure an activity and to problematise relevant features and make them clear to the individual. This corresponds with the perspective of narrative psychology, where stories are cognitive tools that help us structure the surrounding world. These structures provide the story with an inherent ability to motivate the individual and to engage him or her emotionally and to

immerse into the story universe. My interest in the story is explored from two perspectives.

One is the interaction between the story as a tool for learning and the students. The learning perspective means that I consider how the story is used in students' activities, their actions, goals, motivations operations, internalisation and externalisation, and if it provides a scaffold that moves students further than they can go by themselves.

The second is the Activity Systems at Experimentarium and N/T and how the story mediates between the students and these established *learning ecologies*. Both Design Research and Activity Theory highlights context as important in analysing and understanding the subject matter. Narrative theory also describes how students mental microworld of the story is affected by the situation the story is read in.

Three research questions

Working with Design Research as methodology means that I consider these points of interest on the level of the particular design as well as on a broad theoretical level. Hence, I am interested in the story as a tool on a broad theoretical level in relation to the following two research questions:

- **How does a story influence students' perceptions of the learning activity in schools and science centres, and how does the learning activity influence students' perceptions of the story?**

- **How do students apply the properties of stories as a tertiary cognitive tool to learning activities and to what extend?**

The relationship between my points of interest and these two questions are illustrated in Figure 15. The aim is to explore *how* students use stories as tools for learning. I do *not* compare the learning outcome of the story-based learning activity to traditional ways of learning but emphasise the exploration of the nature of the story as a tool in science education.

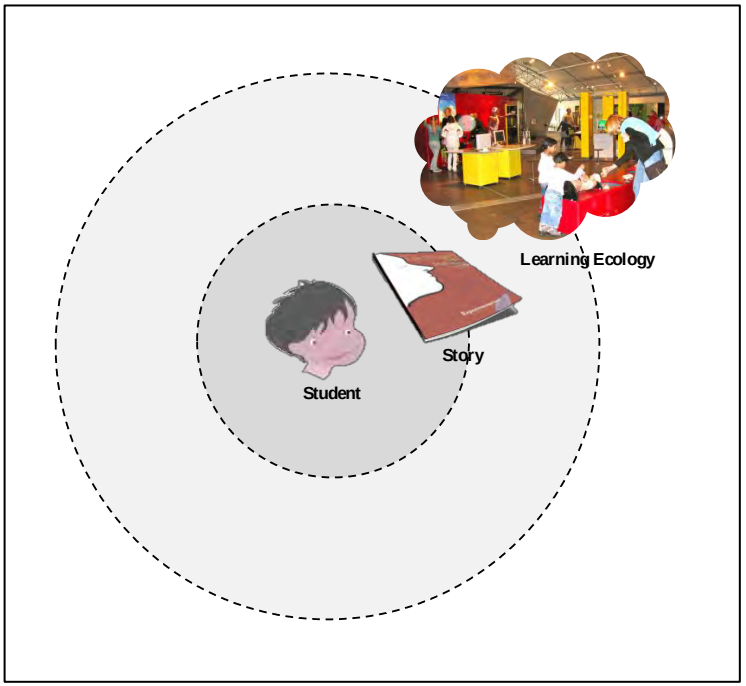

Figure 15: Graphic illustration of two research questions. The first question explores students' use of the story as a cognitive tool, and the second question explores how the context of science centres and schools influences students' perceptions of the story. In this model, Experimentarium exemplifies the learning ecology.

The results generated for this must be seen in relation to the specific design of *The Emperor*, and to the specific problems and context of this design. Hence, the answer to the two questions

must be seen in the light of the answers to a third research question:

- **How does the story-based school material, *The Emperor,* provide scaffolding and when does it fail to do so?**

In the next chapter I will describe how I explored these questions empirically.

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8 Empirical Phase: Exploring students' use of the Story

This chapter outlines the areas of interest for empirical studies, and describes how school classes were selected for the study, the considerations given to techniques of data-collection and the actual data collection.

Defining areas of interest in the study

In the empirical phase I explored how students used *The Emperor* as a tool for learning. To stay focused on this purpose and to avoid generating too much data I chose specific areas of interest, and decided what I wanted to observe and interview respondents about.

Finding relevant entities for data collection

Design Research describes a series of iterations, however, in reality it is difficult to persue this goal. The exhibition SENSES and hence the use of the school material about *The Emperor* was located at Experimentarium from December, 2010 until August, 2011. Due to these time restrictions, as well as those of the PhD program, I decided to only do a single iteration of empirical data collection and testing of the design.

I also chose to explore students' use of the story in all parts of the learning activity. Figure 16 demonstrates the different methods applied to different parts of the story-based learning activity. A plan for data collection of all these parts is found in the Appendix A, page 196. The data falls into two categories.

1) **Actual doings:** What students actually do with the story; audio and video recordings of their discussions at the science centre and at school and letters written for the animals and the Emperor.
2) **Metareflections:** My own, teachers' and students' reflection upon their use of the story; my observations and the interviews with teachers and students.

Having established my points of interest I located seven school classes for the empirical studies. To do this I advertised through Experimentarium newsletter for schools and used my connections and network to find classes in the Copenhagen area.

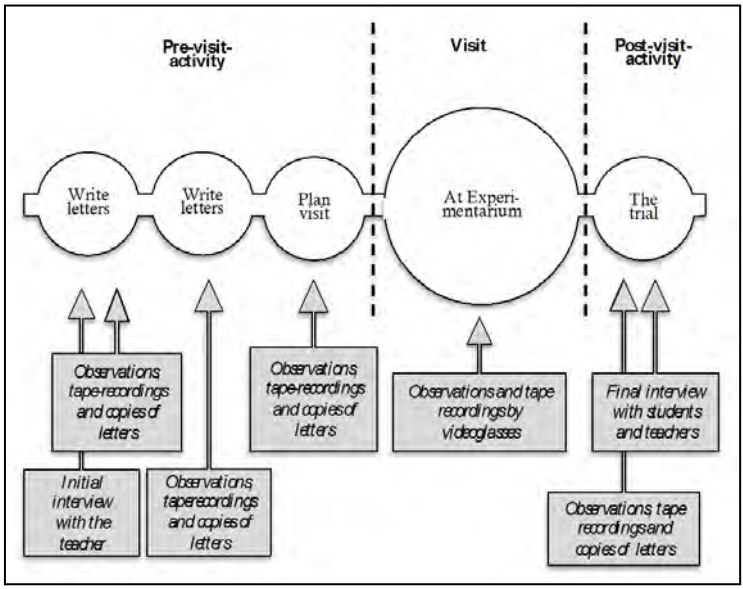


Figure 16: The phases of research in the bubble model.

Initially I intended to observe three fourth grade classes. From my experience students of this age would be appropriate since they are old enough to be articulate about their own learning process but not too old to listen to fairy tales. However, as I got into contact with teachers of other grades I decided to explore whether age played a difference in terms of using the story as a tool for learning. I ended up having seven different classes from Copenhagen. Two third-grade classes, three fourth-grade classes, one fifth-grade class, and one sixth grade class. A short description of the schools and the teacher can be found in the Appendix A, page 196.

The empirical data was collected during February–May 2011, which is at the end of the school year.

Pilot study

As a new researcher in the field, I started out with a small pilot study before I engaged in more elaborate data collection. In the pilot study I followed a class of third grade students to test the design, my method of observation, and my interview techniques and to make mistakes and correlations.

The main insight from the pilot study was an acknowledgment of the story primarily being present, when the teacher mediated it. To my surprise students were very inconsistent in their use of the story as a tool if the teacher was not present. I also realised that students were not very articulate about the story, but mainly used it implicitly or in very short dialogs with the teachers and other students. I had expected the story to be a big part of students discourse and had planned to do discourse analysis in order to understand the status of the story in this discourse. Especially at the visit to the science centre students seemed to leave the story behind as soon as the teacher was out of sight. This was quite problematic in regard to the practical and industrial purpose of my PhD on creating guidelines for science centre staff and teachers on story-based activities for school-science centre activities. However, it was not possible to create other means of mediation at the science centre. Instead I had to put much more focus into the teachers' use of the story and my interpretations during my observations.

Due to these insights I decided to instruct teachers on using the story as a reference, play along, and make questions and responses that originated from the story. I also decided that I would ask teachers to put the most well-articulated students in the animal groups I observed to get an elaborate data material. I was aware that this would influence my data set, but I decided that it was important for students to be able to articulate their impressions and emotions regarding the story. Finally, this insight made me realise, that my main findings on students using the story as a tool

would be during the school activities, and this made it clear that I would have to engage in all the classroom activities the entire time.

Methods for observations, recordings, and interviews

Having decided *who* and *what* to study, I began collecting empirical data. During this phase I used observations and records of letters, audio and video, as well as semistructured group interviews.

Observations and recordings of letters, audio, and video

I captured the "actual doings" of the students by observing them and through recordings using tape recorders, photography, and video recording glasses.

I observed students in class in both open and closed activities. During these activities I paid attention to what the teacher did, what students did and my reflections, and wrote them down in an observation schema. An example of the schema can be seen in the Appendix B, page 200. During my observations I tried to be as passive as possible and not interfere with the use of the material even if the material was misinterpreted or used it in a different way than intended.

I chose to follow two animal groups (bee and snake—with a few exceptions) in each class. When students did group work, such as writing letters to the animals I would record the discussions of the two selected groups to elaborate on my observation schema once I got home. I would also take pictures of the letters to the animals or get a copy of students' letters after class.

The observation of students was difficult at Experimentarium. Students were moving more randomly around, and did not

necessarily stay together. Hence, I equipped students with video recording glasses to capture their dialogue. The visual part of the video was not part of my analysis, but served to clarify what students were talking about. Each animal group consists of three to five students and two students from these groups would be equipped with video glasses.

Semistructured group interviews

At the end of each program I interviewed the two animal groups I had been recording as well as the teachers. I also made a final interview with a group of teachers after my first analysis to expand and verify my results. All questions were made in the perspective of the students' use of the story. I asked the teachers how they thought students applied the story to the task of learning, and I probed question to students to explore their use of the story as a tool for learning. All question protocols can be found in the Appendix C, page 218.

I needed to conduct the student interviews in a manner that would facilitate their expression of emotion and motivation in an earnest way. Students should feel comfortable and secure when I interviewed them and feel part of a conversation with me and with their peers. To achieve this I decided to make semistructured group interviews. Unlike structured interviews, semistructured interviews allow the researcher to engage in a dialogue with the respondents. The advantages of the semistructured interview are described in Table 3. However, semistructured interviews also reduce the control of the situation, take longer to carry out, and is harder to analyse (Smith, 2008).

The advantages of the semistructured interview
Facilitates empathy and connection to the respondents and provides a way to make them open up about their thoughts and feelings. Less important sequence of questions.

Questions do not have to asked in exactly the same way with each respondent, but follows the respondent's interests or concerns.
Provides greater flexibility and coverage by allowing the interview to go into novel areas and by letting the interviewer to probe interesting areas that arise. This tends to produce richer data

Table 3: The advantages of semistructured interviews (Smith, 2008).

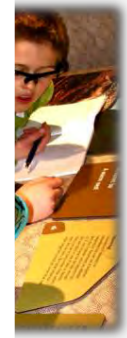
In semistructured interviews the protocol acts as a guide rather than dictation and respondents can introduce issues I as a researcher had not thought of (Smith, 2008). In student interviews I created four small exercises to get the talk started, but other than that I did not have a strict protocol. This allowed me to modify my initial questions in the light of the participants' responses and to probe for interesting and important areas in order for them to tell their own story (Smith, 2008). In student interviews I would make students tell me what they thought of the learning activity and ask them to tell me what happened. I would then use these stories as an offset for further questions. In teacher interviews I also had a protocol of questions, but at most times the actions of the classroom would guide the interview.

In interviews I tried to facilitate and guide rather than dictate exactly what would happen during the encounter. I also tried to memorise the schedule to stay concentrated on what the students and teachers were saying. I tried not to influence respondents with my biases and kept my position as neutral as possible by telling respondents that there were no wrong or right answers (Smith, 2008). However, since I was probing for thoughts regarding the story this was often a difficult task. At the end of the interviews the interview were transcribed. The transcripts were done by an external partner who was informed that the transcript should contain all verbal utterances. (Smith, 2008).

The next chapter considers my method for analysing these texts.

Pictu-rama

Students - in action



Students are the main actors in this story-based learning activity. At age 9-12 they are a diverse group regarding physical and cognitive development.

They engage in the story at a number of levels; cognitively and emotionally, out of necessity and out of desire.

They listen to our creation and design their own creations.

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9 Analytic phase: Themes in students' use of stories

This chapter outlines the use of thematic analysis of interviews, sound bites and observations to extract knowledge about students' use of the story as a tool. It highlights the use of a phenomenological-inspired approach and demonstrates how the analysis was done in five theoretical steps.

Thematic analysis

In order to analyse my data I used a method called thematic analysis. Thematic analysis is a method for identifying, analysing, and recording patterns, called "themes," within data to interpret a research topic. The method is not wed to any pre-existing theoretical framework and can be used across different methods (Boyatzis, 1998). A good thematic analysis will make it clear, which assumptions about the nature of the data it represents (Braun and Clarke, 2006). This chapter outlines my considerations and theoretical position when doing thematic analysis.

Research epistemology

First of all, I am inspired by a phenomenological research epistemology to guide what I can say about my data and theorise meaning.

Unlike a hammer or a computer the story is a mental tool rather than a physical tool. This makes it difficult to observe as it is contained in the students' heads and may vary from student to student and in my and the teachers' interpretation of how students perceive the story as a tool for learning. My approach is inspired by phenomenology in that it attempts to explore personal experience and is concerned with the student's personal perception of the story as opposed to an attempt to produce an objective statement of the story.

Epistemologically, phenomenological approaches are based in a paradigm of personal knowledge and subjectivity, and emphasise the importance of personal perspective and interpretation. It is about understanding people's experience of reality to gain an understanding of the phenomenon in question (McLeod, 2001; Holloway and Todres, 2003). My aim was to explore in detail how the respondents made sense of their personal and social world during a story-based learning activity. A phenomenological

inspired approach allows me to explore students' personal perceptions of the story.

A theoretical analysis at the latent level

Since I work with design-research my thematic analysis is driven by my theoretical interest in the area, which in my case is my prototheory. Hence, my data is coded for by pre-existing theories of the story as a tool for learning, rather than having a more inductive approach, where the research question evolves through the coding process (Braun and Clarke, 2006). It allows me to only consider certain parts of my data. In this case the story as a tool, and gives a more detailed analysis of these aspects of the data.

My establishment of pre-existing theories of stories as tools for learning also prompt an analysis of the text at a latent level rather than a semantic level. A thematic analysis at the latent level goes beyond the semantic content of the data. It examines the *underlying* ideas, assumptions, and conceptualisations that are theorised as shaping the semantic content of the data. This should establish meaning of the content and complexity of those meanings rather than measure their frequency. Thus, the development of the themes involved interpretative work, and the analysis produced was not just description, but was already theorised (Braun and Clarke, 2006).

Five phases of thematic analysis

The actual analysis was done according to guidelines on thematic analysis described in Table 4. The following section describes how I executed my analysis through the first five of these phases.

Phase 1: familiarising myself with data

I started my analysis by reading through the entire data set: my written observations, letters from students to the animals, tape recordings of interviews and discussions and video recording. This

provided me with an overview and helped identify possible patterns of the respondent's psychological world. However, my theoretical approach fostered an interpretative relationship with the transcript. During this first read my interpretations were inspired by prior knowledge, thoughts during the data collection as well as my prototheory.

Phase	Description of the process
Familiarising yourself with data	Transcribing the necessary data and reading and rereading the data noting down initial ideas.
Generating initial codes	Coding for interesting features of the data in a systematic fashion across the entire data set collating data relevant to each code.
Searching for themes	Collating codes into potential themes gathering all data relevant to each potential theme.
Reviewing themes	Checking if the themes work in relation to the coded extract and the entire dataset generating a thematic map of the analysis.
Defining and naming themes	On-going analysis to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions, and names for each theme.
Producing the report	The final opportunity for analysis. Selection of vivid, compelling extracts relating back to the analysis to the research questions and literature producing a scholarly report of the analysis.

Table 4: Phases of thematic analysis (Braun and Clarke, 2006).

During this read I had to distinguish the patterns of different cases and be aware of new emerging issues as I worked through each case to find both similarities and differences between them (Braun and Clarke, 2006).

Phase 2: generating initial codes
The second phase involved the production of initial codes. During this Phase, I would organise my data into meaningful groups, such as "relations to characters" or "fantasy" and extract certain passages that I found interesting and mark them with ideas for coding (Tuckett, 2005). These groups of data constituted narrow terms and should help me understand what constituted the broader themes (Braun and Clarke, 2006).

Phase 3: searching for themes
In Phase 3 I analysed my codes and considered how they could combine to create overarching themes that would fit into my theoretical framework of narrative theory and Activity Theory. To support the themes I would use expressions from my prototheory and use connections across cases but grounded in the particularity of things said. To do this I used visual representation in terms of post-its and cut-outs of data. I did not give attention to what *proportion* of my data set needed to display evidence of the theme for it to be considered a theme nor did I refuse something as a theme if it was only mentioned minimally (Braun and Clarke, 2006).

Phases 4–5: reviewing, defining and naming themes
In Phases 4–5 I refined my themes by moving back and forward in my analysis of the dataset. Some themes were rejected if they were not relevant to the research questions. Others were united to form new themes. Having made a thematic map of my data I described the principles of each theme and how it mattered to my research questions.

The next chapter outlines these results.


Mini-
Pictu-
rama
The art of
organisation

o

10 Findings

In this chapter I present the findings of my analysis. Through quotes and examples from observations, the chapter describes three main themes: the story as a tool for learning, interactions between the story and the learning environments, and evaluation of the design of The Emperor.

Three overarching categories

Throughout my analysis and during my observations, one overarching theme appeared: In the mind of students the story about the Emperor is a learning tool. It is not a tool for playing or entertainment, it is a structure introduced by the teacher that serves to educate them.

However, this does *not* mean that the story loses the characteristics that are traditionally assigned to stories, but the nature of it changes when the story becomes educational. The presentation of my findings is intended to describe and expand the understanding of this educational perspective on the story as a tool. The themes within my analysis fall into three categories that correspond with my research questions.

1. **How does a story influence students' perceptions of the learning activity in schools and science centres, and how does the learning activity influence students' perceptions of the story?**
2. **How do students apply the properties of stories as a tertiary cognitive tool to learning activities and to what extent?**
3. **How does the story-based school material *The Emperor,* provide scaffolding and when does it fail to do so?**

The categories and the related themes found through thematic analysis are presented in Table 5. There is a progression in these categories, which starts with the grand perspective by describing students' understanding of the story in relation to the learning ecology of N/T and Experimentarium. In these sections I consider how the teacher acts as a gatekeeper of the story, a conflict between the existing culture of instruction in N/T and narrative instruction and how students interact with the story in the context of N/T. Then I narrow the perspective and consider the structural and emotional properties of the story as a tool for learning. At the end of the chapter I look at the specific details of

The Emperor with focus on a lack of giving directions, the use of inquiry learning and the absence of mediation of the story at Experimentarium. I will interpret these results in the next chapter.

Interactions among students, story and learning ecology	Properties of the story as a tool	The design of *The Emperor*
• The teacher as gatekeeper • Students perception of the story as an educational tool • Preconceptions on methods for learning in N/T	• Structural components for cognitive guidance • Motivation, immersion and agency	• A frame with little directions • The difficulties of using stories to do inquiries

Table 5: The categories related to the research questions and the corresponding themes.

Throughout the review of my findings, I will present results from the story in both Experimentarium and at schools. However, the use of the story was mostly prevalent in school, and hence, the majority of the findings relate to activities of the school.

The findings presented here are a synthesis of empirical data based on my interviews and observations. Likewise, text bits that describe certain behaviors and interpretations of the story are a synthesis of these different kinds of empirical data.

Interactions among students, story, and learning ecology

In my research I discovered that the crafting of the story continued after the design phase when it was integrated into the existing learning ecology. Especially three parameters seemed to

affect the nature of the story in learning activities: how the individual teacher used the story for his or her instructions; students' and teachers' understanding of the story-based learning activities as a method in N/T; and students' own interpretations of the story as a tool for learning.

The teacher as gatekeeper

My research shows that the teacher was an essential mediator of the story. The individual style of each teacher and their way of integrating the story-based activities into the existing learning activities was reflected in students' use of the story.

During my observations of the learning activities teachers would apply different methods in their way of using the story. Some teachers followed the story material and applied the methods of inquiry learning to a great extent, while others were more loyal to their traditional way of teaching and used the story as a way of framing their instructions or used some of the story elements as sub activities. I observed three different approaches to the story.

The first approach was characterised by a variation between a narrative mode dictated by the story-design and a mode that I interpreted as the teacher's traditional way of teaching. Most of the time the story was just a bullet point in a number of activities students had to engage in. The teachers own way of teaching was predominant and was characterised by being in control of the situation and by giving students assignments with clear directions of how to solve the task. In general, the teacher did not make references to the story during the open activities. The dramatic qualities of the story were not used as a reference point or as a way of explaining concepts to the student.

The second approach paid slightly more attention to the story by creating a humoristic discourse and spent more time emphasising the narrative elements of the story. These teachers would

negotiate a narrative contract by telling students about the method of using a story. They told students that they needed to play along, but that it was OK to keep some kind of ironic distance. Students were told that they had to immerse themselves because they had influence on the story outcome. This contract created a certain discourse, which the teacher used as a transition between the open and closed activities. For example one teacher told students that the animals had received the letter *by the speed of magic*. It was obvious that she had not handed the letters to any animals, but that this was done to move the story forward and to begin the next part of the activity. Students were amused by this and seemed to think of it as a good joke. In this approach teachers often presented themselves as mediators of the story. For example they would have a special relationship to the pigeon that delivers the letters to the animals and say that the pigeon is very shy and only communicates with teachers.

The third approach I observed took the use of the story a step further, and incorporated a physical element into the activities. These teachers would create a narrative contract as described in the second approach and occasionally they would engage students in some kind of role-play to represent parts of the activity. This role-play often took place either when student was reading out loud their letters to the animals or in the final activity, where they had to represent their animal in a court of law. Teachers would instruct students to imagine how all the animals were sitting in court to pretend that they are presenting their arguments to the angry Emperor, and that they needed to talk politely to the Emperor, etc. In addition these teachers used a great deal of dialogue during group work and used the story as a way of mediating dialogue and reflection, as described here:

Teacher: *(4th grade) OK. What do you have to do?*
1st student: *We have to . . .* (Mumbles something about the dog)
Teacher: *OK. Why?*

1st student: (Silence) *Because the dog needs to get its nose back*
Teacher: *What do we have to prove to the Emperor?*
2nd student: *How you are able to smell*
Teacher: *Yes, and do you know something already?*
2nd student: *Yes, that the dog is better at smelling, it is 800,000 better than humans.*
Teacher: *They have more receptors.*

The three approaches presented here represent the categories of instruction I observed in the seven classes. However, in reality teachers would sometimes use a different strategy and be in some intermediate position between these categories.

The three approaches represent different degrees to which the teachers implemented the story. In the first approach the story is primarily used as a way of framing the scientific content and processes presented by the teacher. During open activities the teacher does not articulate the story and the immersion into the story universe completely relies on students. In the second approach teachers apply methods in which students are encouraged to engage in the narrative universe. However, teachers still primarily use the story in the interstices between the open and closed parts of the activity, where the story and the academic activities meet. In the third approach the story is present in most parts of the educational activities. Students are encouraged to engage in the story both verbally and physically through role-play and dialogue and the story is used to articulate problems and solutions.

These different approaches demonstrate the teachers' influence on *how* and to which extend the story is used as a tool and a scaffold. In my interviews with the teachers during and after my observations, teachers also articulated their conceptions of the story as a scaffold applied to learning activities in N/T. In these interviews most teachers describe the story as a useful tool for *framing* the subject. The story represents a way of structuring the

learning activities and provides a tool for memory and motivation that enables students to remember the topic "senses." Especially, one teacher who had prior experience using stories for educational activities emphasised these properties.

However, some teachers also articulated problematic features in regard to using the story as a form of instruction:

Teacher: *(3rd grade) Well, they are doing OK, and they are doing what they are told to do, but I don't really know if they are learning something. I think this narrative format is a bit difficult, when I read the material it is easy, but when I practice it through my teaching I find it very difficult.*

To these teachers the story provides a barrier in terms of giving instructions that provides the right kind of learning.

Preconceptions on methods for learning in nature/technology

In my observations and my interviews I also discovered that several teachers and students experienced a divergence between what they expect to happen in N/T and the story-based learning design.

Several students mention that the use of a story is not "typical" for the subject N/T. Students seem to have an idea about the nature of the activities in N/T, which the story-based learning activity interferes with. According to several students the use of the story was more equivalent to the methods applied in Danish lessons. Several students from different grades mentioned that it was more fun than some parts of traditional N/T, where *"*you just have to write things down*"* but they also expressed a lack of being active and doing experiments. They also said that they were surprised when they discovered that they had actually learned something about science during the educational activities:

1st student: *(Students from 6th grade) I am not really sure about what this has to do with N/T. I mean, when we were writing to those animals I couldn't really see it.*

2nd student: *Well, but the sense is something that has to do with N/T.*

1st student: *Yes, but when we were writing those letters I kept thinking, "What has this got to do with N/T?" I liked it, but I didn't really know why we were doing it like that? But I think it was a much cooler way of learning*

Me: *Do you think you have learned anything about N/T?*

2nd student: *Yes, I have learned a lot, I think.*

1st student: *It is actually quite funny to think of, that all humans have the same senses . . . but dogs have different senses, but the senses are the same in their (the dogs') world. I mean, the dog and the human have the same sense but they are different. That's quite funny if you think about it.*

Me: *But did you think that you had learned about N/T . . . or have you just worked on a story?*

3rd student: *No, I don't think it had much to do with N/T.*

1st student: *No, me neither, I thought it was mainly working on a story, however at Experimentarium it was a little bit more like N/T because that is where we usually go in N/T. But normally in N/T (going to Experimentarium) is not something that I am very fond of because it is just something with magnets and stuff, but this time I was actually looking forward to it.*

Me: *If someone asks you in the future if you have learned anything about sense, do you think you have learned anything about N/T?*

1st student: *Yes.*

Me: *But it is in a different way than usual?*

1st student: *Yes.*

Students seem to have certain expectations to the content, and the procedures of N/T, and they do not realise that the content of the

story is related to N/T. Some of the teachers articulate this as well.

Teacher: *(3rd grade) It is a bit difficult in N/T that the story turns very "Danish-teacher"-like, and that there weren't a lot of experiments. In the beginning I didn't think too much about it, but later it actually started to bother me and I thought, "What is really hands-on in this?"*

Me: *OK, so you have some expectations about what constitutes N/T, that it involves certain procedures?*

Teacher: *Yes, I think it is a very practical subject, and it makes it difficult when they have some clear expectations to what things they should do in these classes . . . But it wasn't because they were frustrated, they received it really well, and no one was complaining. But I could tell that it was very difficult to them that these (practical) things didn't happen as well.*

Another teacher says.

Teacher: *(5th grade) It's probably the first time* (*that we have used the story for framing the instruction). I have used fictional material, based on historical facts and it works really well in History, but I have not done it before in N/T.*

Me: *No. And what do you think about now? When you see it from a distance?*

Teacher: *Well it's obviously something students like, but personally I would probably not use it because it's not my way of teaching. It has to do with the way you present (the story). You have to be authentic, and that is difficult when I don't feel that it is me. I am very academic in the nature of my thinking. It is not necessarily a contradiction . . . (mumbles) . . . I've tried it before in a math class, where I used dolls and it was just the same. I could feel that the students liked it very much and was happy with it, but I did it for their*

sake and did not feel comfortable in that way of teaching.

It seems as if N/T is associated with a specific mind-set that dictates the use of tools in N/T. Within this mind-set a specific discourse and specific processes guides the activity.

Students perception of the story as a tool for learning

My research also showed that students are very aware of *The Emperor* being for learning purposes and not just for entertainment. Placing the story into a context of learning changed the way students engaged in the story compared to the ways described in literary theory, where readers are transferred to another time and place.

During my observations I noticed a fluctuation between two opposite positions.

One position, which were the primary one, students would engage in the educational activities without any references to the story. During group work the assignment was often done just according to the teacher's instructions and not because of the need of the animal to regain its senses. When students presented their arguments collectively they would not refer to the story, and their presentation seemed to have the nature of any other presentation at school. In my recordings of student discourse during group work the story did not seem to be present. Students would talk about how bees are able to see in the dark, they would talk about UV light and how bees can see patterns in the flowers. They were also able to explain what they did at the exhibit even though they did not make connections between the scientific content of the exhibit and what they've learned at school and the story. The story or the structures from the stories that should guide them were not present in their discourse.

We have been to the laboratory and we know how snakes see (sense heat) and catches it's prey. The Emperor has other priviliges than the snake, but humans are also able to do things, that a snake cannot do.
LOSER

Threatening letter.
If you remove the senses from the animals Freddy Kruger will drown you in dry gin. You die if you remove the animals senses… Get it?

Figure 17: Two letters for the Emperor, demonstrating how students create their own little narratives during the activity.

In the second position, which was rarer, and was almost completely absent at Experimentarium, students would engage in the narrative universe and make up their own short stories about the Emperor, and the animals without any reference to the topic about senses. In these short stories they tell each other how cute the dog is, how terrible the Emperor is, and make small plans for making demonstrations against the Emperor (or even killing him). They also make drawings and discuss how to write letters appropriate for an Emperor. However, these discussions usually only lasted a few minutes.

In between these two positions are different intermediates of which the students' drift in and out of depending on which activity they are engaged in. The narrative position is mainly present when they hear the closed story bits, or if the teacher articulate the story in dialogs with students during group work or presentations. Students do have a few discussions on whether they should help the Emperor or the animal, but other than that little references are made to the story in open activities.

In an interview with a teacher who has been using stories previously in N/T, he tells me that it is perfectly normal that students zoom in and out of the story universe. Normally the story just frames the instructions. While students engage in the educational content, they do not use the story but stays focused on the assignment. He described it as a communication between two worlds in which students are immersed in the story at some times of the lesson while they "are in school" at other parts:

Teacher: *(4th grade) . . . They (students) are used to the books with chapters for example. And that's the same: "OK, we will read more tomorrow." The world goes on . . . I mean, this world, and then we enter the story again, right? And into the game, and kids are good at that: "OK, you have to go and peel carrots" and then you do that, and then you*

return to playing, right? . . . Kids are good at that, and I think that is kind of the same.

Me: *OK, so this way of moving back and forward . . . ?*

Teacher: *Yes, it is something that adults do as well. I mean, you sit and talk and then you return to work, right. In reality that is two separate levels you are at, right?*

The awareness of the story as a tool for learning is visible in especially two cases. First was when the teacher presented the story students would often challenge the story and find circumstances, where the story does not match reality: if the story says six o' clock, the students wondered why they have to be ready at one o' clock. If the cat runs through the park when it has to deliver a letter, the students asked which park it was. According to the teachers in my final interview this is something that often happens when students are introduced to new topics or new formats. According to the teachers this is a way for students to demonstrate that they know what the teacher is doing right now, or as a way of coping with insecurity about the new learning activity. This implies that even though the story has a familiar structure and holds a potential for immersion it also represents a new learning activity, and this affect students approach to the story.

Second, during my observations, I noticed that all students—even the older ones—were surprisingly comfortable with the somewhat childish story universe. A few students expressed dissatisfaction with the story being a fairy tale and said that they were too old to engage in this kind of story-based learning activities. However, most students seemed to accept the story as a part of the learning activity, as illustrated by this interview:

1st student: *(Student 6th grade) I think it is OK that it a little childish, that makes it kind of cosy. I mean, you laugh a little. "Uhh, we just got mail."*

Me: *Do you think your classmates felt the same way?*
2nd student: *I think some of them thought it was a bit stupid.*
1st student: *No, I don't think so. I really do not. Some of the girls would say "Oh no, not a letter again" and they didn't want to do it and stuff. I think some feel that way, but not a lot . . . I don't think it is everybody.*

This interview segment represents many of the comments from students. Age did not seem to matter much in terms of engaging in the narrative. In my final interview with three of the teachers I asked them how students perceived the story in the context of a learning activity:

1st teacher: *It doesn't seem to be necessary for them to play a part to participate in this story and to make it work. They can relate to their own part at a distance, still play the part, and be aware of the part they are playing. I mean, they participate in this situation because we are playing.*
Me: *Do they see it as play?*
1st teacher: *The story itself—them being lawyers. They have to . . . but as being something funny and something they control themselves, no.*
Me: *So it is a different kind of play?*
2nd teacher *Controlled play . . . it is not the kind of play they engage in when they have a break.*
1st teacher: *I think it might be a kind of role-play.*
2nd teacher *But that is probably why they thought it was fun because they don't have to read a text and fill out some sheets. I don't think my sixth graders were playing. But I think that they did understand the story and were willing to engage on the premises. So I do think it is possible to work with this material without playing.*

This indicates that students recognise the properties of the tool as being motivating for learning. However, they seem to keep a bit of

a distance from the story, and they do not surrender themselves completely to the story.

The story as a tool for learning

With the contextual influence of the learning activities in mind, I move on to describing "the story as a tool for learning." This section describes students' use and perception of the properties of stories as tools in learning activities. When we equip students with a learning tool, such as calculators in math or computers to write essays, certain properties are assigned to this tool. This section explores the properties assigned to the story in the classroom and at the science centre and the nature of these properties.

Motivation, immersion, and agency

In my research the three emotional properties: motivation, immersion, and agency seemed to play a great part during the learning activities. It is difficult to separate these properties from each other and I instead I will describe them concurrently.

In general, in my observations, students seemed very motivated when they were working with the activities in the story-based material. Teachers also explained that the fantasy universe motivated students and helped them perform better. Several teachers told me that they were able to keep students focused on the subject for a longer time when they used this format. One teacher explained that students would normally lose interest in a topic within a few weeks, and that he was surprised that they stayed focused for the entire period. According to this teacher the story provided a motivation and engagement in the subject, which is usually difficult to establish. Consequently, students were less *laid back* than usual because they felt they had to *achieve something*.

In all my interviews with students they emphasised that *The Emperor* was "more fun" than usual activities. In general they

seemed to compare the narrative activities to their usual activities and make a very clear distinction between the two of them.

1st student: *(Student 6th grade) . . . It was funny because it was a kind of play.*
Me: *OK, is it OK to play in school?*
1st student: *Yes, because this was funny.*
2nd student: *Yes, especially because normally we are used to just sitting and writing on a piece of paper and stuff, and you don't really want to do that. But this was a lot of fun because it had a storyline.*
Me: *Yes, it had a storyline . . .*
1st student: *Yes, and it is probably more fun because it had animals and stuff. If you have to write something about hearing or something visual, it is probably not that fun.*
Me: *And that is because of the storyline, you say?*
1st student: *Yes, and because of the time, one might say. You had to hurry up writing those letters, and stuff . . .*
Me: *Did you have to engage in the story?*
1st student: *Yes, quite a lot. I was picturing all kinds of stuff.*

Having to defend the animals also seemed to create a sense of "agency," which students normally do not feel they have at school. Several students said they had a sense of making a difference when they worked within the framework of the story, and that it made their work seem meaningful. Students claimed to feel influential on how the story evolved, compared to usual programs were they have very little influence. They felt like adults, such as protectors or lawyers. They also mentioned that it was better to work with the story than "normal lessons" in which "you just have to write all the time," despite the fact that this particular design contains much writing. One group also said that they felt more physically active during these lessons than usual.

In my observations a lot of the emotional engagement in the story seemed to be related to the characters of the story. Students were

very conscious about their own animals and interpreted much of what happened from the animal's perspective. In all my observations students were excited when they had to pick an animal to defend against *The Emperor*. In these situations the students showed preferences toward the scorpion and the dog, whereas no one wanted to defend the rat. Students also showed great interest in the letters from the animals, and were comparing letters from different animals. In interviews students were also very aware of how they ended up dividing the animals between them, and discussed eagerly which animal is the best:

Me:	*(Students from 4th grade) How was it to have your own animal?*
1st student	*It was fun, we were happy that we were in charge of the Python . . . It is totally the coolest animal.*
2nd student	*The scorpion was cool too.*
1st student	*It had been shaved.*
3rd student	*So it wasn't so cool anymore.*
1st student	*It (the Python) had its tongue cut out. That's probably a little sad too . . .*
2nd student	*It (the text) didn't say that it (the tongue) was cut out.*
3rd student	*No, it (the Python) was just locked in the tower.*
1st student	*Well, I am guessing that they had cut the tongue off.*

In general students seemed to interpret a lot of what was going on according to the abilities, actions and intentions of the animals. In interviews several students believe that the animals in the story were the best part of the program (besides the trip to Experimentarium). Several teachers also say that students got very attached to their animals, as exemplified here:

Me:	*(Students 3rd grade) Did it mean something to have an animal to defend?*
1st student:	*It meant, that you have to immerse yourself in the story.*
Me:	*You had to immerse yourself?*

1st student: *Yes, but at first I thought, "Oh no, I don't know how you do this" but the further we got the more I understood.*

2nd student *But to save the animal you had to immerse in to it . . . I did not expect it to go that far at all.*

Students also found it important to position themselves in the story. In their letters to the animals they would either be the "lawyers of the animals" or "sweet children," depending on whether they were writing for the animals or the Emperor.

1st student: *(Students 4th grade, said during my observation) Wow, we have to be lawyers.*

2nd student: *Yes! WE are the lawyers.*

3rd student: *What's a lawyer?*

1st student: *A lawyer is some who defends someone else.*

In my interviews students expressed that they found it important to identify themselves with the story. Some students say that they consciously tried to do so and that the learning activity became more fun while other students said they found it difficult to do so, and this made the story a bit *dull*.

During my observations I found it difficult to differentiate immersion and motivation. It was not obvious why students engaged in the activity. However, in my interviews several teachers mentioned that students were immersed in the narrative universe, and some students did not even realise the story was fake. After class the teachers had experienced that kids would come up and ask them if it was real or if they were just playing. In my interviews with students they would also describe some elaborated mental images of how they pictured the animals, the Emperor, and the land of senses.

1st student: *(Students in 4th grade) I think it is pretty wild that the Emperor is able to talk to the animals. I would really like to see that Emperor.*

Me: *You would like to see him?*

1st Student *Yes, I picture him looking like Aladdin. The little fat guy.*

2nd student: *I picture him looking like that guy from "Once upon a time." The one with the nightingales. A Chinese Emperor with a really big beard.*

Me: *A beard, yes?*

3rd student: *I picture this tiny man with a really long rope that just roles three meter behind him.*

1st student: *Yeah, yeah!*

3rd student: *And he has this giant turban with a little crystal*

Different students would have different images of the story. In some cases students imagined an Emperor very alike the drawings in the material (see the pictures in Appendix D); but other times they would present more elaborated universes, which were not depicted in the material, and explain emotional relations to this internal narrative universe. For students this provided them with ideas about the universe in which the story and hence the learning activities took place.

Teacher: *(4th grade) . . . they picture the story and create a visual image, and then they are engaged in the story . . . It's about elaborating the fantasy, and I think that's something positive. It's like, "Wow, we know something about this" and "Hey, you can't write that." I mean, it is quite funny that they actually think like that.*

Structural components for cognitive guidance

My research also showed that the story-based learning activity provide structural guidance for both teachers and students in different aspects of the activities.

During my observations I saw several implications for students using story structures to navigate by, for understanding and for making decisions. Especially the plotline "animals and humans

sense things differently" was often used as a common reference. Students also seemed to take directions from the letters of the animals, which made it clear to them which sense they had to explore. This was especially obvious with regard to planning and executing the visit to Experimentarium. Students were engaged when choosing relevant exhibits, and they would refer to their animal in their argument for each other when they have to decide which exhibits to visit. At Experimentarium students were looking specifically for the area of their animal and its sense. In regard to the objective, students seemed to understand that they had to create arguments to free the animals; however they did not know *how* to do it. I will elaborate on this in the next section about the design of *The Emperor*.

Some students, particularly in the older classes, explained that the story makes it easier for them to work with the topic. The story makes them understand what to consider and makes it clear to them how they should work in groups. Students also say that the story made things easier to understand, even though it is difficult for them to say why.

The classical fairy tale structure also seemed to influence students. Students recognised the structures form previous fairy tales. In my interviews and observations students had specific ideas about how the story would develop. They stated that they expected a build-up of tension, which they looked forward to. However, they also felt that the structure made the story very predictable and they assumed they would not have much impact on the story. Students expressed a demand for more uncertainty, to feel a greater freedom of action. In the classic format of the fairy tale they expected that the story would have a happy ending whatever they did.

Several teachers said that the story tied things together and created a meaningful context for the topic and that the story provided a good framework for instruction. They believe that it sets clear

goals and guidelines for students and creates a common reference to the class.

Teacher: *(4th grade) I don't see the framing (of a story) as a way of demarcating, but as a place, where we can always return to, in case they move out of track, or a place to start the instruction. The story is a frame, and when they move in opposite directions it is a place for them to return to. That's the essence . . .*

Teachers also emphasised that the story could be used to remember what happened previously in the lessons. The story-based learning activities helps students' knowledge "stick" better, or at least differently, as a way of remembering things. It creates a common reference by its recognisable story structures that it is easy for students to remember.

Some teachers note that a story-based learning activity is not a way of making students "learn more," but a way to make students able to remember what they have learned for a longer time. This makes it easier to return to the topic later on. One teacher who was familiar with using stories said that he often had to say very little before students' remembered the topic compared to other ways if teaching, where it would take a while to refresh students' memory. As he says, he will only have to mention one reference, such as "remember the dog that lost its nose to the Emperor" and students would be reminded or have a picture of the entire sense of smell. He sees this as strength since he, as a teacher, often has to make students remember previous programs.

Teacher: *(4th grade) . . . The story makes them remember certain parts of the educational content. There is not a lot of it in this material, but they can remember a lot of the program, and they remember the last procedures of the trial, and what they said, right. And what their augments were, and stuff like*

that . . . And it is easier for some students to remember it again when they have a story. That's my experience. They are able to say more things about the animals and . . .

Me: *You mean, more things than if they did not have a story?*

Teacher: *Yes, that's my experience. They find it easier to remember if I say, "Do you remember last year when we worked with this," and they can't remember it, but stories they remember and through that I am also able to ask questions about the educational content.*

Me: *Are they able to remember more, or is it just a way of communicating?*

Teacher: *They are able to remember more if they have a story . . . but it is linked together.*

Me: *OK, so if you ask them about the educational content and dug into that, would they be able to remember that as well?*

Teacher: *Yes, it (the story) does, but it triggers them faster. Usually I have to use more keywords related to the educational content before they start remembering. . . . It (the story) is easier to refer back to, I think.*

I get the same impression from student interviews, where students especially remember the Emperor and their animals, but can also lively retell previous taught topics in which they used stories.

The design of *The Emperor*

During the design phase the aim was to create the strongest possible design to explore how students used the story as a tool. However, this design is not perfect. During my interviews and observations I found three primary problems that undermined the intentions of the story. One was a lack of guidelines on how to solve the narrative objective in school and at the science centre, the other was a lack of mediation during the visit to Experimentarium, and the third was the object of inquiry learning.

A frame with little directions

During my observations I noticed a lot of confusion of how to solve the different assignments in the learning activities. The story did not seem to give students sufficient guidelines to gain knowledge or execute specific procedures of posing questions or constructing arguments. I observed this problem at both schools and at the Experimentarium.

In school students were often very confused about how to solve the problems of the animals. Neither students nor teacher felt that the material gave them sufficient knowledge about how to solve the narrative objective. Consequently most teachers would provide students with extra material in terms of factual sheets of knowledge that would help them gain knowledge about animal senses.

Teacher: *(5th grade) I also think it was a weakness that the material did not give students new knowledge. They had to explore it on their own. In reality that means that all their arguments come from what they already know, unless they go online and find it on the web. And that can be an overwhelming assignment for students if they don't get where to go. That means that the teacher has to find, I would say. And it might as well have been articulated in the material, where to get some knowledge about the animals they have to create arguments about.*

Me: *Yes. And you did get them some material. Was it difficult to find something that was spot on what they needed?*

Teacher: *Yes, a little. It was three different libraries and it was the last place they had that book and one of the animals was missing. No wait, two of the animals were missing and I found one animal and the second I just couldn't find . . . I couldn't find a lot. But the book called* Senses of the Animals *was good for most things.*

At the students also seemed to lack directions in terms of using the exhibits correctly. In the design we had relied on the teacher as the mediator of the story and on the structures of the story as a scaffold during the visit. However, when students entered Experimentarium, only some teachers would give them instructions related to the story while others did not talk about the story-based learning activity prior to the visit. Either way when students entered the exhibition, they would typically only consider the objectives given by the teacher for the first couple of minutes. In this time span students would be very focused on finding the exhibits relevant for their animal sense. They would to some extend be directed to the right place in the exhibition, but they struggled to interpret the scientific phenomena illustrated by the exhibits.

(Extract from my observation. Fourth-grade students; students have been at the exhibit for five minutes at this point) The students are very focused on the planning paper, and the map in terms of choosing their exhibits. They start at the "nectar sucker," where they have to wear a helmet with a small antenna that should be stuck into some plastic flowers in order to suck nectar. At some point the flowers change, and you can see their UV patterns. The students seem to get that the exhibition demonstrates bee vision, but they don't get that the pattern does not disappear once the flowers are empty of nectar.

Student: *Can you see the patterns?*
Student: *You haven't got that one (points at a flower that still has a pattern).*
Student: *Do you still have bee vision?*
Student: *What's the next one? (Looks at the map).*
Student: *Where's the berry picker? (Finds the exhibit).*
Student: *Here!*
Student: *Yeah, that's the berry picker.*
Student: *Is it on?*
Student: *What should we do?*

The students do not get that the light is dimmed at the "berry picker" exhibit to illustrate a change in vision depending on lighting. They just press the buttons in order to pick as many berries as possible.

Student: *Pick berries!*
Student: *You have to use your vision!*
Student: *Why does it say, "Bvadrr?"*
Student: *How many did you get?*
Student: *Four.*
Student: *Two.*
Student: *OK. OK. Let's move on.*

Students move to the exhibit "colorshifter" glares at me for a minute, and then look at their papers.

Student: *Shouldn't we start with UV light and end with this one?*
Student: *Let me see the map . . . This one we just have to look at.*
Student: *Ohhh, OK.*
Student: *OK, let's go see the eye gallery.*

Students move to the eye gallery, look at it and then move to the UV exhibit.

Student: *OK, what's this?*
Student: *I don't know what is this?*
Student: *Should we smell it?*

They leave without getting it. And return to the "colorshifter" exhibit.

Student: *We have to build a rainbow.*
Student: *No, we have to mix the colors.*
Student: *Remember to write our discoveries down!*
Student: *I never Figured out what those UV patterns were for?*
Student: *Nope, me neither . . .*

Student: *Just write something down . . .*
Student: *What should I write?*
Student: *What we learned!*
Student: *But what did we learn?*
Student: *I don't know? That a bee has bee-vision?*
Student: *We have to write . . .*
Student: *OK, let's write something . . .*

It's been fifteen minutes, and they still haven't written much despite much talking about it.

Student: *Come on, write something.*
Student: *What should I write?*
Student: *Write down that we saw those patterns in the flowers, and that it wasn't that difficult.*
Student: *OK, what do I write here?*
Student: *That it was difficult, but practice makes perfect?*
Student: *We also tried the UV light.*
Student: *But I still don't get the UV light?*
Student: *I get the UV light. You can tell that this rock has it (goes over to UV and demonstrates it).*
Student: *Nectar hunters?*
Student: *Yes, at that one we learned how important bee vision is.*
Student: *It's much easier when you have bee vision.*

In most cases when students reached the exhibitions, they seemed to forget the objectives and the determination, and they would behave as described in the Current Situation, by running around to different exhibits and only staying shortly at each exhibit. In most cases students returned to the task shortly every now and then, but they were easily distracted by something else in the exhibition. Only if the teacher intruded would they stay on the task for a longer time and engage in discussions related to helping the animals. Sometimes they would also stay focused when they referred to the paper they used to plan their activities, but they hardly ever referred to the story. References would be implicit and

would often serve as a way of giving answers to exhibits they did not understand. Students typically spent between a quarter of an hour and half an hour in the exhibition before they said that they were done and were allowed to go out and play. In two cases the teacher was particular active, and in these situations students worked in the exhibition for a little more than an hour.

In my interviews students had difficulties explaining what they did at Experimentarium. Most just said that they had fun. Students also complained that it was difficult navigating the exhibition. They often expressed either frustration over not being able to find what they should or not being able to understand it. Only one student is able to describe how an exhibit enlightened him in relations to the story. His group was in charge of the snake and had to find the right temperature with a heat sensitive camera. He says he was impressed that the snake only had to "look" (this is actually wrong) at something in order to sense the right temperature.

Teachers complained that the exhibition and the story material were too far apart. According to teachers several of the exhibits were too weak in terms of describing the phenomena of senses, they missed a greater representation of the animals in the exhibition, and they did not feel that the exhibition was aligned with the rest of the learning activities. Teachers thought it was difficult for students to link what they saw at the exhibit with what they had to do according to the story.

The difficulties of using narratives to do inquiries

In the design we decided to let the learning objectives be based on both content and inquiry learning. However, the process of inquiry learning turned out to be a problem in several classes for both teachers and students.

The idea of inquiry learning was to make students pose questions, do investigations, and create their own arguments. Students would have to engage in these different activities throughout the program, and the story should guide them through this process. However, during my observations I noticed that students did not know how to reach the learning objective. They understood the plot and connected to the characters, but they did not feel that they are able to gain the relevant knowledge to help the animals. After the first part of the story in which the problem was introduced students often asked, *"How should we be able to help the animals?"*

In general, students did not know what resources they had for helping the animals and during group work students found it difficult to solve the tasks. Students' letters would often just be a repetition of the facts presented in the letters from the animals. Students would also find it difficult to interpret the knowledge gained from exhibits at the Experimentarium and use it to create arguments. In general students complained that they did not understand the content of the exhibits and did not know how to use these exhibits to reach the objective. The narrative objective seemed to be too abstract with regard to inquiry learning.

Several teachers also found it difficult to give instructions in relation to inquiry learning. Many of them expressed a lack of facts and substantial knowledge in the design and would ask for more practical work and more technical knowledge. They also asked for clearer working questions in order to make it clear to the students what to do. They felt that a lot of learning was more related to reading skills and cooperation rather than *real science*. As a consequence most teachers would give students sheets of factual knowledge to use during group work.

One teacher who was in charge of a third grade wondered if doing inquiries would be in the zone of proximal development of third graders. She believed that students were not able to reflect upon

the narrative but rather than digging into the scientific content of the story students would choose a narrative path and just write their own little stories. Another teacher articulated this problem as well.

Teacher: *. . . The thing about writing letters is classic in Danish lessons, but of cause the content had to be scientific, but, I don't know, sometimes I thought that they would just write things like, "Don't do that, Emperor, you're not being fair" or something like that. It is not that I mind the thought of using the narrative world, I think that is interesting and a new way of thinking, but it has advantages and disadvantages.*

Another teacher saw the story as a great way of introducing inquiry learning. To this teacher the story provided a structure that made it easy to introduce the procedures in inquiry learning. However in most classes both teachers and students seemed to be challenged when they were trying to balance both the story and a new learning format.

In the next chapter I will discuss these findings.

11 Discussion

In this discussion I interpret the findings in relation to the proto-theory to create a basis for a new theory-based model of story-based designs. I also consider the design of The Emperor *and how the experiences made in this design may be considered in future designs.*

Explorative Reasoning of the design

In this chapter I will interpret the findings and discuss how these findings relate to my prototheory, and the problems described in the Current Situation as outlined below.

In my opinion Design Research creates a very earnest way of creating research designs. It makes the intentions and biases of the researcher very explicit and makes it possible to review the original expectations of the design in the analysis of the empirical studies. In my prototheory I presented three assumptions.

- *A story can be used as a tertiary cognitive tool in a learning activity and provide structure and direction.*
- *The connection between story structure and cognition provide a gateway to design narratives that act as cognitive tool for learning.*
- *When using a story as a cognitive tool for learning the story provides a number of properties, such as familiarity, understanding, interpretation, immersion, and motivation. However, these properties are influenced by the context and students' personal experiences.*

During the design phase I imagined that the structural and emotional properties of stories could be integrated into a learning activity and serve as a tertiary cognitive tool. This *internalised* narrative microworld should help students interpret certain parameters in the learning activities, such as navigating in the complex task of doing inquiries, and posing arguments and helping them engage in the scientific phenomena at the Exhibition SENSES.

Based on these assumptions I created the design *The Emperor* with the following intentions:

- *To create a story structure that motivates students for the learning activity by emphasising personal relevance and interest in the subject "senses", enhances students ability to reflect upon the scientific phenomena of the SENSES exhibition, support students in the process of scientific inquiry, experimenting and in creating arguments about the topic senses, reduce the novelty effect by considering students' prior knowledge about senses, and orients students to the trip setting prior to the visit to SENSES.*

In the following sections I will explore these intentions and assumptions. I will start by interpreting the findings and consider how these interpretations correspond with my original prototheory and the design intentions.

Interpretations of the findings

As stated in "Findings," in the mind of students, the story about *The Emperor is* a learning tool. It is not a tool for playing or entertainment, it is a structure introduced by the teacher that serves to educate them. In the findings I have described how the learning ecology and the teacher influence the students' perception of the tool and the nature of the emotional and structural properties of the story as a tool for learning.

In general it seems as if the story acts as a vehicle for motivation and immersion into the learning activity. However, the story in the design does not offer a constant "Suspension of disbelief" (Bruner, 1986) or play the same part in class as it does in plays or books, video games, and movies. As described in the Situation model: context matters (Graesser et al., 2002). Students are not constantly immersed in the story or motivated by it. Due to interactions with educational elements the story gains a new status when it is introduced to a learning activity. In students' mental microworld of the story-based learning activity, there seems to be a hierarchy in which the formal structures of the classroom, and

the existing educational contract negotiated between students and teacher dictate the degree of presence of the story.

The teachers' effect on students' mental representation of the story

Among other things students' use of the story seems to be dependent on the teachers' way of using the story for instruction. If teachers have difficulties applying stories to the learning ecology, it represents an extra challenge when they are planning their teaching. If the teacher chooses not to implement the story as a scaffold in all parts of the activity it loses its status as a scaffold to students in these parts. The teacher needs to acknowledge the story as a tool and to understand the properties of this tool by using it for structuring and problematising issues and thereby provide stimuli that support their reflection and articulation (Reiser, 2004). It seems to me that the teacher is the gatekeeper of the story or the media that the story lives from. The story-based learning design needs a teacher to mediate the cognitive properties of the story and to ensure that the story is available as a tool. If the teacher does not provide an entrance to the narrative universe the students never enter. Hence, the presence of the story in the mind of students' is dependent on the teacher's use of the story.

A cultural clash in N/T

The use of the story also depends on students and teachers preconceptions of methods and procedures in N/T. In some classes there seem to be a specific mind-set or culture related to N/T. As described in the chapter on Activity Theory the present Activity System does not only exist in "present time". It also relates to "past time" (Kaenampornpan and O'Neill, 2004). Hence. Students have certain preconceptions of the learning ecology and the tools in N/T of which stories like The Emperor are not a part.

The story seems to meet some cultural obstacles when it is placed in the classroom of N/T. Students and teachers are unfamiliar with the use of a story as a tool in this setting, and this influences the use of the tool. It seems to me that being able to use a story as a tool require experience for both teachers and students. If they do not have this experience they do not know how to use the potential of the story as a tool, and this affects their perception of the story in the learning activity. This posse the risk that students cannot combine the two formats, but either chooses a narrative discourse or a science learning discourse, and the story loses its potential as a learning tool.

Keeping an emotional distance to the story

Students' awareness of the story as part of a leaning activity also seems to affect their emotional engagement in the story. Like the first assumption of the Situation model states, *readers goals*, seems to matter. When the goal is learning, students connect to the text in a different way than if it is purely for entertainment purposes (Graesser et al., 1994).

When the narrative program is set at school the existing learning environment seems to affect the degree to which students engage emotionally in the story. Students are very aware of the story as a tool for learning, and even though they engage in the story (sometimes more than others) they are not willing to completely surrender to the emotional aspects in the story. On one hand they are accepting the narrative universe as a way of learning in school on the other hand they notice things from the real world that are in conflict with the narrative world. But they are willing to let these conflicts go if the teacher tells them to play along for the sake of moving forward in the story. This could be because they simultaneously are given tasks that are grounded in logical thinking. As A consequence of the story being a tool for learning it seems as if students are constantly moving in and out of the story in favor of educational elements.

Consequently the emotional aspects are only coming through as long as students are kept aware of the story either by letters from the characters or by the teacher. As described by one of the teachers in an interview, the story resembles a kind of "controlled play". Students enjoy being engaged in the story, but they do not take major actions as characters of the story unless the teacher instructs them to do so.

On the other hand, students' awareness of the story as a learning tool also seems to make it possible to use more childish stories. Students seem to accept the childish story because it is part of teaching, and therefore they can distance themselves a little to it.

The nature of structural and emotional properties of the stories in learning

Despite the influence of the learning ecology on students' perception and use of the story, it still holds a potential for creating motivation, immersion and a sense of agency. Students seem to create a "landscape of actions" and a "landscape of consciousness" (Bruner, 1986) that they carry with them throughout the activity in which they can use if they choose to or are asked to do so.

These emotional properties of the story provide students with a sense of meaning as to why they have to engage in learning activities. Through the story, and especially because of the characters in the narrative, they get a reason to stay focused and motivated, which prolongs their interest in the topic. Making students play a part in a story seems to provide them with a sense of having a greater responsibility for their own actions during the learning activity. The story provides a feeling of being in charge and being influential that seems to boost students' confidence, and hence their motivation for engaging in the educational activities. Students create elaborated mental images of the story that seems

to create the basis of their understanding of the learning activity. These mental images represent an emotional attachment to their characters, which again creates an emotional goal for solving different assignments. However, these mental images also create great expectations and if the physical environment of the story design does not match these expectations students get disappointed.

The story also provides structural guidance for students and teachers. It provides a number of explicit and implicit directions for students during the learning activity, which makes it easier for students to interpret their own role in the activity and create a common reference within the class and during group work. Like Mandler describes (Mandler, 1984) the story grammar makes it possible for students to foresee future elements in the educational activities, and it serves as a memory tool for past actions.

Design considerations for The Emperor

These previous findings describe my interpretation of students' mental representation of a story-based learning activity and the factors that influence it. However, these findings are closely related to the particular design of *The Emperor*. Hence, the strengths and weaknesses in the crafting of this particular design also influence students' perceptions of the tool.

In the particular design of *The Emperor,* the use of a story should provide a scaffold for a number of problems in the Current Situation, described in the design phase. However, this design fails to break down the tasks of content and inquiry learning and to support students in their exploration of the SENSES exhibition and the scientific phenomena of the exhibits. In the terminology of Activity Theory, we present students with *actions* we want them to do, but we do not break them down to *operations* (Nussbaumer, 2011). A general problem of the design is a lack of educational guidelines and considerations regarding how students should

acquire the intended learning outcome. *The Emperor* mainly creates a frame for learning and does not give directions for how to achieve the outcome.

As designers we thought that giving students and teachers a story would provide the necessary scaffolding for learning. We assumed that the *internalised* story would somehow make it obvious what to learn about senses, and how to engage with exhibits. However, bringing students to the exhibits or telling them to inquire does not provide them with knowledge of *how* to solve the task even if they are motivated by a story. If, for example, the exhibit poses a challenge in terms of interpreting the scientific phenomena it is supposed to illustrate, the story cannot help. *The Emperor* does not give specific direction for how to solve individual tasks, such as engaging with exhibits in a way that helps interpret the scientific phenomena. The *externalised* story structures are representatives of the design. Only if the story gives direction for how to engage with the exhibit, it may serve as a tool for understanding the educational content of science centre exhibits.

The design also demonstrates that *The Emperor* has been designed for an *ideal teacher*, who knows how to execute the methods we prescribe. However, designers cannot rely on teachers to break down these tasks for the students. Story-based learning activity needs to be combined with methods of instructions that are already familiar to the teacher or give direction for how to teach. If the teacher is familiar with the methods described, such as finding scientific facts and executing small experiments by interactive exhibits, it does not pose a problem. However, if the teacher and students are unfamiliar with these methods of creating arguments or interacting with exhibits through inquiry, these methods must be introduced as a part of the story-based learning activity. Otherwise students and teachers make their own interpretations of the narrative learning objectives. The story-based learning activity cannot introduce new methods of learning that the teacher is unfamiliar with, without being explicit about

how to handle these issues. This obstacle may have been overcome by acknowledging the problem and create better instructions or education of the teachers on how to use stories as tool for learning in N/T.

The design also showed that the story needs mediation all the time to be present in the minds of students. Students do not involve themselves emotionally in the story enough for them to carry the story with them and use it as a learning tool at a science centre. In school the teacher serves as a natural mediator of the story, however in more informal environments some teacher do not fulfil this part. Without mediation the affective values of the story is competing with the affective values of the Experimentarium, such as playing, having fun, being with peers in a social fashion and the fact that students are in a new and exciting environment that are immensely different from the context of the school. Consequently, if the story is not mediated by other means at the science centre it only offers a brief engagement.

Limitations

The intention of the design of "The Emperor" was to create a scaffold to help structure problem solving and to problematize subject matter to help learners pay attention to new issues. However, because of teacher difficulties in using the story and a lack of mediation of the story at Experimentarium, this particular design sometimes failed. Hence, on a more general level the use of Design Research, and the specific design of The Emperor, provides certain obstacles in terms of exploring how students perceive stories as tools for learning.

Obstacles of Design research

Despite its intentions to create more "useful" research, Design Research is not problem-free. It faces a number of challenges, such as difficulties comparing across designs, a need for making clear

decisions to avoid massive data collection and difficulties that arise from the complexity of real world problems (Collins et al., 2004). It also faces the challenge of avoiding "lethal mutations," where the design does not work in the intended way (Brown and Campione, 1996). Participants have a variety of needs, interests, abilities, interpretations, interactions, and goals that make them use designs different than planned. The designer can never take all these parameters into consideration. This means that the underlying principles or objectives and actions can be undermined by the way the design is enacted.

In general, in *The Emperor,* a number of parameters influence students' perception of the story and are present along with the one imagined. They even change or eliminate certain uses intended by the design. For example, I had imagined that I could use discourse analysis of students' conversations from my interviews and from group work. I thought that recording student conversations could provide a clue to students' externalisation of the story and to how they used the components of the story to create meaning, without my interference. However, students did not articulate their use of the story and I had to rely on observations and students' interviews to provide access to this information. It is possible that a different design would create a different discourse among students, however, this study cannot tell if and how students use a story as a way of negotiating meaning as a part of their discourse.

Having to rely on students' interviews and having to probe for answers illustrates another thing to consider in Design Research; the Hawthorne effect (Brown, 1992; Collins et al., 2004). In the Hawthorne effect subjects improve or modify the aspect of their behaviour being experimentally measured simply in response to the fact that they are being studied, not in response to any particular experimental manipulation. Hence, my probing for answers and asking specific questions about students' experiences with the story, may have influenced student answers, especially

since I had already picked students who were well-articulated for my interviews. As a researcher I also tended to select which helped illustrate the research hypotheses. This is endemic for all research and must be regarded (Brown, 1992; Collins et al., 2004), especially when working with a specific proto-theory in mind as is the case in this study. Both issues may have biased my data and my findings.

Limitations in the design

A major limitation in terms of exploring students' use of stories at science centres turned out to be the Experimentarium's SENSES exhibition itself. The story about The Emperor was created as a way of overcoming certain obstacles that usually occur in science centre exhibitions such as keeping students focused on the exhibits. Consequently, the story relies on students' abstracting knowledge about the senses from the exhibits.

However, students did not intuitively grasp how to use the exhibits and extract knowledge, and in the majority of my research they never achieve this outcome. As described previously the design of The Emperor also failed to give students instructions on how to use the exhibits. As a consequence students hardly used the story at the science centre and consequently this study gives limited understanding as to how a story-based learning activity affects a visit to a science centre.

In my opinion this illustrates a general problem of creating exhibits that present science in a comprehendible way. One might argue that the responsibility for creating understandable exhibits lies in the hand of the exhibit designers, rather than the designers of the school material. However, when exhibits become part of the school material, it becomes the responsibility of the designer of the school material to make them comprehendible to students and teachers. Hence, in the design of the Emperor we "adopted" a number of "comprehendible exhibits", which posed a limitation

on not only an exploration of the use of story structures at science centres, but also a general obstacle in terms of learning about the phenomena in question.

Recommendations for future designs

Throughout this project I have gained new knowledge and experience about creating story-based designs for schools and science centres. I will wrap the discussion up by presenting a number of issues, which may be useful in future designs or iterations of a design similar to "The Emperor".

First of all, a new design would have to take the teachers familiarity with the use of stories as learning tools into consideration. Teachers should be made aware of their role as mediators of the story and the potential that the story holds as a scaffold. Teachers should also be informed that it might take some practise to master the use of stories as a way of scaffolding students.

The design should also take into consideration that using stories in science poses a challenge in terms of overcoming students' expectations and traditions of how science is usually taught. This might be done by integrating more traditional ways of teaching science, for example by emphasising the use of hands-on experiments.

Furthermore, if the design cannot be mediated by the teacher at all times, e.g. at science centres, it should be mediated by other means, such as computers, books, or other representations of the story that makes the story universe available to students.

In the design phase the use of narrative structures should be considered carefully. Designers should create a narrative learning objective, which emphasises students' interests, and make the

scientific topic relevant as a "helper" to reach this objective. To promote motivation and immersion into the story universe future designs should also consider the structural components of the story-based design. The design should create a part for students to play out, and create characters, which students can relate to emotionally. Similarly, the story should contain a plot-line, which is easy to remember, to constantly guide students in their actions and to move the story forward. The plotline should act as a common reference for students and teachers during discussions, inquiries, and presentations. Each of these narrative structures should be aligned with the educational content by the use of "Narrative Reasoning" to ensure that the story support all parts of the content and vice versa.

Finally, a thorough analysis of the intended outcome and how the story may support students in achieving this outcome should also be considered in future designs. The story design should not just introduce students to tasks, but should help students break down these difficult tasks, in order to solve them. This is particularly important at science centres where exhibits may provide an obstacle in terms of understanding the scientific content.

The recommendations for future designs are summed up in Table 6 in the next chapter. Based on this discussion of my findings I will review my proto-theory and present a model for students' mental micro world of the story-based learning activity in my final chapter on "Implications".

12 Implications

In this final chapter of the thesis a new model for story-based learning designs is presented and recommendations for future guidelines are made.

Revising the story-based design

I will end this thesis by summing up issues and implications of this project and by providing a list of recommendations the findings point to. The list should help inform practitioners in future narrative designs that integrate school and science centre activities.

A new theory-based model for story-based learning design

My empirical studies and the analysis presented in the previous chapter, make it possible to revise my original theory and create a new theoretical model of the story as a cognitive tool in activities that are similar to the one described in the design of *The Emperor*.

In my prototheory I imagined the story as a tertiary tool and a mental *microworld*, which students could use as a way of interpreting their surroundings. My empirical studies show that this internalised *microworld* is influenced by a number of aspects from the learning ecology of schools and science centres.

My research shows that in a story-based learning activity the story provides a social, cognitive, tertiary tool, which students and teachers may use as a common reference. However, the story is not omnipresent but provides a frame and a memory tool, which students and teachers may use as a common reference, when it is needed. To students the story is part of a controlled way of playing in which they still take directions from the teacher. Consequently, the teacher (or other means of mediation) provides and essential mediation of the story to help students immerse in the story.

Students' use of the story demonstrate that the story as a learning tool inhabits a number of qualities known from psychology and literary theory, such as immersion, motivation, agency, and structures for cognitive guidance. However, students' perception

of these properties is influenced by the educational elements and hence students often keep a slight emotional distance to the story and only immerse completely into it in their own acts of imagination. The story primarily serves as a tool which teachers and students can rely on to create a sense of agency and motivational, meaningful, and cohesive educational activities.

The particular story-based design in this research; *The Emperor*, demonstrates that in schools and science centres the story must support every part of the learning activity and provide teachers and students with guidance in how to achieve the intended learning outcome. If the story fails to do so, it also fails to scaffold students in certain aspects of the leaning activity. Hence, to create a story that gives directions in all parts of a learning activity, it is important to dissect the educational elements of the activity and make sure that these are properly scaffolded.

Recommendations for future designs

The findings and my interpretations presented here represent one iteration of a story-based learning design. However the finding and discussion of them opens up to a number of new projects, which can explore new issues, raised by this project. Based on this research I will end my thesis by proposing a list of recommendations for science centre staff members and teachers for future designers of story based learning material. The recommendations are found in Table 6.

	Recommendations for designs of story-based learning activities at schools and science centres
1	Emphasise the teachers' part in mediating the story and highlight the difficulties and advantages of introducing this genre to learning activities in the subject of science.
2	Explore if the methods necessary to execute the learning activity is familiar to the teachers'
3	Integrate elements that students and teachers associate with science, such as experiments and other hands-on activities.
4	Analyse the learning outcome and make sure that the story-based design gives directions on how to achieve this outcome.
5	Create a part for the students that they find personally relevant and create characters they can relate to emotionally.
6	Create a plotline that is easy to remember, as a common reference for students and teachers during discussions, inquiries, and presentations.
7	Make sure that the story is mediated during the visit to the science centre, by the teacher, staff, computers, booklets, etc., and that some kind of representation of the story universe is available to students.
8	Create a narrative learning objective, which emphasises students' interests, and make the scientific topic relevant as a "helper" to reach this objective.
9	Make sure that all parts of the learning activities are grounded in "narrative reasoning" that connects the story structures to the educational content.

Table 6: Design recommendations

Appendix A

Phases in the collection of empirical data

Phases	Methods	Product
Instructing the teacher	Dialogue	Written notes
1st lesson **Student-animal correspondence**	Observation, entire class Tape recording two groups during group work Pictures of mails, all groups	Written notes 2 x audio 6 x pictures
1st dialogue with teacher	Dialogue	Written notes
2nd lesson **Students planning visit to Experimentarium**	Observation, entire class Tape recording two groups during group work Pictures of plan for the visit, all groups	Written notes 2 x audio 30 x pictures
2nd dialogue with teacher	Dialogue	Written notes
Experimentarium	Observation of one group Video glasses on two students, two groups	Written notes 4x video and audio
3rd dialogue with teacher	Dialogue	Written notes
3rd lesson **Preparation for the trial**	Observation, entire class Tape recording two groups during group work	Written notes 2 x audio
4th lesson **The trial**	Observation of the entire class Tape recording discussions	Written notes 6 x audio

	and presentations Pictures of presentations of all groups	6 x pictures
Final interview with students	Group discussion	1 x audio
Final interview with teacher	Interview	1 x audio

Description of schools

Name	Description (based on my observations and interviews)
Third grade, school A, male teacher, about 35 years old	A traditional Danish school (whatever that means). In N/T their teacher teaches students in a combination of classical instruction combined with a number of general pedagogical tricks that keeps them engaged and disciplined. Being very much in control during class characterises the teachers' way of instructing students. He is outlining everything in the program during class. The program lasted for five weeks in total. Before going to Experimentarium the class spend two hours two Fridays in a row preparing the visit. They went to Experimentarium the following Monday. The class has not been to Experimentarium as a group before and the school does not do many of these trips. The following week they finish up their final presentation, and it is presented in a small play, where the school principal plays *The Emperor*.
Third grade, school B, female teacher, about 55 years old	This school emphasise alternative teaching, where students work in groups in different areas of the school. The school emphasise freedom to learn depending on your own learning style. In N/T their teacher seem to employ somewhat traditional methods. She is very interested in the narrative format and has been doing some acting herself before. She makes a few extra hands on experiments at class, but other than that she makes no adjustments to the program nor does she give students complimentary material. The program took place in three weeks, four lessons

	at school one week, two lessons at school two weeks later immediately followed by the visit to Experimentarium (the school is only 500 meters away, and students are used to coming to the Experimentarium) for two lessons, and the program finishes a week later with four lessons at school, where students presented their final results in a small play.
Fourth grade school C male teacher, about 35 years old	The school has a tradition of using drama from the students are very young. They are very inspired by an author named Marianne Ødegård who used drama in science teaching. The school has students from various nationalities, and opposite to the other schools in this research project, the students do not come from well off families, and there is great variation in socio economic status. Hence the class is familiar with drama as a tool for learning. In N/T the teacher is exceptionally engaged in students and their process of learning science through dialogue and even costumes. He is constantly mediating them, by talking to them and directing them. He added a lot of extra material in order to increase the amount of conceptual knowledge and for students to immerse in the research/investigative part of the program. The teacher has been a part of another narrative program created by Experimentarium and is familiar with the format. The program lasted for three days in a row, in which students at the first day prepared themselves for the visit at school, at the second day went to Experimentarium, and at the last day prepared for the trial.
Fourth grade school D,	A traditional Danish school but with a low number of students with learning difficulties. In

female teacher, about 30 years old	N/T their teacher teaches students in a combination of classical instruction combined with a number of general pedagogical tricks that keeps them engaged and disciplined. She uses humour a lot. Students are described as very easy to handle and eager to learn. The program lasted for three weeks. Before going to Experimentarium the class spend two times two lessons the week before the visit, and they spend two lessons the week after the visit.
Fourth and sixth grade, school B, female teacher about 30 years old	See previous about school B. In N/T the teacher emphasise freedom and dialogue with the kids. She is very emphatic toward students' perspective on teaching, and changes things instantly if they do not work in dialogue with the students and is open-minded toward new methods of teaching. The teacher describes the sixth class as being a bit difficult due to a shift in teachers. Some of the students have social problems and are being teased, whereas other students are socially and intellectually strong. The fourth grade is relatively unproblematic. Both programs are done in three weeks, where students spend one day each week. The first week they prepare the visit, the second week they go to Experimentarium, and the last week they execute the trial.
Fifth grade school E, two male teachers about aged 30 and 35.	Private school that emphasise students' ability to reflect and debate. In N/T they have two teachers who are very focused on achieving the discussions by providing students with the right tools for learning. They tell me that the students are easy, but that they have not been working with narratives before. The program takes place in four weeks, where students are prepared for the visit to Experimentarium the first two weeks,

	then goes to the SENSES exhibition and at the end finishes with a trial in which the teachers act as judges.

Appendix B

Example of observation schema

The following is a description of my empirical studies of fourth grade at Værebro skole. During this study I observed a class of fourth graders as they used the narrative school material *The Emperor*. The teacher of the class is a thirty-five-year-old male named Jacob Sundby, who has been teaching for about ten years.

This paper outlines the tentative notes of my observations in the classroom and during a visit at Experimentarium.

Teacher	**Students**	**Me**
16.02.2011, initial interview and instruction of the teacher		
Jacob tells me that the school in general does a lot of teaching through storytelling. He says that they are very inspired by an author named Marianne Ødegård who uses drama in science teaching. He says that his experience with students' memory afterward is that they remember a mixture of both the narrative and the	Jacob describes the students as being found of projects; especially the boys are very enthusiastic. The girls are quieter. There are a lot of bilingual students. Nine boys and ten girls. They are used to stories.	I have instructed Jacob to make groups beforehand in order to make sure that I get some good groups to follow. Jacob says that it is a good idea to create the groups based on gender, as the boys tend to overrule the girls. I have e-mailed Jacob a map of the exhibit for the students to use while they are in the

content. Jakob points out that there is a problem in the material being a PDF since it is not possible to make changes in the material.		exhibit.
22.02.2011, in class, 8.00–14.00		
Jakob asks the students what they already know about the senses. He makes them explain how they use their senses right now. J: We use the senses to feel, where we are at right now. He asks them how the senses can be used to against danger and for pleasures. Can they taste a nice cake or be afraid of a man with a hatchet?		
Jakob reads the story.	S: Was that the end of the story?	
Jakob pretends that he has received a	A student reads the story out loud.	

letter from the pigeon, and he puts the letter up on the projector. J: I saw the letter earlier this morning. S: Fnis!		
	The students discuss which animal they would prefer. There is a lot of whispering and shouts of joy whenever they get their animal.	
Jakob tells the students to go get a computer and answer the animals if they want to help them. (The computers take forever to start up!)	S: We would like to help! J: OK, go answer the pigeon. S: How do we answer? Do we just say yes, yes? J: You can't just write, "Yes, yes, I want to help" Don't you know how to start a letter? S: "Dear Emperor." S: Do you have to write who send it? S: "Best wishes from your superiors."	

When the students send their mails, Jakob sends the first letter from the animals back to them.	The students are suspecting that the letters are from Jakob: S: Jakob, you didn't write "best wishes" . . . :)	
J: OK, so now you have received some letters from the animals. S: From you . . . :) J: No, from the animals, and now you have to explain the animals the consequences of losing their senses. What things are you not able to do when you have lost a sense?	Students list a number of things on the blackboard. S: Doesn't it hurt to have your nose cut off? J: No, not if you have sedatives, but that's not something we shall talk about right now . . .	
Jakob tells the students to write letters for the animals.	The students don't really know how to do it. Jakob has to move around the classroom and help them out.	Jakob tells me that the problem with the material is, that the problem presented here is very theoretical, and students this age normally does not have this kind of teaching till later. He says that the fairy tale suits the

		age group well, but they have difficulties handling this way of working even though the story tells them to. They need something more concrete and that is perfectly normal for students their age.
	The students have great difficulties understanding the assignment.	It seems as if the assignment and the reflections take up more of students' attention than the story does. The story was created in order to understand the assignment and solve it, but it is competing with other narratives, e.g., "what happens when you cannot feel" and stories about what would happen if you cannot feel a wound and would die of the bleedings. In order to solve the assignment students have to create these narratives, to understand the

		problem the story introduces.
J: Have you learned something about the animals that you didn't know before?	Students tell Jakob what they have written to the animals and what they've learned. S: If you didn't have your sense of taste you would die if you ate something toxic. S. Or something mouldy. S: Maybe it would be quit cheap. Then you could just eat sand? J: Well, we have to see if *The Emperor* thinks that is sensible . . . S: The scorpion had its sense-hairs removed (makes a face and a hand movement that shows an evil Emperor shaving). S. This must be the most dangerous sense to miss, you can die if you can't	

	feel that your arm has been cut off! S: You wouldn't be able to feel it when you were a goalkeeper in football.	
	The students in the bee-group mention a lot of things that you won't be able to see without your eyes.	It seems to be a tendency that students list very concrete consequences of losing a sense. This could be seen as a symbol on how difficult it is for students this age to solve the assignment given by the story. *Maybe it could be interesting in the interviews to ask whether the students actually fell that their answers made a difference to the animals.*
	S: Shouldn't we try our own senses (do some experiments)? J: I'm just helping the pigeon, it tells us what to do. S: Hmmm.	I'm not sure if students are used to N7T being something, where you do experiments and if this format really interferes

		much more with the didactical contract of N/T than any other class?
		During lunch Jakob tells me that he thinks the students are doing fine. He says that it is perfectly normal that students do not use the story all the time. Normally the story just frames the teaching, but once the students engage in an assignment they do not really use the story, but stays focused on the assignment. *(Ask Charlotte Koldby about her experience during ide-jagten)*
Jakob reads a letter from the animals that he has turned into a mail from the animals: Mærkværdige verdener.	J: OK, letter from the animals. S: You wrote that. J: No, I promise that I didn't write this letter!	
Jakob asks the students to go search the Internet		

for information about the senses of both humans and animals on dr.dk/skole.		
Students have to write letters.	S: Do we have to write to the Emperor or the animals? J: The Emperor. S: But what about the animals? J: No, this time it is for the Emperor.	There are a lot of actants in the story—pigeons, Emperor, animals, and servants—which means that the information from the kids to the Emperor can go through numerous parts, and it is a bit uncertain what part each actant plays or why they are essential for the problem. Students do not really know who to communicate with. *Maybe I should ask the students in the interview how they see the different Figures/actants in the story.*
Jakob spends some time at each group telling them a bit about their senses and how they work.	Group work	

J: *The Emperor* doesn't seem very smart, he does not get how important the senses are. Do you get it? S (all together): YES! J: OK, try to describe how boring the world would be without if you didn't have your senses. Think about how boring it would be if you couldn't see or taste an ice cream. Or dangerous. I think these are the two main arguments when we want to convince *The Emperor*. Don't you guys think that *The Emperor* likes to smell the flowers and perfume, and that he too likes good food and soft pillows against his skin? Do you think we can convince him? S: Uhmmm . . .	Students seem more engage with writing the letter this time, the firm intro seems to work . . . at least for a while. After a while, and after having written the narrative introduction to the letter they still don't seem to get the assignment.	They seem to be able to write within the narrative frame but it is difficult for them to use the story as a tool for interpretation.

J: Do you think you can explain it to him? S: Maybe we should tell him that the Python only sees the world as a foggy spot . . . J: I think you need to describe to *The Emperor* that he isn't too bright, and explain to him how his world would be without his senses. And work hard so that he believes you S: We don't want to . . . J: that's not very helpful . . . J: OK, how do you get the attention of an Emperor? S: You have to juice him up S: Dear sweet Emperor . . . S: Write "Dear Emperor . . ."		
	One boy is shouting, the other answers: don't shout, I have two ears and I am	

	perfectly able to hear on both of them . . . a second later one of the farts and the boy says: well, now I wish I didn't have the sense of smell.	
		I am wondering if the goal of the narrative is too weak and if this means that the faglige mål is too weak and if this means that the teacher has difficulties teaching according to the goals.
		I am considering making a small séance in a few months and gather the teachers and ask what their students remember from the story and what the teachers themselves think retrospectively.
During lunch Jakob tells me that he thinks that it might suit the program		It takes carefully considerations to construct a story as a tool for

better if it doesn't run for three project days, but is spread over a longer period of time. That gives time for reflection in-between the lessons, especially since the assignments of writing letters for the animals are so similar to each other. Typically, he says, children will think it over, and then you can pick up on some things. Some of the students love the story format and others need to be persuaded to it. "Yusef fx doesn't want to engage in it, he thinks it is stupid" Some are able to reflect others still need some more maturity.		motivation, if some students actually are demotivated by it. Why does some students like while others do not?
Jakob tells the students to present their letters, and he evaluates what they	S: What's the name of the Emperor? J: He's just called the Emperor of	

have written. He explains to the students how they can improve their letter and if they can expand on certain topics.	everything.	
Jakob reads the letter about the laboratory: J: Do you want to come with me and check this out? S: Yeahh! S: Where is it? J: It looks very much like Experimentarium. S: Yeahhh. S: We're on it, Jakob!	Students plan the visit, and ask if they are allowed to try other exhibits than the ones about their sense. Jakob says yes, but that they have to find their own sense first. S: So it looks like Experimentarium. J: Yes, very much indeed. S: OK, when do we have to go to Experimentarium :)? S: So it looks exactly like Experimentarium, is it located at the same place as well? J: Yes, it is very close:)	
	J: Do you know why dogs are able to detect smell	

	better than humans? S: No . . . ?	
When Jakob instructs the students he use the story as reference: J: So if you want to find out about something, what would make most sense? S: Smell. J: Yes, why? S: Because we have the sense of smelling. J: Yes, why are some smells very important in order to tell the Emperor he can't see the same way as the bee?	The students plan the visit but with no reference to the story. S: Do we have to do more than the ones about the sight? S: I don't want to do the ones that aren't about the sight.	
When the students are done with their planning of the visit Jakob asks them to Google their sense. This works very well except for the sense of heat and cold, who doesn't find much information.	It takes a while, but all the students are quite good with Google.	
J: OK, what do you have to do		

S: We have to . . . (Something about the dog) J: OK, why? Silence S: Because the dog needs to get its nose back. J: What do we have to prove to *The Emperor*? S: How you are able to smell. J.: Yes, and do you know something already? S: Yes, that the dog smells better. It is 800,000 better than humans. J: They have more receptors.		
Jakob tells students to explain why some exhibits might be useful.	S: Because not all animals see the same colors as we do. J: So why is the bee any different from us? S: We don't know. J: Could you check that out? What more? S: Berry picker? J: OK, what can	

	you do at that? S: (reads out loud) J: OK, so you are able to use your sight to see what is poisonous? That sounds exciting, I am very curious to see if you find something that might convince the Emperor.	
When everybody has read what to do, Jakob ends the lesson.	J: OK, tomorrow we are going to X. S: No, the Emperor's lab:) J: Haha, yeah, the Emperor's lab . . . S: Does Mai work at the lab? S: Does she care about the animals? S: Mai, don't you care about the animals? J: OK, now you have to get ready to defend the animals, you are the defense of the animals. S: Are we the heroes of the animals? J: Yes! S: Yeahh, we are	

	the heroes of the animals!	
		Jakob tells me that he thinks the students would be able to do much of the work without the story. But that it helps them, when they have someone to write for, a goal.
23.02.2011, at Experimentarium		
When the students arrive, Jakob has told them that I am the servant of the Emperor, and they are quite excited about that.	S: Hello, servant. S: Where are the animals?	(This ends up taking more than one and a half hour, as opposed to other visits, where students only spend twenty minutes solving their tasks.)
Jakob gathers the students at the staircase before entering the exhibit, and tells them to write down what they find in the Emperor's lab.	Students stick to their planning paper and the map.	
Jakob cruises around the groups and instructs them in what to do, to read, write, and try out the exhibits. They get instructed	In general students don't know how to use the galleries. Jakob goes through some of the texts with a group of	The Pythons are generally well reflected and independent.

very well on what to do. He has to describe the electronic signs with information to them; otherwise they don't use them at all. Once the students are done, they have to go to Jakob and describe what they have done and what information they have gathered. The students are very conscious about having his approval before they are done.	girls. They look a bit tired but are good at answering his questions. The Python group doesn't get any instructions in the beginning (Jakob and I agreed on this), and they start out in the area about the sense of touch. They finish quite fast and then move around in a random way for about twenty minutes. Then they find the area about the thermosense, and they read the signs, take notes on "lun rede." S: OK, let's say that's it S: Wait a minute I'm writing a bit more. At "snake eyes" it takes them a while to get the exhibit, but then they get very excited about	

	finding the rats and using the thermocamera.	
Jacob is quite familiar with the exhibit since he has been in it before. In general he has a lot of enthusiasm, nice explanations, analogies and knowledge to support the students with.	J: Why is it important to have the sense of smell? S: In order to smell something toxic. J: OK, try and see if you can find something that proves that in the exhibit, otherwise it is fine.	
Jakob asks the students from the bee-group to explain what they need to know in order to explain the consequences of missing the sense of sight. They talk about the consequences of losing the sense in terms of the hen lying on an egg.	J: So what's the consequence for the Emperor? S: That he himself can't get food . . . J: You have to make a defense against the Emperor, so what's the consequences with the bee? S: If it doesn't have its eyes it can't find the flowers. J: Yes, and then we can't get the pollination. You have to explain to the Emperor that removing the senses of the bee has	

	consequences for the whole ecosystem. I think he'll understand that.	
24.02.2011, in class, 8.00–12.00		
Before the class begin Jakob notices that the two boys who are defending the rat are missing.	S: It doesn't look as if the rat will get its ears back, there's no one to defend it . . . S: Maybe it is just that one rat maybe the other rats are able to get their ears back despite that?	
Jakob tells the students that he has received another part of the story from the animals. Jakob reads the story out loud, and end up telling the students that the cat has given a letter to the pigeon, that is on their computer right now.	S: Those animals are pretty hi-tech . . . S: It's the pigeon . . . S: How does it type? S: Maybe it uses its beak? S: I really don't get how those letters got in to the computer? J: It is magic animals S: We didn't have a mail from the pigeon this morning, so it must have arrived just	

	now.	
Jakob explains the students that a great lawyer will be present at the trial.	S: I thought we were supposed to lead the case? S: So why don't the animals just get a great lawyer as well? J: But you guys are the lawyers!	It takes a while for students to get the different formats. They do not instantly get how to write a letter or how to lead a trial.
Jakob asks one of the students to read the anklageskrift out loud.	J: OK, so what do we have to do? S: Prove the innocence of the animals . . . J: Yes, you have to prove that the animals actually are able to sense more than *The Emperor*. S: We know it because we made some investigations S. And because we are smart:) S: Yeah, we did it in his own lab so maybe that means something. S: We'll make a demonstration. Down with *The Emperor*! S: Yeah, and then	

	we storm his castle with høtyve and torches. J: Yes, but right now you have to make a defense S: I have something really good for the defense!	
Jakob walks around between the groups and helps them sum up what they know.	The students are a bit disorientated. The students in the group that defends the rat have great difficulties: L (another teacher): How is the rat able to sense differently than *The Emperor*? S: It has a better hearing. L: Why? S: I don't know. L: All right then the rat dies! S: No, it must not! L: OK, then you have to explain why . . .	I think this is a good illustration on how the teacher may use the story as a way of making the students understand why it is important for them to know something and to specify what they need to know.
	The group defending the dog has made a lot of good notes during their visit, but they	In general students struggle to write down their knowledge. Some groups make nice

	are the only group actually using the notes.	letters almost on their own, whereas others need massive help, and despite that only writes a few lines. Note: I need to interview two girls from the bee-group and two girls from the dog-group; otherwise I end up with too many giggly girls.
	S: What does the judge look like? S: Have you spoken to him, Jakob? S: Does he have white curly hair?	
Another teacher pretends to be the judge. She uses a ping pong bat as her hammer, and makes the students stand up in her honour. Jakob has dressed up as the lawyer Albert Frimand with a wig and a suit, and they are now interviewing	Students read their defenses. J: How did you Figure this out? S: We did some experiments (reads them out loud from the note sheet). J: And what does this mean? S: (explains different exercises they've done)	I have tape recorded this entire trial.

the students in order to get as much knowledge as possible out of the students. Jakob has done this because he thinks students sometimes find it difficult to write down what they know. Jakob makes a small performance in the beginning, where he says that it is nonsense that the animals should be able to sense more than humans.	Students have to raise their arms if they agree that the animals should be set free, based on the trial.	
Jakob ends up setting all the animals free. He then says that The Emperor has followed the entire trial on web camera and now has sent a mail for the students telling them that the animals are free. He does not read the last bit of the story, as he doesn't feel that it matches the trail he did with the		

students.		
Jakob ends up evaluating the story asking students if they were satisfied with their own explanations	Students are generally satisfied. The rat-group who only wrote two lines thought they got off the hook too easy though!	If the students do not feel that they live up to what the story asks but are rewarded after all they feel a bit disappointed.
		Afterward Jakob says that the trial is really good for creating a conflict and a common enemy, which is important in every good story. He also says that on a long term he believes that the story is good for the students as a way to remember what they have learned. Even if they do leave the story every now and then during the teaching. He says that when he wants students to remember a certain program or content he quit often use the story as reference in order for him to

		make students remember what they have learned. It is a way of triggering the students' memory.
10.03., 2011, interviews		

Appendix C

Interview guide for students

Introduction: Hi, take some juice and some cookies, and make sure that you are comfortable and are sitting in a way where you can see me. We have to do four small exercises the next half an hour.

Getting students to talk:

1. Let's begin with a little chat. If each of you should tell me your thoughts about this sense-material what would it be?
    a. Do you agree with each other?
    b. What was good/bad?

Exploring if students use the story as a reference

2. Let's try a different exercise, where you tell me what you know about the senses. I will write everything you know down on this piece of paper until it is full or you cannot think of anymore. You can say anything about the senses that you can think of.
    a. What is the difference between human and animal senses?
    b. Do you know more now than before? What?

Introduction to talking about the story as a tool for learning

3. OK, let's talk about the story. Can you help each other tell me the story about *The Emperor*?
    a. How did it begin?
    b. What did that mean to you?
    c. What happened then?

Discussing the use of the story at the science centre (and the pre- and postactivities at school)

4. Finally we have to discuss what happened at Experimentarium. Can you tell me what you did to help the animals and *The Emperor*?
    a. How did you collect knowledge about the senses
    b. Were any of the exhibits particularly good? Why?

Interview guide for teachers

- Do you have some opening comments?
- How do you think students received the material?
- Did you see a change in students' behavior? At school, at Experimentarium?
- What expectations do you have in relation to how much students remember after this?
- Have the students learned more or less compared other courses? How does it vary?
- What shortcomings there were in the material?
- Does it mean anything having to spend time on the story in order to introduce science to students?
- What do you think worked particularly well in the material?
- Did the outcome of the activity vary amongst students?
- Did it affect student's collaboration?
- Did you experience that students used the story as a reference?
- How does the fact that students are engaged in a learning activity influence their comprehension of the story?

Interview guide for interview with teachers one month later

First and foremost I would like you to think about the "Emperor Who Only Believed His Own Eyes" and write down three strengths and three weaknesses. You can also write other things essential for the process.

Next, I will ask you to do the same again but this time on a metalevel. This means that I will ask you to consider how the presence of the story influence teaching and learning. What are three strengths and three weaknesses of using stories in education generally?

In addition, I will ask you speak to your students about how they remember *The Emperor Who Only Believed His Own Eyes.* You have all used the material in slightly different ways, so I will ask you to follow the guidelines below, but also ask questions that you find natural to ask I ´n relation to this material. I want you to ask students:

- What they remember of the story? Do they remember the storyline, *The Emperor* or the animals they defended?
- What do they remember having learned about the senses? Can they remember the overall objectives of the story or do they mainly remember their own animals' sense, do they remember the learning process or the academic objectives?
- How do they look back on the process of working with a story? Is it easier to remember, was it more fun than other classes, was it more difficult, did they feel more focused and in control, was it meaningful to use a story in "nature and technology," what strengths and weaknesses did they see in using a story?

Appendix D

The SENSES material

The following pages show the booklet containing the story-based learning activity for *The Emperor* who only believed his own eyes. Each page has an English translation next to it. The translation is done in Google Translate.

Introduction to SENSES

The senses of the body are fascinating tools that have helped humans survive through generations. They are constantly at work sending a constant stream of information: The traffic lights changes color to red. A friend calls. A kiss on the cheek. A scent of flowers.

Is there a sixth sense, a seventh or an eighth?
Your students may know the five senses: vision, hearing, smell, taste, and touch. But human senses detect only a tiny fraction of the information from our surroundings. Many animals experience parts of the world that are unavailable to human perception. Sharks have a sense that marks tiny electric fields in order to catch its prey. A pigeon feel Earth's magnetic field by an internal compass to find their way.

Our skin can sense touch, heat, and cold. But if we study the skin under a microscope different receptors detect touch, heat or cold. One kind of receptors detects heat and cold and another kind detects touch. In many animals, these receptors are located in their sensory system. Cats' whiskers detect such touch, but they do not register when something is hot. And some snakes have special heat sensory organs, similar to human eyes. Even you and I sense the world differently! Human senses have great individual differences in sensitivity.

What do your students experience in the exhibition?
The exhibition SENSES is about how animals and humans sense the world and how the senses fit our needs and helps us to survive. The exhibition is divided into eight areas with more than forty activities. The exhibits examine the sense of vision, hearing, smell, taste, hot/cold and touch along with the two more exotic senses: magnetic sense and sense electrodes. Students can also test their own senses and compare them with animal senses.

School visits in the exhibition SENSES

The exhibition SENSES is directed at students from the first grade to the sixth grade. A visit is particularly relevant in the course nature/technology or Danish. The exhibition is interactive and well suited to create independent involvement in a subject area. It emphasises bodily experiences and disseminates factual

knowledge in ways that lie outside the traditional school environment. However, the exhibition has limited space for reflection. You can add this through your teaching.

This booklet is made in order to give you an overview of the exhibition and to plan a good visit. Use it when it is meaningful to you and your teaching and add on other materials and activities you find suitable for your class. For further inspiration on planning and conducting a field trip to an informal learning environment, you can visit www.experimentarium.dk/education

Possible learning objectives are:

- Students become aware of their own senses
- Students acquire factual knowledge about the senses
- Students become acquainted with the difference between "thinking" and "knowing" something
- Students learn to plan and conduct an investigation on their own
- Students are trained in discussing and formulating natural science arguments

Teaching SENSES

The booklet contains inspiration for a lesson you can choose to use. The lessons are all linked by the tale of *The Emperor Who Believed His Own Eyes*. The story should help students consider their use of the exhibition and the scientific content in it. It has been constructed to train students to do inquiries and make scientific arguments of their knowledge and experience in front of you and their classmates.

In the tale, we meet the angry Emperor of the land of senses. One day he gets into a fight with his dog, as it claims to be able to smell a bone buried in the park. *The Emperor* cannot smell the bone, and therefore believes the dog is lying, so he cuts off its nose and sends it to jail. But soon *The Emperor* learns that all the

animals in the Land of Senses claim to sense something different than he can. *The Emperor* puts them all in prison and robs them of their senses.

Mulige læringsmål for et besøg

- **Eleverne bliver bevidste om deres egne sanser.**
- **Eleverne tilegner sig faktuel viden om sanserne.**
- **Eleverne stifter bekendtskab med forskellen på at "tro" og "vide" noget.**
- **Eleverne træner at gennemføre en undersøgelse af egne arbejdsspørgsmål.**
- **Eleverne træner at diskutere og formulere naturfaglige argumenter.**
- **Eleverne træner at bruge talesproget i samtale, samarbejde og diskussion.**

På skolebesøg i Sanser

Sanser henvender sig til elever i 1. til 6. klasse. Et besøg er særlig relevant i fagene natur/teknik eller dansk. Udstillingen er interaktiv og velegnet til at skabe selvstændighed og engagement i et fagområde. Den kan give kropslige oplevelser og formidle faktuel viden på en måde, der ligger uden for skolens traditionelle rammer. Udstillingen giver til gengæld begrænset plads til refleksion. Det kan du tilføre gennem din undervisning.

Hæftet her er lavet, så du kan danne dig et overblik over udstillingen og planlægge et godt besøg. Brug dét, som giver mening for dig i din undervisning, og supplér med andre tilgængelige materialer og aktiviteter, der passer til din klasse. Hvis du vil have yderligere inspiration til, hvordan du kan planlægge og gennemføre ekskursion til et uformelt læringsmiljø, så kan Experimentariums besøgsguide anbefales. Den finder du på www.experimentarium.dk/undervisning.

Undervisningsforløb til Sanser

Hæftet indeholder inspiration til et undervisningsforløb, som du kan vælge at bruge. Det er bundet sammen af eventyret om **Kejseren, der troede sine egne øjne**. Historien skal hjælpe eleverne til at overveje deres brug af udstillingen og tænke over det faglige indhold. Undervisningsforløbet er derfor bygget op, så eleverne trænes i at undersøge et arbejdsspørgsmål. Efter besøget kan de argumentere for deres viden og erfaring foran klassen.

Rammehistorien

I eventyret møder vi den hidsige Kejser af Sanselandet. En dag bliver han uvenner med sin hund, fordi den påstår, at den kan lugte et kødben, der ligger begravet i slotsparken. Det kan Kejseren ikke lugte! Så hunden må jo lyve! Og derfor hugger Kejseren næsen af hunden og sætter den i fængsel. Snart erfarer Kejseren, at alle dyrene i Sanselandet påstår, de kan sanse noget andet, end han kan. Kejseren sætter derfor dem alle i fængsel og frarøver dem deres sanser.

Introduktion til Sanser **3**

That is the meaning for the course. Now it is up to the students to help the animals in the land of senses by convincing *The Emperor*

that they are not lying, but simply experiencing the world differently than him. To solve the task, students explore how human and animal senses work, and they must use the insight to formulate arguments to convince *The Emperor*. The task is solved both in the classroom and during a visit to Experimentarium. The frame story is to help engage students, guide them through tasks, and give them some mental hooks they can hang their new experiences and knowledge on. As a teacher you can even take a role in the story. The animals send letters to the students in your class via a "carrier pigeon" who delivers them to you. Maybe you even know the pigeon.

OVERVIEW

Here is an overview of what the three-part teaching material about *The Emperor Who Believed His Own Eyes* covers. You and your class can use it before, during and after the visit of the exhibition SENSES at Experimentarium.

Before the visit (three to four lessons)

- Students are introduced to the story of *The Emperor Who Believed His Own Eyes*. Students have to relate to their own senses, animal senses and as to why the Emperor and the animals sense the world differently. They get the opportunity to articulate their experiences and knowledge on the senses.
- Students prepare to work on their assignment questions during the visit at Experimentarium

At Experimentarium (min. two lessons)

- Students work in groups to answer their assignment questions at Experimentarium.

After the visit (three lessons)

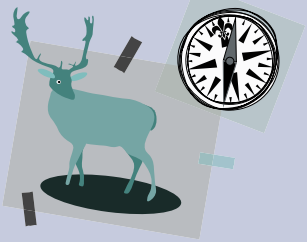
- Students pick up on the studies they have done in relation to their assignment issues and formulate arguments as to

why the Emperor, and the animals experience the world differently.

- The story is rounded up.

Dét er anslaget til undervisningsforløbet. Nu er det elevernes opgave at hjælpe dyrene i Sanselandet med at overbevise Kejseren om, at de ikke lyver, men blot oplever verden anderledes end ham. For at løse den opgave må eleverne undersøge, hvordan menneskers og dyrs sanser virker, og de må bruge den indsigt til at formulere argumenter, der kan overbevise Kejseren. Opgaven løser eleverne både hjemme i klassen og på besøget på Experimentarium.

Indholdsfortegnelse



Rammehistorien skal engagere eleverne, guide dem gennem opgaverne og give dem nogle mentale kroge, de kan hænge deres nye erfaringer og viden på. Som lærer kan du selv tage en rolle i historien. Dyrene sender breve til eleverne i din klasse via "en brevdue", som afleverer dem til dig. Måske kender du ligefrem duen ...

Oversigt over undervisningsforløbet

Her er en oversigt over undervisningsforløbet, om **Kejseren der troede sine egne øjne**. Det har tre dele. Du og din klasse kan bruge det før, under og efter besøget i udstillingen Sanser på Experimentarium.

Før Experimentarium - Sanseløs
Varighed: 3-4 lektioner

- Eleverne indføres i historien om **Kejseren der troede sine egne øjne**.
- Eleverne skal forholde sig til deres egne sanser, dyrs sanser, og hvorfor kejseren og dyrene sanser verden forskelligt. De får mulighed for at italesætte deres erfaringer og viden om sanserne.
- Eleverne forbereder sig til at arbejde med deres arbejdsspørgsmål under besøget på Experimentarium.

På Experimentarium - Kejserens laboratorium
Varighed: mindst 2 lektioner

- Eleverne arbejder i grupper med at besvare deres arbejdsspørgsmål på Experimentarium.

Efter besøget - Retssagen
Varighed: 3 lektioner

- Eleverne samler op på de undersøgelser, de har lavet.
- De formulerer argumenter for, hvorfor Kejseren og dyrene oplever verden forskelligt.
- Historien afrundes.

4

Introduction to the exhibition

SIGHT

This page shows what the students can see in the exhibition area on the perception of sight

- In *the berry picker*, the students compete to see how good they are at distinguishing colors as their color vision is weakened because the light is weaker.
- In *color shift*, the students examine how colors change when they change the composition of red, green and blue light.
- They can play *nectar hunter* and gather nectar with and without UV vision. And they can learn more about the UV light's properties in "Can you see UV?" and "UV patterns in nature."
- Students are challenged in the *infrared mase*, where only the gold fish's infrared vision can see the road. In infrared graffiti, the students make graffiti using remote controls and mobile phones.
- The *eye gallery* shows various animal eyes.
- Finally, the students get an artistic experience in *sense light*.

Facts about sight

Humans and animals use sight to find their way, choosing the right food, spotting prey and predators, etc. Most animals have eyes similar to humans. But some primitive animals, such as flatworms have photosensitive cells, which sit in bottom of a cavity, forming a so-called primitive mind. Insects have compound eyes made up of thousands of small simple eyes, each with one sensory cell. Visual sense senses light as electromagnetic waves. In the retina the light is detected into two kinds of sensory cells—the rods and cones. Rods are sensitive to very faint amount of light and cones are sensitive to the wavelength of light—

meaning the color of the light. Humans have three types of cones that detect different colors. Cats have only one type of cone and therefore cannot distinguish colors. Dogs have two types of cones and probably see the world in shades of grey. Some animals, such as the bee have four types of cones. Different wavelengths also affect what different animals are able to see. Bees see light in the ultraviolet spectra at short wavelengths, which humans cannot perceive. Some fish that live in muddy water can see long-wave light in the infrared spectra, which we cannot see either. The long wavelengths of light penetrate better through the murky water.

Aktiviteter **Her er en gennemgang af, hvad eleverne kan opleve i SE-området:**

I Bærplukker kan eleverne konkurrere om, hvor gode de er til at skelne farver, når deres farvesyn svækkes, fordi lyset bliver svagere.

I Farveskifter undersøger eleverne, hvordan farver ændrer sig, når de ændrer sammensætningen af rødt, grønt og blåt lys.

De kan spille **Nektarjæger** og samle nektar med og uden UV-syn. Og de kan lære mere om UV-lysets egenskaber i **Kan du se UV?** og **UV-mønstre i naturen**.

Eleverne udfordres i **Den infrarøde labyrint,** hvor kun guldfiskens infrarøde syn kan se vejen. **I Infrarød graffiti** laver eleverne graffiti med fjernbetjeninger og mobiltelefoner.

Øjegalleriet viser eksempler på, hvor forskellige dyrs øjne kan være.

Endelig får eleverne en kunstnerisk oplevelse omsluttet af lys i **Sans Lyset**.

Se

Fakta Mennesker og dyr bruger synet til at finde vej, vælge den rigtige føde, spotte bytte- og rovdyr m.m. De fleste dyr har øjne, som minder om menneskets. Men nogle primitive dyr såsom fladorme har lysfølsomme celler, der sidder i bunden af et hulrum og danner et såkaldt primitivt øje. Insekter har facetøjne, der består af tusindvis af små enkeltøjne, hver med en sansecelle.

Synssansen sanser lys, som er elektromagnetiske bølger. På nethinden registreres lyset i to slags sanseceller, stave og tappe. Stave er følsomme for helt svage lysmængder, og tappe er følsomme for bølgelængden af lyset - altså lysets farve. Mennesker har tre typer tappe, der registrerer forskellige farver. Katte har kun én type tappe og kan derfor ikke skelne farver. Hunde har to typer tappe og ser formentlig verden i gråtoner. Nogle dyr, fx bien, har hele fire typer af tappe. Der er også forskel på, hvilke bølgelængder forskellige dyr ser. Bier ser fx lys i det ultraviolette spekter med korte bølgelængder, som vi mennesker ikke kan opfatte. Nogle fisk, der lever i mudret vand, ser langbølget lys i det infrarøde spekter, som vi heller ikke kan se. De lange bølgelængder af lys trænger bedre igennem det grumsede vand.

Gennemgang af udstillingen **5**

HEARING

This page shows what the students can see in the exhibition area on the perception of hearing

- In *Superhearer*, students can measure which frequencies they are able to hear and compare it to animals.

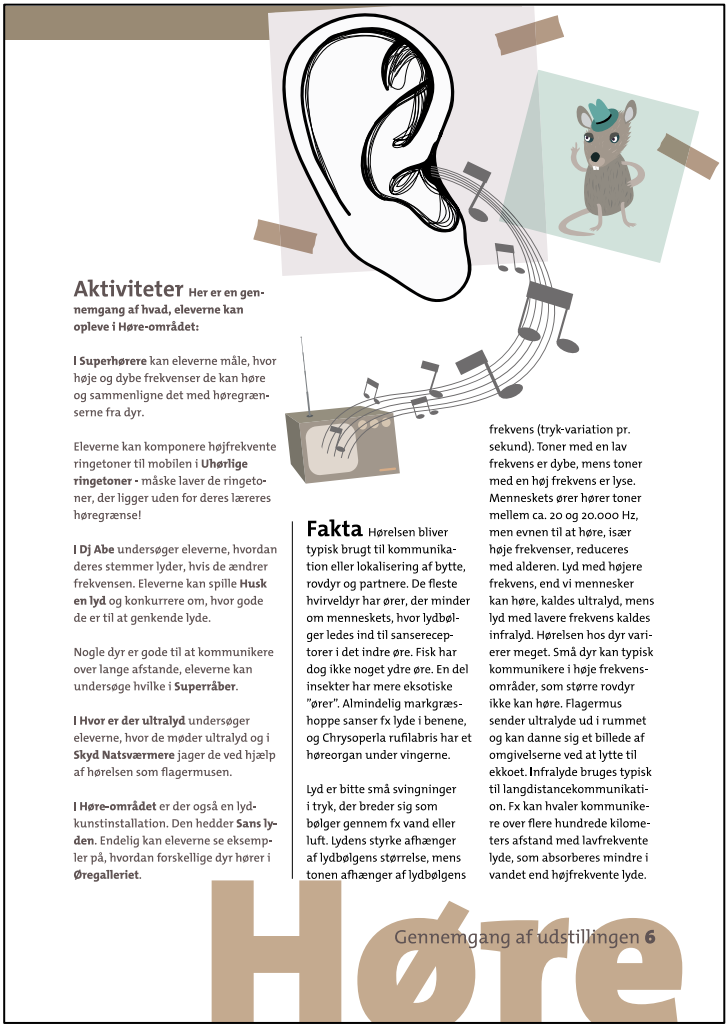
- Students can compose high-frequency ring tones for the mobile phone in *ring tones inaudible*—even ones beyond their teachers hearing limit!
- In *DJ Monkey*, the students examine how their voices sound if they change the frequency.
- Students can find animals that are good at communicating over long distance in the *Superyeller*.
- In *Ultrasound*, students shoot moths by using the hearing of bats.
- *Sense the Sound* is also a sound-art installation.
- Finally, students can see examples of ears in the *Ear Gallery*.

Facts about hearing

Hearing is typically used for communication or detection of prey, predators and partners. Most vertebrates have ears that are similar to humans, where sound waves are directed into the sensory receptors in the inner ear. Fish have no outer ears. Some insects have more exotic "ears." Common field grasshopper sense sounds in their legs and *Chrysoperla rufilabris* has a hearing organ under its wings. Sound is tiny fluctuations in pressure that spreads out like waves through, e.g., water or air. The strength of the sound depends on the sound wave sise, while the tone depends on the sound wave frequency (pressure variations per second). Tones with a low frequency are deep, while the tones with a high frequency are bright. Human ears hear tones between approximately, 20 Hz and, 20,000 Hz, and the ability to hear, especially high frequencies decreases with age. Sound with a frequency greater than we humans can hear is called ultrasound while the sound with lower frequencies is called infrasound.

Hearing in animals varies widely. Small animals can typically communicate at high frequencies, which larger predators cannot hear. Bats send ultrasounds into space and can form a picture of their surroundings by listening to echoes. Infrasound is typically

used for long distance communications. For example, whales communicate over several hundred kilometres with low frequency sounds that are less absorbed in the water than high-frequency sounds.



Aktiviteter

Her er en gennemgang af hvad, eleverne kan opleve i Høre-området:

I **Superhørere** kan eleverne måle, hvor høje og dybe frekvenser de kan høre og sammenligne det med høregrænserne fra dyr.

Eleverne kan komponere højfrekvente ringetoner til mobilen i **Uhørlige ringetoner** - måske laver de ringetoner, der ligger uden for deres læreres høregrænse!

I **Dj Abe** undersøger eleverne, hvordan deres stemmer lyder, hvis de ændrer frekvensen. Eleverne kan spille **Husk en lyd** og konkurrere om, hvor gode de er til at genkende lyde.

Nogle dyr er gode til at kommunikere over lange afstande, eleverne kan undersøge hvilke i **Superråber**.

I **Hvor er der ultralyd** undersøger eleverne, hvor de møder ultralyd og i **Skyd Natsværmere** jager de ved hjælp af hørelsen som flagermusen.

I **Høre-området** er der også en lydkunstinstallation. Den hedder **Sans lyden**. Endelig kan eleverne se eksempler på, hvordan forskellige dyr hører i **Øregalleriet**.

Fakta

Hørelsen bliver typisk brugt til kommunikation eller lokalisering af bytte, rovdyr og partnere. De fleste hvirveldyr har ører, der minder om menneskets, hvor lydbølger ledes ind til sanseceptorer i det indre øre. Fisk har dog ikke noget ydre øre. En del insekter har mere eksotiske "ører". Almindelig markgræshoppe sanser fx lyde i benene, og Chrysoperla rufilabris har et høreorgan under vingerne.

Lyd er bitte små svingninger i tryk, der breder sig som bølger gennem fx vand eller luft. Lydens styrke afhænger af lydbølgens størrelse, mens tonen afhænger af lydbølgens frekvens (tryk-variation pr. sekund). Toner med en lav frekvens er dybe, mens toner med en høj frekvens er lyse. Menneskets ører hører toner mellem ca. 20 og 20.000 Hz, men evnen til at høre, især høje frekvenser, reduceres med alderen. Lyd med højere frekvens, end vi mennesker kan høre, kaldes ultralyd, mens lyd med lavere frekvens kaldes infralyd. Hørelsen hos dyr varierer meget. Små dyr kan typisk kommunikere i høje frekvensområder, som større rovdyr ikke kan høre. Flagermus sender ultralyde ud i rummet og kan danne sig et billede af omgivelserne ved at lytte til ekkoet. Infralyde bruges typisk til langdistancekommunikation. Fx kan hvaler kommunikere over flere hundrede kilometers afstand med lavfrekvente lyde, som absorberes mindre i vandet end højfrekvente lyde.

Høre

Gennemgang af udstillingen **6**

SMELL

This page shows what the students can experience in the exhibit area on the perception of smelling

- In the *Smell Your Way*, students can investigate how good they are at smelling their way to food and hazards.
- They can test how small concentrations of cannabis they can smell in *How Little Can You Smell*? How good are they compared to a trained police dog?
- In *Can You Smell the Flower***,** students get answers to whether they are genetically predisposed to being able to smell the flower Freesia.
- Our language is very limited when it comes to describing smells, but in *Name a Scent*, the students will try it.
- In *Can You Find Smells* the students compete about how good they are at identifying individual odors in a mixture of scents.
- Finally, students can see examples of different animal noses in the *Nose Gallery***.**

Facts on smell

Smelling helps us identify food and poisonous food, warns us of danger from predators, fire, or toxic gases. It helps us communicate and find a partner. Odor impressions are processed in the limbic system of the brain that also plays a major role in the experience of emotions. Therefore, odors evoke strong emotions and memories. It is far from all animals in which the smelling sense is located in the nose. Many insects have odor receptors located on the antennae, while snakes smell by catching scent particles with its tongue and leading them up to the smelling receptors in its palate.

Odors are typically organic molecules. The human nose has about forty million scent receptors distributed on 400 different types of receptors. The human brain can distinguish 10,000 different smells because they activate different combinations of receptors. Yet the

human smelling sense is not very sensitive compared to many animals. Some dogs have up to 220 million scent receptors. This means that they can distinguish between several scents and can detect much less odor concentrations. However the smelling senses of most animals do in principle work the same way as humans'.

Aktiviteter **Her er en gennemgang af, hvad eleverne kan opleve i Lugte-området:**

Eleverne kan undersøge, hvor gode de er til at lugte sig frem til mad og farer i **Lugt dig frem**.

De kan teste, hvor små koncentrationer af hash de kan lugte i **Hvor lidt kan du lugte?** Hvor gode er de mon, sammenlignet med en trænet politihund?

I Kan du lugte blomsten? får eleverne svar på, om de er genetisk disponeret for at kunne lugte blomsten Fresia.

Vores sprog er meget begrænset, når det gælder om at beskrive lugte, men i **Navngiv en duft** skal eleverne prøve det.

I Kan du finde lugtene konkurrerer eleverne om, hvor gode de er til at identificere de enkelte lugte i en miks-tur af dufte.

Endelig kan eleverne se eksempler på forskellige dyrs næser i **Næsegalleriet**.

Fakta Lugtesansen hjælper med at identificere føde og giftig mad, advarer mod fare fra rovdyr, brand eller giftige gasser. Den hjælper os med at kommunikere og finde partnere. Lugtindtryk bliver behandlet i det limbiske system i hjernen, som også spiller en stor rolle i oplevelsen af følelser. Derfor kan lugte vække stærke følelser og erindringer. Det er langt fra alle dyr, hvor lugtesansen er placeret i en næse. Mange insekter har fx lugtreceptorer placeret på antennerne, mens slanger lugter ved at fange duftpartikler med tungen og føre dem op til duftreceptorer i ganen.

Lugte er typisk organiske molekyler. I menneskets næse er der omkring 40 mill. lugtreceptorer fordelt på 400 forskellige typer af receptorer. Menneskets hjerne kan skelne 10.000 forskellige dufte, fordi de aktiverer forskellige kombinationer af receptorerne. Alligevel er menneskets lugtesans ikke særlig fintfølende sammenlignet med mange dyrs. Nogle hunde har fx op til 220 mill. duftreceptorer. Det betyder, at de kan skelne mellem flere dufte og kan registrere langt mindre duftkoncentrationer. De fleste dyrs lugtesans fungerer dog principielt som menneskets.

Lugte

Gennemgang af udstillingen 7

TASTE

This page shows what the students can experience in the exhibit area on the perception of tasting:

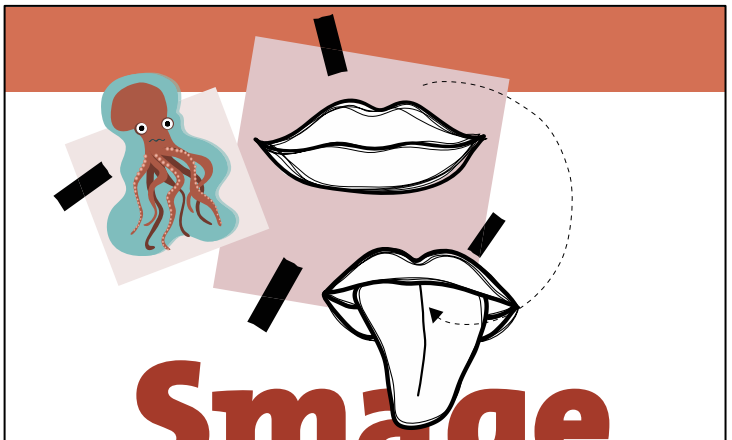
- In *The Taste Area* students can explore how the tongue is able to taste sour, sweet, salty, bitter, and umami taste in *The Five Flavors*.
- They examine whether they can recognise flavors as vanilla and cinnamon, if they cannot smell anything *smell a taste.*
- They can also locate their own taste buds in the *find the taste buds* and examine whether they are *supertaster***s** with a drop of the bitter substance PTC that not everyone is able to taste.
- Finally, students can see examples of how different animals perceive taste in the *Tongue Gallery*.

Facts about taste

The sense of taste helps us choose nutritious foods and warn us against toxic food. Taste is detected in taste buds in the palate and tongue. The receptors can distinguish between five different flavors: sour, salty, sweet, bitter, and umami. Most mammals have taste buds in the mouth, but many insects, such as flies, have taste buds on the antennae and legs. Cephalopods have taste buds on the suction cups on their arms so they can taste their food just by sticking an arm out.

Taste is typically water soluble, so if the tongue is completely dry, it's hard to taste anything. Although we only have five basic tastes, we can get many flavor impressions. This is due to the fact that the taste experience is influenced by the body's other senses as the food's color and odor. The tongue also has a volume of temperature and sensory receptors, and therefore temperature and texture has a great influence on our tasting experience. Not all animals can taste all five basic tastes. For example, cat food consists primarily of meat, and therefore it does not need to be able to taste sweet. Many animals also use the tongue to other

things than to taste. For example, the dog uses it to secrete heat, and many reptiles and amphibians can use it to catch insects.



Smage

Aktiviteter

Her er en gennemgang af, hvad eleverne kan opleve i Smage-området:

I Smags-området kan eleverne undersøge, hvor på tungen de kan smage surt, sødt, salt, bittert og umami i **De 5 smage**.

De undersøger, om de kan genkende smagsindtryk som vanilje og kanel, hvis de ikke kan dufte noget i **Lugt en smag**.

De kan også lokalisere deres egne smagsløg i **Find smagsløgene**.

Endelig kan eleverne se eksempler på, hvordan forskellige dyr opfatter smag i **Tungegalleriet**.

Fakta

Smagssansen hjælper os med at vælge næringsrig mad og advarer os mod giftig mad. Smage registreres i smagsløg i ganen og på tungen. Receptorerne kan skelne mellem fem forskellige smage: surt, salt, sødt, bittert og umami. De fleste pattedyr har smagsløg i munden, men mange insekter, fx fluer, har smagsløg på antennerne og benene. Blæksprutter har smagsløg på sugekopperne på deres arme, så de kan smage deres mad blot ved at stikke en arm ud.

Smage er typisk vandopløselige, så hvis tungen er helt tør, er det svært at smage noget. Selvom vi kun har fem grundsmage, kan vi godt få mange smagsindtryk. Det skyldes, at smagsoplevelsen påvirkes af kroppens andre sanser, som madens farve og lugt. Tungen har desuden en mængde temperatur- og følereceptorer, og derfor betyder temperatur og konsistens også meget for vores smagsoplevelse. Det er ikke alle dyr, der kan smage alle fem grundsmage. Fx består kattens mad primært af kød, og derfor har den ikke behov for at kunne smage sødt. Mange dyr bruger også tungen til andre ting end at smage. Fx bruger hunden den til at udskille varme, og mange reptiler og padder kan bruge den til at fange insekter.

Gennemgang af udstillingen **8**

TOUCH

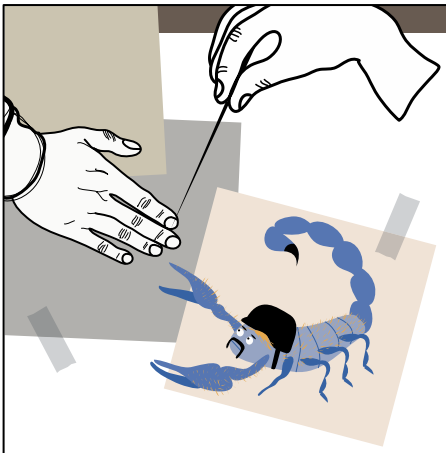
This page shows what the students can experience in the exhibit area on the perception of touch:

- In *Superfeeler*, students examine where they are most sensitive to touch.
- In *Feel Your Way***,** they can test how difficult it is to recognise shapes by touch.
- In addition, students can explore the connection between emotions and touch in *Touch and Feel*.
- Finally, students can see examples of what the feeling organs look like on various animals in *Touch Gallery*.

Facts about touch

Our sense of touch helps us find food, recognise and use things in our surroundings and communicate with each other through touch. Our skin is filled with about half a million touch receptors. The receptors are not evenly distributed, so some areas are more sensitive than others. Man's most sensitive areas are the hands, face, lips, tongue, and neck. The middle piece of the back is the least sensitive.

There are five kinds of receptors that detect various kinds of touch, such as hard pressure, light pressure, prolonged pressure and stretch. Even hair cells detect when we are touched. Some receptors adapt quickly to touch. That is why you do not constantly feel that you have your clothes on. Many animals have special sense organs. For example, cats have whiskers, which affect the pressure receptors in the nose when the hairs are touched. Many insects have feeling hair distributed on the body. Many fish, such as mackerels and salmons have a dedicated line system along the body. The side lines consists of pressure-sensitive nerves that can detect movements in the water around them. The star nosed mole has the most sensitive nose in the world with twenty-two tentacles, each with 25,000 receptors that help the mole find its prey in the dark underground passageways.



Aktiviteter **Her er en gennemgang af, hvad eleverne kan opleve i Føle-området:**

I Super-føler kan eleverne undersøge, hvor de er mest sensitive over for berøring.

I Føl dig frem kan de afprøve, hvor vanskeligt det er at genkende former med følesansen.

Desuden kan eleverne undersøge forbindelsen mellem følelser og berøring i **Rør og føl**.

Endelig kan eleverne se eksempler på, hvordan føleorganerne ser ud på forskellige dyr i **Følegalleriet**.

Fakta

Vores følesans hjælper os med at finde føde, genkende og anvende ting i vores omgivelser og kommunikere med hinanden gennem berøringer. Vores hud er fyldt med cirka en halv mill. trykfølsomme receptorer. Receptorerne er ikke jævnt fordelt, og derfor er nogle områder mere sensitive end andre. Menneskets mest følsomme områder er hænderne, ansigtet, læberne, tungen og nakken. Det midterste stykke af ryggen er mindst sensitivt.

Der findes fem slags receptorer, som registrerer forskel-lige former for berøring, såsom hårde tryk, lette tryk, langvarige tryk og stræk. Selv hårceller registrerer når vi bliver berørt. Nogle receptorer tilpasser sig hurtigt berøring. Det er derfor, man ikke hele tiden kan mærke, at man har sit tøj på. Mange dyr har specielle føleorganer. Fx har katte knurhår, som påvirker trykreceptorer i næsen, når hårene berøres. Mange insekter har følehår fordelt på kroppen. Mange fisk, fx makrel og laks, har et særligt linjesystem ned langs kroppen. Sidelinjen består af trykfølsomme nerver, der kan registrere bevægelser i vandet omkring dem. Den stjernenæsede muldvarp har den følsomste næse i verden. 22 tentakler med hver 25.000 receptorer hjælper muldvarpen med at finde sit bytte i de mørke underjordiske gange.

Føle

Gennemgang af udstillingen **9**

HOT/COLD

This page shows what the students can experience in the exhibit area on the perception of HOT/COLD.

- In the area of the heat/cold sense, students can meet a real live Royal Python.
- In *Snake Eyes*, they can go hunting for rats, by feeling their way to their heat. They can also get help from a heat sensitive camera, so they can "see" the rats' heat like the royal Python can.
- Some animals are very dependent on distinguishing small temperature differences, such as Mallee fowl. In *A Warm Nest* the students can test how good they are at that task.
- Finally, students can see examples of hot/cold sensory organs in different animals in the heat/cold gallery.

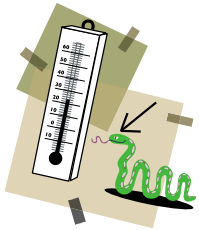
Facts about the heat/cold sense

Our heat/cold sense helps us maintain a steady body temperature through heat/cold receptors scattered throughout the body. Humans and other warm-blooded animals with a regular body temperature, generally have difficulty distinguishing differences in temperature between one degree and two degrees. An exception is the vampire bat that has a small fold on the nose with heat sensors, in order for it to find the veins on its prey more easily. We sense no temperature differences, which are close to our own skin temperature of thirty-one to thirty-five degrees. But if we notice that something is warmer or colder than our own body, either our heat or cold receptors are activated.

Ectothermic animals like fish, reptiles and amphibians do not have a solid body temperature. It depends on ambient temperatures. They are therefore more sensitive to temperature changes and are more dependent on their warm-cold sense than warm-blooded animals. Some of them have special heat-sensing organs, such as butterflies that have heat receptors on the tips of their wings, which tell them when it has become too hot to be in

the sun. Some snakes have small cavities on the head with heat receptors that detect heat emissions from their prey.

Varme/kulde



Aktiviteter

Her er en gennemgang af, hvad eleverne kan opleve i Varme/Kulde-området:

I Slangeøjne kan de gå på jagt efter rotter ved at mærke sig frem til deres varme. De kan også få hjælp af et varmefølsomt kamera, så de kan "se" rotternes varme ligesom Kongepytonen.

Nogle dyr er meget afhængige af, at kunne skelne små temperaturforskelle fx Mallee-høne. **I En lun rede** kan eleverne teste, hvor gode de er til den opgave.

I Varme/Kulde-området kan eleverne også møde en ægte levende **Kongepyton**.

Endelig kan eleverne se eksempler på varme/kulde-sanseorganet hos forskellige dyr i **Varme/Kulde-galleriet**.

Fakta

Vores varme/kulde-sans hjælper os med at holde en fast kropstemperatur, gennem varme/kulde-receptorerne spredt ud over hele kroppen.

Mennesker og andre varmblodede dyr med en fast kropstemperatur har generelt svært ved at skelne temperaturforskelle mellem 1-2 grader. En undtagelse er Vampyrflagermusen, der har en lille fold på næsen med varme-sensorer, så den lettere kan finde blodårerne på sit bytte. Vi sanser heller ikke temperaturforskelle, som er tæt på vores egen huds temperatur på 31-35 grader. Men mærker vi, at noget er varmere eller koldere end vores egen krop, aktiveres enten varme- eller kulde-receptorer.

Vekselvarme dyr som fisk , krybdyr og padder har ikke en fast kropstemperatur. Den afhænger af omgivelsernes temperatur. De er derfor mere sensitive over for temperaturskift og er mere afhængige af deres varme/kulde-sans end varmblodede dyr. Nogle af dem har særlige varmesansende organer - såsom sommerfugle, der har varmereceptorer på spidsen af deres vinger, som fortæller dem, hvornår der er blevet for varmt i solen. Nogle slanger har små hulrum på hovedet med varme-receptorer, der registrerer varmeudledning fra deres byttedyr.

MAGNETISM

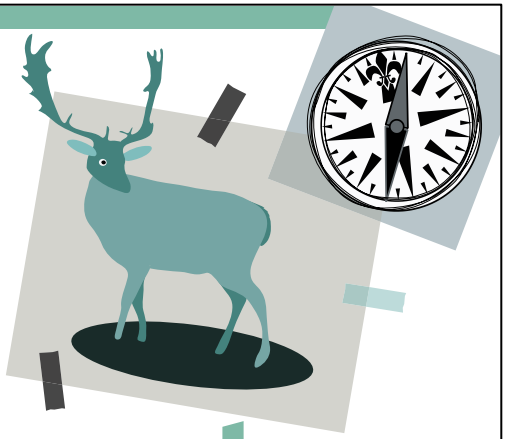
This page shows what the students can experience in the exhibit area on the perception of magnetism:

- In *Magnetogallery*, students can see examples of animals that have magnetic sense and they can see examples of research in cows' magnetic sense in *Magnetic cows*.
- Students can explore a magnetic field in *View the magnetic field*.
- Finally, they can test if they have a magnetic sense that helps them find North in *A Sense of North*.

Facts about the magnetic sense

There are many things science does not know or understand about the magnetic sense yet. This far it is known that the sense is used only for navigation, and it is still unsure whether humans can sense magnetic fields. Some animals can sense Earth's magnetic fields. It is believed that some animals have organs that contain a magnetic material, magnetite, but the exact mechanism is still unknown. It is possible that some animals navigate by a kind of magnetic map of variations in the Earth's magnetic field and magnetic materials in the mountains and rocks.

Even though the mechanisms behind the magnetic sense are not discovered yet, the magnetic sense has been registered in many animals. For example, it was discovered that the Robin, who is a migratory bird, have magnetite in their beaks and that magnetically sensitive reactions occurs in its eyes. It is also discovered that cows and deer always grase and sleep with their heads facing north. And leatherback turtles swim constantly to their breeding territory, whether they are placed in the water against the south or north of this area. Only under the influence of an artificial magnetic field they will swim in the wrong direction.



Magneto

Aktiviteter

Her er en gennemgang af, hvad eleverne kan opleve i Magneto-området:

I Magneto-galleri kan eleverne se eksempler på dyr, der har magnet-sans, og de kan se eksempler på forskning i køers magnet-sans i **Magnetiske køer**?

Eleverne kan undersøge et magnetisk felt i **Se det magnetiske felt**.

Endelig kan de **I Sans for Nord** prøve, om de selv har en magnetisk sans, der hjælper dem med at finde nord.

Fakta

Der er endnu mange ting naturvidenskaben ikke ved eller forstår omkring den magnetiske sans. Så vidt man ved, bruges sansen kun til navigation, og man er endnu usikker på, om mennesker kan sanse magnetiske felter. Visse dyr kan føle Jordens magnetfelter. Man mener, at nogle dyr har organer, der indeholder et magnetisk materiale magnetit, men man kender ikke den præcise mekanisme. Det er muligt, at visse dyr navigerer efter en slags magnetisk kort over forskelle i Jordens magnetfelt og i magnetiske materialer i bjerge og sten.

Selvom man endnu ikke kender mekanismerne bag den magnetiske sans, har man alligevel registreret sansen hos mange dyr. Fx har man fundet ud af, at Rødkælken, som er en trækfugl, har magnetit i næbbet, og at der sker magnetisk følsomme reaktioner i øjnene på den. Man har også opdaget, at køer og hjorte altid græsser og sover med hovedet vendt mod nord. Og Læderskildpadder svømmer altid mod deres yngleområde, uanset om de er sat i vandet mod syd eller nord for dette område. Kun under indflydelse af et kunstigt magnetfelt svømmer de i den forkerte retning.

ELECTRO

This page shows what the students can experience in the exhibit area on the perception of electro:

- In *electro-gallery,* the students can see pictures of animals that are able detect electrical signals.
- In the *Electric Fish,* they can see and hear the electrical signals from living electric fish that use the signals to navigate and communicate with.
- In the *Electricity in the Body*, the students can also measure their own bioelectricity.

Facts about the electric sense

People do not have an electric sense, but many animals have developed the sense for navigation, hunting, detecting predators, or to communicate with. Most animals with an electric sense are fish because water is better at conducting electrical signals than the air is. There are two kinds of electric senses: the passive and the active electric sense.

The passive electrical sense means that the animal can detect the electrical field that surrounds all living creatures. It is useful for finding prey when you cannot use sight. For example, rays are able to find prey that has been hiding under the sand with its electrical sense. The platypus closes its eyes, nose, and mouth when it dives and instead uses the electrical receptors on the beak to find its prey. The active electrical sense means that the animal can feel other animal's electric fields and also have special organs that can generate a stronger electric field. Disturbances in the electric field tell of another animal or object is nearby. Relatively weak signals are primarily used for navigation and communication. The elephant nose fish uses it to find a partner or find their way through muddy water. Strongly electric fish like the electric eels use electrical pulses to stun their prey.

Introduction to the learning activity

You can choose to use this material, during and after your visit to the exhibition SENSES. It is created as a story called *The Emperor Who Only Believed His Own Eyes*. Students must help the animals in the land of senses in order for the animals to get their senses back. The students must do this by

- gathering knowledge about the senses to the animals so they can explain to the Emperor how difficult it is to cope without a sense
- helping the animals find out why they and the Emperor perceive the world differently
- convincing the Emperor that the animals are not lying about how they experience the world

First part—Before going to Experimentarium (approx. four lessons)
In the first part of the program (before the visit Experimentarium)—the student activities are guided much by the story in order to motivate students into working with academic problems. Students work together in groups of three to five students. Through correspondence with the animals from the land of senses the students receive the mission, are introduced to the senses as a natural sciences subject, and prepare for their visit to Experimentarium. In the younger classes, each group will only work with one animal and one sense each. In the older classes, groups can explore several senses and complement their studies at Experimentarium with information from, e.g., Web, books, and experiments.

Learning objectives: In parts 1, 2, and 3, the goal is to raise the awareness of students about how the senses and the senses sense. In part 4, the learning goal to train students to prepare a study from a survey question.

First part: Read the first part of the story**.** You can find it on page 15 under the title *The Emperor Who Only Believed His Own Eyes*. The story explains how the animals in the land of senses have been thrown in jail and deprived of their senses by the Emperor. The Emperor was angry at the animals because they claim the world to be different than what the Emperor is experiencing. Animals ask students to help them get their senses back.

Task: Each group chose an animal to help and as a personal contact to the land of senses. The choice of animal determines the group's sense to become experts in. It is a good idea that the groups have different animals in order to get around all subjects and make the students feel that they are experts in their particular animal.

Gennemgang af undervisningsforløbet

Du kan vælge at bruge undervisningsforløbet her før, under og efter dit besøg i Sanser. Forløbet er bundet sammen af historien om Kejseren der troede sine egne øjne. Det har tre dele: Sanseløs, Kejserens laboratorium og Retssagen. I forløbet får eleverne en mission: De skal hjælpe dyrene i Sanselandet med, at få deres sanser tilbage. Det skal eleverne gøre ved at:

1. Samle viden om sanserne til dyrene, så de kan forklare Kejseren, hvor svært det er at klare sig uden en sans
2. Hjælpe dyrene med at finde ud af, hvorfor dyrene og Kejseren oplever verden forskelligt
3. Overbevise Kejseren om, at dyrene ikke lyver om, hvordan de oplever verden

Første del af undervisningsforløbet er styret meget af rammehistorien. Gennem en korrespondance med dyrene fra Sanselandet modtager eleverne missionen, introduceres til sanser som naturfagligt emne og forbereder deres besøg på Experimentarium.

Eleverne arbejder sammen i grupper på tre til fem elever. I de yngste klasser skal hver gruppe kun arbejde med ét dyr og én sans hver. I de ældre klasser kan grupperne undersøge flere sanser og supplere deres undersøgelser på Experimentarium med information fra fx web, bøger og eksperimenter.

Aktiviteter i klassen før besøget

1. Læs første del af historien.
Du finder den på side 15 under titlen **Kejseren der troede sine egne øjne**. Historien forklarer, hvordan dyrene i Sanselandet er blevet smidt i fængsel og frarøvet deres sanser af Kejseren. Han er blevet vred på dyrene, fordi de påstår, at verden er anderledes, end Kejseren oplever den. Dyrene beder eleverne om hjælp til at få deres sanser tilbage.

Opgave:
Hver gruppe vælger et dyr, de vil hjælpe, og som er deres personlige kontakt til Sanselandet. Valget af dyr bestemmer, hvilken sans gruppen bliver eksperter i. Det er en god idé, at grupperne har forskellige dyr, så I kommer rundt om emnet, og eleverne oplever at de bliver eksperter i netop deres dyr.

Følgende dyr og sanser hører sammen:
- **Bi og synssans**
- **Rotte og høresans**
- **Hund og lugtesans**
- **Blæksprutte og smagssans**
- **Skorpion og følesans**
- **Pyton-slangen og varme/kuldesans**

Gennemgang af undervisningsforløbet **13**

Før Experimentarium
Sanseløs

Varighed ca. 4 lektioner

Læringsmål
Aktivitet 1, 2 og 3 skal bevidstgøre eleverne om sansernes betydning og hvordan de sanser.
Aktivitet 4 skal træne eleverne i at formulere et undersøgelsesspørgsmål.

Second part: Give students the letter from the animals they are helping. The letters are on pages, 20–25, entitled, *My Conflict with the Emperor*. In the letter the animals thanks for the students' answers and describe their conflicts with the Emperor: the bee can see flower patterns the Emperor cannot see. The dog can smell bones, etc.

Task: The teams must describe for the animals, how it is to do without a sense. The animals will gather the students' responses and use them to convince the Emperor of how difficult it is to do without the senses, in order for him to give them back their senses. The task can be answered orally, in writing or via subscription. The students give you the answers as you promise to pass on to the carrier pigeon so the animals will get the letter.

Third part: Read the letter "Strange Worlds" out loud in the classroom. You'll find it on page 26. The letter tells the animals that the students' responses have made them wiser about how humans sense the world, but they dare not give the letters to the Emperor yet. They need more and stronger arguments. The animals ask the students to send a letter explaining the Emperor how the human world would be if they all lacked for example vision. Maybe it can get the Emperor to understand how the world is difficult and tedious if all animals and people are senseless.

Task: The questions from the animals are distributed to groups and are answered either orally in writing or via subscription. They can also be used to wonder about issues jointly philosophising in class for five to ten minutes.

Fourth part: Read the "Invitation to the Emperor's laboratory" out loud in the classroom from page 28. Here the animals invite students to the Emperor's laboratory, where the Emperor is in the process of investigating the senses of the animals. In the laboratory, students can explore issues on their own body and find

information to convince the Emperor that the animals are not lying. Then give students the assignment "Experiments in the Emperor's Laboratory" on page 29.

Task: The teams must plan their studies at Experimentarium. They must articulate what they already know, that may explain why their animals and the Emperor perceived the world differently. They must describe what they need to find out at the Experimentarium, and they must decide which activities in the Emperor's laboratory to work with and develop a timetable. You need to consider how students will collect information in the exhibition. Should they use pen and paper, a Dictaphone to confide their discoveries or use the camera in their mobile phones to photograph the things they need to remember?

2. Giv grupperne brevet fra det dyr, de hjælper.
Du finder brevene på side 20-25 under titlen **Min konflikt med Kejseren**. I brevene takker dyrene for elevernes svar og beskriver deres konflikter med Kejseren: Bien kan se mønstre i blomsterne, som Kejseren ikke kan se. Hunden kan lugte kødben, osv. Evt. skal du hjælpe eleverne med at læse brevet.

Opgave:
Grupperne skal beskrive for dyrene, hvordan det er at klare sig uden en sans. Dyrene vil samle elevernes svar og bruge det til at overbevise Kejseren om, hvor svært det er at klare sig uden sanser, så han giver dem deres sanser tilbage. Opgaven kan besvares mundtligt, skriftligt eller via tegning. Eleverne giver dig opgavebesvarelsen til sidst, som du lover at give videre til Brevduen, så dyrene kan få brevet.

3. Læs brevet Mærkværdige verdener højt.
Du finder det på side 26. I brevet fortæller dyrene, at elevernes svar har gjort dem klogere på, hvordan eleverne sanser verdenen, men de tør ikke give brevene til Kejseren endnu. De har brug for flere og stærkere argumenter. Dyrene beder grupperne om at sende dem et brev, der forklarer Kejseren, hvordan menneskenes verden ville se ud, hvis alle manglede fx synet. Måske kan det få Kejseren til at forstå, hvordan verden bliver besværlig og kedelig, hvis alle dyr og mennesker er sanseløse.

Opgave:
Dyrenes spørgsmål uddeles til grupperne og besvares mundtligt, skriftligt eller via tegning. De kan også bruges som undrespørgsmål, som klassen i fællesskab filosoferer over i 5-10 min.

4. Læs Invitation til Kejserens laboratorium højt.
Du finder det på side 28. Her inviterer dyrene eleverne til **Kejserens laboratorium**, hvor Kejseren er i gang med at undersøge alle de sanser, han har taget fra dyrene. I laboratoriet kan eleverne undersøge problemstillingerne på egen krop og finde oplysninger til at overbevise Kejseren om, at dyrene ikke lyver.
Giv dernæst grupperne opgaven **Eksperimenter i Kejserens laboratorium**, som du finder på side 29.

Opgave:
Grupperne skal planlægge deres undersøgelser på Experimentarium. De skal formulere, hvad de allerede ved, der kan forklare, hvorfor deres dyr og Kejseren oplever verden forskelligt. De skal beskrive, hvad de skal finde ud af på Experimentarium. Og de skal vælge, hvilke aktiviteter i Kejserens laboratorium de vil arbejde med samt lægge en tidsplan.

Du skal overveje, hvordan eleverne skal opsamle informationerne i udstillingen. Skal de bruge blyant og papir, kan de bruge en diktafon til at betro deres opdagelser, eller bruger de kameraet i deres mobiltelefoner til at fotografere de ting, de skal huske?

Oversigt over materialer til 1. del

- Kejseren der troede sine egne øjne s. 15
- Min konflikt med Kejseren s. 20-25
- Mærkværdige verdener s. 26
- Invitation til Kejserens laboratorium s. 28
- Eksperimenter i Kejserens laboratorium s. 29

Story: The Emperor who only believed his own eyes

Once upon a time there was a distant realm where the Emperor fell out with the animals that lived around his palace. It was not really because the Emperor was particularly evil or cruel, but he had difficulty understanding why others could experience the world differently than he. And he was not alone about this. In some way we all feel a little bit like that but the problem was that the Emperor had much power and a terrible temper.

Let me give an example. In front of one of the Emperor's windows there was a place without trees—and there was no flags in the place. Only a single stone statue depicting the Emperor himself. One of his minions said,

"If your highness goes out today then you should not wear your hat because the wind blows terribly and your hat will blow off."

"Nonsense!" said the Emperor. "I cannot see any wind."

"You cannot see the wind . . . ," the minion said carefully. "Maybe you can see it if it shakes a tree or grabs a flag. But the wind itself you cannot see, even though it is there."

And it was in such a situation that the Emperor would get furious. What you could not see, no one should claim to exist, and the poor minion would probably have lost his head had it not been for a servant running in to open the window. Now the Emperor could feel the wind rushing into the room.

"Kejseren der troede sine egne øjne" **15**

The servant pulled the curtains aside, and the Emperor could feel the cold against his skin—in fact, he could also smell the salty sea, which was quite far away . . . So the wind was strong that day. And immediately the Emperor was calmed. He nodded and said, "Yes, the wind is certainly blowing—I will leave the hat at home."

o

As soon as the Emperor's senses spoke to him, he was friendly and sociable. But he did not trust others and constantly feared that they would cheat him—and this was the worst thing he knew. This was why it all went wrong one day when he took a walk in his park and started chatting with his dog.

"Someone has buried a bone here . . . ," it said as they walked across the large lawn in front of the castle.

"Why do you think that?" the Emperor asked, surprised.

"I can smell it," the dog said.

The Emperor stopped, surprised, and breathed in as heavily he could. And when he could not smell anything, he breathed in again. But he still could not smell anything and therefore furiously asked the dog to take back his lie. But the dog kept on. It could smell that there was a bone buried. Now the Emperor was so furious about the assertiveness that he had the dog's nose cut off—and then the dog had to admit that it could no longer smell anything as the Emperor could not smell it.

And this case could very well have ended here, but the Emperor found it difficult to forget the episode. He began talking to other animals that lived in his kingdom and to his resentment he discovered that they were just as mendacious as the dog. They claimed either that they could see things that were invisible to the Emperor, smell things the Emperor could not smell or hear, feel, and sense things that the Emperor could not.

vinden suse ind i værelset. Den trak i gardinerne, og han kunne mærke kulden mod huden - faktisk kunne han også lugte det salte hav, der lå ganske langt væk ... så vinden var stærk den dag. Og straks blev Kejseren rolig, nikkede og sagde:

"Ja, det blæser sandelig - jeg lader hatten blive hjemme".

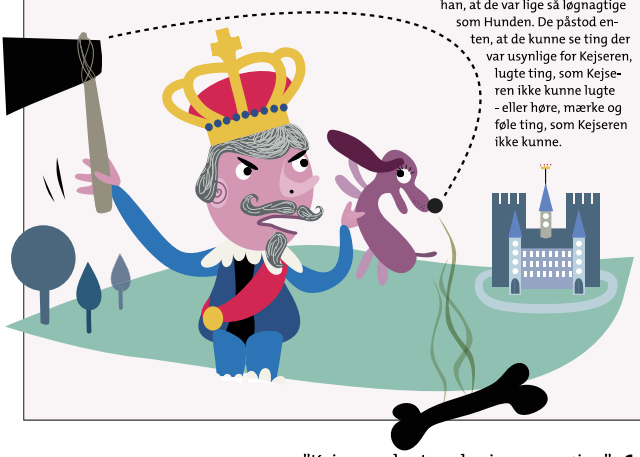
Så snart Kejserens sanser talte til ham, var han venlig og omgængelig. Men han stolede ikke på andre og frygtede konstant at man snød ham - og det var det værste, han vidste. Derfor gik det så galt en dag, hvor han gik rundt i sin park og faldt i snak med sin hund.

"Nogen har begravet et kødben her ..." sagde den, da de gik over den store græsplæne foran slottet.

"Hvorfor tror du det?" spurgte Kejseren overrasket.

"Det kan jeg da lugte!" sagde Hunden.

Kejseren standsede overrasket op og trak vejret så dybt ind, han kunne. Og da han ikke kunne lugte noget, åndede han ud og trak vejret igen. Men han kunne stadig ingenting lugte, og rasende bad han Hunden trække sin løgnehistorie tilbage. Men Hunden holdt på sit. Den kunne lugte, at der var begravet et kødben. Nu blev Kejseren så rasende over den påstålighed, at han lod Hundens næse hugge af - og herefter måtte Hunden indrømme, at den ikke længere kunne lugte noget, som Kejseren ikke kunne lugte.
Og her kunne sagen godt være endt, men Kejseren havde svært ved at glemme episoden. Han gav sig til tale med andre af de dyr, der boede i hans rige og til sin ærgrelse opdagede han, at de var lige så løgnagtige som Hunden. De påstod enten, at de kunne se ting der var usynlige for Kejseren, lugte ting, som Kejseren ikke kunne lugte - eller høre, mærke og føle ting, som Kejseren ikke kunne.



"Kejseren der troede sine egne øjne" **16**

The Emperor had only one choice, either to admit that the world consisted of things he could not perceive or to silence those who claimed that there was more things to sense than the Emperor could see, smell, hear, feel, or taste. The Emperor thought, "If I cannot perceive the world, how will I be able to govern it? I cannot decide what is true or false."

Therefore, he issued an order saying that no one could perceive more than the Emperor. Those who violated this would have their eyes gouged out, nose or ears cut off and be locked up in a tower chamber until they admitted that the world looked like the same as what the Emperor said. This was convenient because now there were no more people who walked their dogs. They suddenly think that the dog was worth more than them because it could smell something they could not. In the tower sat all the locked up rebellious animals, where they could think about their actions.

"It is terrible that we ended up in a kingdom where the Emperor is so cruel," said the pigeon while looking down over the lawn through the tower bars. It was longing to get out. The others nodded their heads sadly, but not the cat.

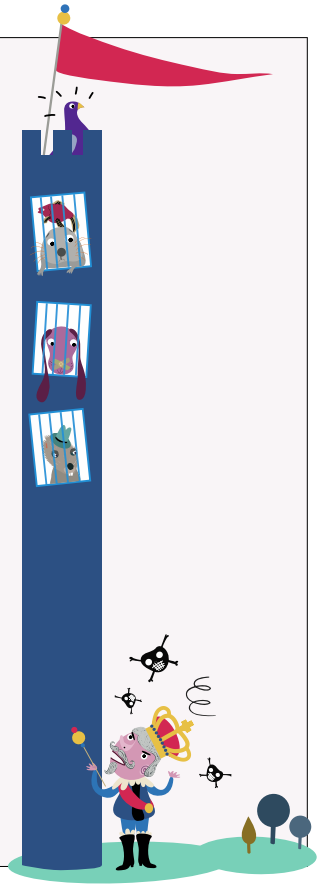
"I do not think he is that bad after all," it said, wriggling on the floor. The cat was one of the animals that had been so lucky to keep his eyes because it did not see more colors than the Emperor but on the contrary had been so modest that it only saw two colors. "I do not think he is cruel. He is just afraid of not knowing what is true and false in the world. Therefore he refuses to believe what he cannot sense . . . But personally I think it is possible to persuade him to see reason if one would just spend enough time and argue on why we are right . . ."

Kejseren havde kun ét valg - enten at indrømme verden bestod af ting, han ikke kunne opfatte, eller at lukke munden på dem der påstod, at der var mere at sanse, end det Kejseren kunne se, lugte, høre, føle eller smage. Og Kejseren tænkte, ***"hvis jeg ikke kan opfatte hele verden, hvordan skal jeg så kunne regere den? Jeg kan jo ikke afgøre, hvad der er sandt eller falskt".***

Derfor udstedte han et påbud om, at ingen måtte sanse mere end Kejseren. Og de der overtrådte det fik øjnene stukket ud, næsen eller ørene skåret af - og blev sat op i et tårnkammer til de indrømmede, at verden så ud, som Kejseren sagde. Og det var praktisk, for nu var der ikke nogen mennesker, der gik tur med deres hund - og pludselig synes, at hunden var mere værd end dem, fordi den kunne lugte noget, de ikke selv kunne lugte. Og i tårnet sad de oprørske dyr spærret inde og tænkte over tingene.

"Hvor er det forfærdeligt, at vi er endt i et rige, hvor Kejseren er så grusom", sagde Duen, mens den kiggede ned over græsplænen gennem tårnets tremmer. Den længtes sådan ud. De andre nikkede trist med hovedet, men ikke katten.

"Jeg tror slet ikke, han er så slem endda," sagde den og snoede sig på gulvet. Den var et af de dyr, der var så heldig at have beholdt sine øjne, fordi den ikke så flere farver med dem end Kejseren, men tværtimod havde været så beskeden, at den kun så to. ***"Jeg tror ikke, han er grusom, han er bare bange for ikke at vide, hvad der er sandt og falskt i verden. Derfor nægter han at tro på det, han ikke kan sanse ... Men personligt tror jeg godt, at man kunne tale ham til fornuft, hvis man bare ville bruge tid nok og argumentere for, hvorfor man havde ret ..."***



"Kejseren der troede sine egne øjne" **17**

"Maybe . . . ," the dog said thoughtfully. "As soon as I could not smell better than him he became friendly again. He did cut my nose off though, but after that he gave me a bone. Although now it does not taste quite as good as when I had a nose. To be totally honest I do not have the same pleasure in bones anymore."

Now a deer trudged out from the wall. “I have an idea,” it said. “Down at the edges of the park is a small school, where a lot of people come every morning. It’s the kind of people who are not so high yet.”

“They’re called children,” the cat interjected, who apparently knew everything that morning. “It is a kind of human kittens. They just yell louder, and they never learn to catch mice. They’re actually miserable at it.”

“Yes,” nodded the deer. “It fits nicely. But the Emperor listens to them because they are human beings and see the world the same way as he does, but they are less angry. I once asked them about what they learned in school. I was told that they learn to understand the world and find out what is true and what is a lie, and that is what the Emperor is so concerned about.”

“Could we get them to convince the Emperor that we animals are actually right? Maybe we can get our eyes and noses back. Maybe even be shut out of this tower,” mumbled the dog.

Therefore, the animals agreed to ask the children for advice, although they agreed that it would not be an easy case. It was the spider who finally found a hole that was large enough for the pigeon to get out of the tower room. And with a little letter around its foot the pigeon flew down toward the children’s school.

"Måske ...," sagde Hunden eftertænksomt ved siden af, ***" så snart jeg ikke kunne lugte bedre end ham - blev han venlig igen. Han skar godt nok snuden af mig, men siden gav han mig et kødben ... selvom det nu ikke smager helt så godt, som dengang, man havde en snude - skal jeg være helt ærligt, har jeg ikke den samme fornøjelse ved ben længere."***

Nu stavrede et rådyr ud fra væggen. ***"Jeg har en ide"*** sagde det. ***"Nede ved parkens udkant ligger en lille skole, hvor en masse mennesker kommer hver morgen. Det er den slags mennesker, der ikke er så høje endnu ..."***

"De hedder børn ..." indskød Katten, der åbenbart vidste alt den morgen. ***"Det er en slags menneske-killinger. De råber bare højere, og de lærer aldrig at fange mus - de er faktisk elendige til det ..."***

"Ja." Nikkede rådyret. ***"Det passer fint. Men Kejseren lytter til dem, fordi de er mennesker og ser verden på samme måde som Kejseren, men de er mindre hidsige. Jeg forhørte mig engang om, hvad de lærte inde i skolen. Og jeg fik at vide, at de lærer at forstå verden og finde ud af hvad der er sandt, og hvad der er løgn - og det ligger Kejseren meget på sinde..."***

"Kunne man få dem til at overbevise Kejseren om, at vi dyr faktisk har ret, så kunne vi måske få vores øjne og snuder tilbage - måske endda blive lukket ud af tårnet her..." Mumlede Hunden.

Derfor blev dyrene enige om, at spørge børnene om råd, selvom de var enige om, at det ikke ville blive en let sag. Det var Edderkoppen, der til sidst fandt et hul, der var stort nok til, at Brevduen kunne komme ud af tårnværelset. Og med et lille brev om foden fløj den ned mod børnenes skole.

"Kejseren der troede sine egne øjne" **18**

o

The animals' letters for help

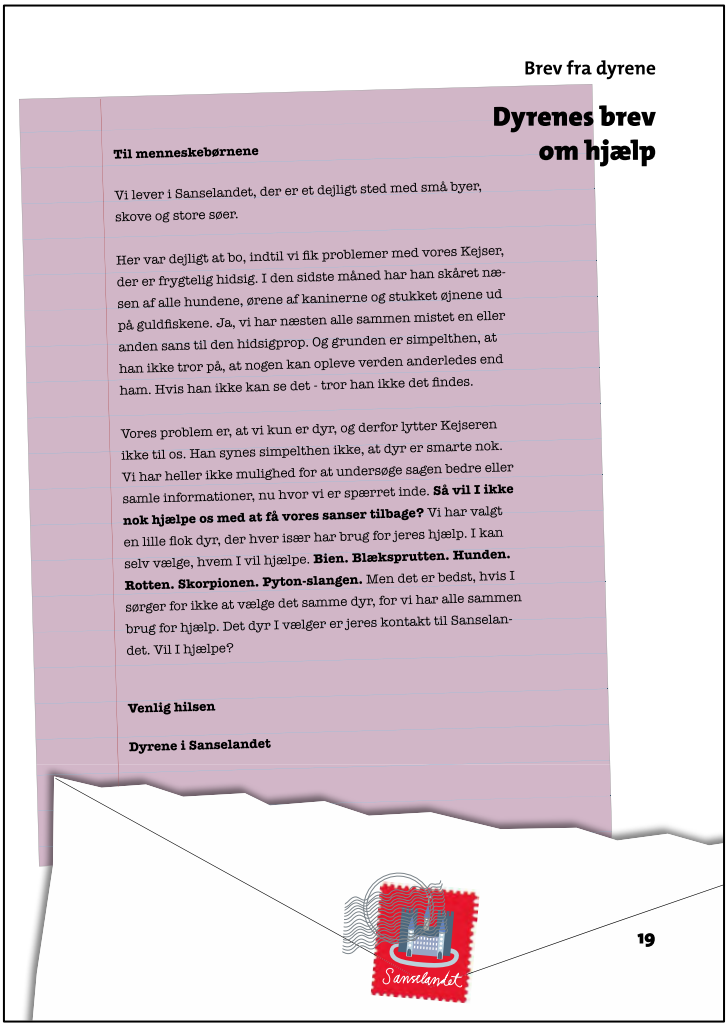
To the human children,

We live in the land of senses, which is a nice place with small towns, forests, and large lakes. It was nice place to stay until we got problems with our Emperor, who is terribly angry. In the last month, he cut the noses of all the dogs, the ears of the rabbits, and stung the eyes of the goldfish. Yes, we have lost almost all of our senses because of the heated plug. And the reason is simply that he does not believe that anyone can experience the world differently than him. If he cannot see it, he does not believe it exists.

Our problem is that we are only animals and therefore the Emperor will not listen to us. He simply does not like the fact that animals are smart enough. We have no alternative but to investigate or collect better information now that we are trapped. So will you please help us get our senses back? We have chosen a small group of animals, each of which need your help. You can even choose who you want to help. The bee. The octopus. The dog. The rat. The scorpion. The Python snake. But it is best if you care not to choose the same animal because we all need help. The animal you choose is your contact to the land of senses. Will you help?

Sincerely,

The animals in the land of senses



Brev fra dyrene

Dyrenes brev om hjælp

Til menneskebørnene

Vi lever i Sanselandet, der er et dejligt sted med små byer, skove og store søer.

Her var dejligt at bo, indtil vi fik problemer med vores Kejser, der er frygtelig hidsig. I den sidste måned har han skåret næsen af alle hundene, ørene af kaninerne og stukket øjnene ud på guldfiskene. Ja, vi har næsten alle sammen mistet en eller anden sans til den hidsigprop. Og grunden er simpelthen, at han ikke tror på, at nogen kan opleve verden anderledes end ham. Hvis han ikke kan se det - tror han ikke det findes.

Vores problem er, at vi kun er dyr, og derfor lytter Kejseren ikke til os. Han synes simpelthen ikke, at dyr er smarte nok. Vi har heller ikke mulighed for at undersøge sagen bedre eller samle informationer, nu hvor vi er spærret inde. **Så vil I ikke nok hjælpe os med at få vores sanser tilbage?** Vi har valgt en lille flok dyr, der hver især har brug for jeres hjælp. I kan selv vælge, hvem I vil hjælpe. **Bien. Blæksprutten. Hunden. Rotten. Skorpionen. Pyton-slangen.** Men det er bedst, hvis I sørger for ikke at vælge det samme dyr, for vi har alle sammen brug for hjælp. Det dyr I vælger er jeres kontakt til Sanselandet. Vil I hjælpe?

Venlig hilsen

Dyrene i Sanselandet

Sanselandet

19

o

Letter from the bee—my conflict with the Emperor

Oh, thanks for your good message, it is so nice to hear from you. I got help in writing this answer by the octopus because he still has his eyes. We must help each other for it is difficult to live without sight.

All the trouble I had with the Emperor began on a really nice summer day. The Emperor sat, and enjoying himself, on the grass while I was buzzing around and gathering honey.

"Hey, you're missing the flowers there," he said smiling and pointing at the yellow flowers, which stood close by him. I shook my head and laughed. "No, I do not. There is absolutely no nectar in them. They are completely empty, and I can tell that by the pattern" I said. But now the Emperor was angry and he said that everyone could see that the flowers do not have patterns.

"The filled flowers have a very clear pattern," I said and laughed again because I thought at first he made fun of me. But he did not and before I knew it, the Emperor had taken my eyes out.

Now I can no longer tell the difference between the filled and empty flowers. Actually I cannot see anything. The Emperor has put me in the tower, and here he will have me stay. But I simply do not understand why he cannot see the pattern! I wonder what the difference between my eyes and the Emperor's eyes is?

I do not think the Emperor knows how serious it is to lose your sense of vision. But you are human. Can you help me by explaining to the Emperor how difficult it is to succeed in the world without sight? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Sincerely, the bee

Brev fra Bien

Min konflikt med Kejseren

Åh tak for jeres gode besked, det er så dejligt at høre fra jer. Jeg har fået hjælp til at skrive svaret her af blæksprutten, den har nemlig stadigvæk sine øjne. Vi må hjælpe hinanden, for det er svært at leve uden at kunne se.

Al den ballade, jeg fik med Kejseren, startede i virkeligheden på en rigtig dejlig sommerdag. Kejseren sad og hyggede sig i græsset, mens jeg summede rundt og samlede honning.

"Hov, du mangler blomsterne der", sagde han smilende og pegede på de gule blomster, der stod helt tæt ved ham. Jeg rystede på hovedet og lo. "Nej, jeg gør da ej. Der er slet ikke nogen nektar i dem. De er helt tomme, det kan man se på mønsteret," sagde jeg. Men nu blev Kejseren sur, og han sagde, at enhver da kunne se, at blomsterne var helt uden mønster.

"De fyldte blomster har da et helt tydeligt mønster!" sagde jeg og lo igen, for jeg troede først, han gjorde grin med mig. Men det gjorde han ikke, og inden jeg vidste af det, havde Kejseren taget mine øjne.

Nu kan jeg ikke længere se forskel på de fyldte og de tomme blomster. Faktisk kan jeg ikke se noget som helst. Og Kejseren har sat mig op i tårnet, og her vil han altså lade mig sidde. Men jeg forstår simpelthen ikke, hvorfor han ikke kan se det mønster! Hvad er mon forskellen på mine øjne og Kejserens øjne?

Jeg tror ikke Kejseren ved, hvor alvorligt det er at miste sin synssans. Men I er jo mennesker. Kan I hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verdenen uden synet? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

☺ Kh Bien

Hjælp mig med at få mine øjne igen

Til: de søde børn

Bien

20

o

Letter from the rat—my conflict with the Emperor

Hello. I have got the carrier pigeon to smuggle a letter out to you without the Emperor noticing it. You must speak low when you talk about me as the Emperor has spies everywhere.

I lost my ears in an early morning when I was coming home from my night job. The Emperor had just woken up and stood on the balcony, where he enjoyed the birdsong, while the sun rose. When he saw me, he asked me to stop and listen to the beautiful birdsong.

"I would love to," I replied. "But unfortunately I must hurry home to my kids. They are calling me." The Emperor tilted his head and listened, but he heard nothing. "Are you sure that it is not a poor excuse for getting home quickly to bed?" he asked.

And then I said that even the guinea pigs, who lived upstairs above the rat hole, complained about the noise from my kids. That made the Emperor angry. "Should such a small squeaking guinea pig hear better than the country's Emperor!" He shouted. For he himself thought that he had a great hearing. But I kept my opinion, and before I got to see it, he had cut my ears off me and had me sent up in the tower for lèse-majesté.

But why cannot he hear the same things as I do? And why is it that I can clearly hear the babies' screams when people cannot hear it?

I do not think the Emperor knows how serious it is to lose your sense of hearing. But you are human. Can you help me by explaining to the Emperor how difficult it is to succeed in the world without hearing? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Sincerely, the rat

Brev fra Rotten

Min konflikt med Kejseren

Hej

Jeg har fået Brevduen til at smugle et brev ud til jer, uden Kejseren har opdaget det. I skal tale lavt, når I snakker om mig, for Kejseren har spioner alle vegne.

Jeg mistede mine ører en tidlig morgen, hvor jeg var på vej hjem fra mit natarbejde. Kejseren var lige vågnet og stod på altanen, hvor han nød fuglesangen, mens solen stod op. Da han så mig, bad han mig stoppe og lytte til den smukke fuglesang.

"Det ville jeg frygtelig gerne," svarede jeg. "Men jeg må desværre skynde mig hjem til mine unger. De kalder på mig." Kejseren lagde hovedet på skrå og lyttede, men han kunne ingenting høre. "Er du sikker på, at det ikke er en dårlig undskyldning for at komme hurtigt hjem i seng?" spurgte han.

Og så var det, jeg sagde, at selv det marsvin, der boede oven på rottehullet, klagede over støjen fra mine unger. Og det gjorde Kejseren vred; "skulle sådan et lille knirkende marsvin høre bedre end landets Kejser!" råbte han. For han synes selv, at han havde en fantastisk hørelse. Men jeg holdt på mit, og før jeg fik set mig om, havde han skåret ørene af mig og fået mig sendt mig op i tårnet for majestætsfornærmelse.

Men hvorfor kan han ikke høre de samme ting som mig! Og hvordan kan det være, at jeg tydeligt kan høre ungerne skrige, uden at mennesker kan høre det?

Jeg tror ikke, Kejseren ved, hvor alvorligt det er at miste sin høresans. Men I er jo mennesker. Kan I hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verden uden hørelsen? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

(-: Rotten

Hjælp mig med at få mine ører igen!

TOPHEMMELIGT

Rotten

21

o

Letter from the dog—my conflict with the Emperor

Hello.

How nice of you to help me. I have heard that the kids in your school are the very smartest in the country, so the Emperor must believe you. The sense of smell is hard to live without. I am not at all like a real dog without it. I know that the Emperor still have my nose stuck in the basement. I wish I could get it back again one day.

You have already heard how it went the day I said to the Emperor that I could smell that a bone was buried in the park. So the sad story is no reason to tell again. But it is not just me who miss my nose now. My poor friend, the pig, also misses his nose and is sitting here in the tower with me. We talk a lot about how it could be that there is such a big difference between how the Emperor and many other animals can use their nose to smell different things.

How can it be that I can smell better than humans?

I do not think that the Emperor knows how serious it is to lose your sense of smell. But you are human. Can you write him a letter that can help me to explain to the Emperor how difficult it is to succeed in the world without being able to smell? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Sincerely, the dog

Brev fra Hunden

Min konflikt med Kejseren

Hej medjer

Hvor er det pænt af jer, at I vil hjælpe mig. Jeg har hørt, at børnene på jeres skole, er de allerklogeste i landet, så jer må Kejseren da tro på. Lugtesansen er svær at leve uden, jeg føler mig slet ikke som en rigtig hund uden den. Og jeg ved, at Kejseren stadig har min snude hængende i kælderen. Bare jeg kunne få den tilbage igen en dag.

I har jo allerede hørt, hvordan det gik mig den dag, jeg sagde til Kejseren, at jeg kunne lugte, der var begravet et kødben i parken. Så den triste historie er der ikke grund til at fortælle igen. Men det er ikke kun mig, der savner min snude nu - min stakkels ven grisen savner også sin tryne og sidder her i tårnet sammen med mig. Vi snakker meget om, hvordan det kan være, der er så stor forskel på, hvordan Kejseren og mange andre dyr kan bruge deres næse lugte til forskellige ting.

Hvordan kan det være, at jeg kan lugte bedre end mennesker?

Jeg tror ikke Kejseren ved, hvor alvorligt det er at miste sin lugtesans. Men I er jo mennesker. Kan I skrive et brev, der kan hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verden uden at kunne lugte? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

Kærlig hilsen

☹ Hunden

Hjælp mig med at få min snude igen

Til: de dygtige børn

Hundepost

22

o

Letter from the octopus—my conflict with the Emperor

Dear all,

Many thanks for your message. I was not expecting that you would answer such an old octopus. You tend to see things a little dark without being able to taste. I am sitting here in a small tub of water, at the top of the tower longing back to when I could taste everything.

It all started on a dreary and cold day when the Emperor was in a terribly bad mood. He had gathered us animals for a little entertainment. So the mice were running around in their little wheels, and the parrot told stories. But nothing helped. The Emperor was still in a bad mood. So he shouted to the kitchen, he would have his favorite cake. The cooks made a big effort to make this. Shortly after, there stood the loveliest apple pie with cinnamon on the Emperor's bed. He tasted it. "Boring . . . ," he said. "There is no fullness of flavor. It's rubbish."

"But, Your Majesty," said the cook, "the cake is made by the book. Just ask the octopus!" I reached out one of my arms and laid it on the cake and agreed with the cook. It WAS a good cake. But the Emperor was furious and said that I could not speak of this without having placed the cake in my mouth. Then he cut off my arms, threw me into a bucket and sent me up the tower.

Why does he not think you can taste a cake by putting the arm on it! How do you people taste things?

I do not think the Emperor knows how serious it is to lose your sense of taste. But you are human. Can you help me by explaining the Emperor how difficult it is to succeed in the world without being able to taste? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Sincerely, the octopus

Brev fra Blæksprutten

Min konflikt med Kejseren

Kære alle sammen

Mange tak for jeres besked. Jeg havde ikke ventet, at I ville svare sådan en gammel blæksprutte. Man kommer let til at se lidt sort på alting uden smagssansen. Jeg sidder her i en lille balje vand øverst i fangetårnet og længes tilbage til dengang, jeg kunne smage alting.

Det hele startede en trist og kold dag, hvor Kejseren var i frygteligt dårligt humør. Han havde samlet os dyr for at få lidt underholdning. Så musene løb rundt i deres lille hjul, og papegøjen fortalte historier. Men ingenting hjalp. Kejseren var stadig i dårligt humør. Så han råbte til køkkenet, at han ville have sin yndlingskage. Og kokkene gjorde sig frygteligt umage. Kort efter stod der den dejligste æblekage med kanel på Kejserens seng. Han smagte på den. "Kedeligt ..." sagde han, "der er ingen fylde i smagen. Det er noget bras."

"Men deres majestæt," sagde kokken. "Kagen er lavet efter alle kunstens regler. Bare spørg blæksprutten!" Jeg rakte en af mine arme ud og lagde den på kagen og gav kokken ret. Det VAR en god kage. Men Kejseren blev rasende og sagde, at det kunne jeg ikke udtale mig om, uden at have puttet kagen i munden. Og så huggede han mine arme af, smed mig ned i en spand og sendte mig op i tårnet. Hvorfor synes han ikke, man kan smage en kage ved at lægge armen på den? Hvordan smager I mennesker tingene?

Jeg tror ikke, Kejseren ved, hvor alvorligt det er at miste sin smagssans. Men I er jo mennesker. Kan I hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verden, uden at kunne smage? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

Kærlig hilsen

Blæksprutten

Til børnene
- hvis det ikke er til besvær

23

o

Letter from the scorpion—my conflict with the Emperor

OK. You want to help. Then you must explain to the Emperor how difficult it is to cope without that part of the sense of touch you use to touch things with. The Emperor has taken some of my sense of touch a week ago when his barber trimmed me bald. It all started when the Emperor came by and said, "Good morning!" Unfortunately I could not really hear this because an ant stomped by me simultaneously, so I apologised and said that I had not hear what he said.

"Is your hearing bad?" he asked. I do not think it was. It was just because the ant walked by.

"Are you saying that you could hear the ant stomp?" He asked irritably.

I said that I could definitely not. "But I can feel it in my hair!"

"You can feel it in your hair!" cried the Emperor because he thought I played cheeky. And then he sent for the imperial barber to remove everything I had of feeling hair on the body before they shut me up in the tower.

But I do not even understand how the Emperor can cope without feeling hair! How are you people then able to sense touch?

I do not think the Emperor knows how serious it is to lose your sense of touch. But you are human. Can you help me by explaining the Emperor how difficult it is to succeed in the world without the sense of touch? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Sincerely, the scorpion

Brev fra Skorpionen

Min konflikt med Kejseren

OK. I vil hjælpe. Så må I forklare ham Kejseren, hvor svært det er at klare sig uden den del af følesansen, man mærker berøringer med. Kejseren har nemlig taget noget af min følesans for en uge siden, da hans barber klippede mig pilskaldet.

Det startede, da Kejseren kom forbi og sagde godmorgen! Desværre fik jeg ikke rigtigt hørt det, fordi der samtidigt trampede en myre forbi mig. Så jeg undskyldte og sagde, at jeg ikke havde hørt, hvad han sagde.

"Er din hørelse dårlig?" spurgte han. Og det synes jeg ikke, den var. Det var bare fordi myren gik forbi.

"Vil du påstå, at du kunne høre myren trampe?" spurgte han irriteret.

Og jeg sagde, at det kunne jeg bestemt ikke – **"men jeg kan mærke det i håret."**

"Du kan mærke det i håret!" råbte Kejseren, for han troede, jeg spillede fræk. Og så sendte han bud efter den Kejserlige barber, der fjernede alt, hvad jeg havde af følehår på kroppen, før de spærrede mig inde i tårnet.

Men jeg forstår ikke engang, hvordan Kejseren kan klare sig uden følehår! Hvordan bærer I mennesker jer så ad med at mærke berøringer?

Jeg tror ikke, Kejseren ved, hvor alvorligt det er at miste sin følesans. Men I er jo mennesker. Kan I hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verden uden følesansen? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

Skorpionen

Hjælp mig med at få mine følehår igen!!

24

o

Letter from the snake—my conflict with the Emperor

Dear children,

It was great to hear from you. I tried to write to you earlier today, but the carrier pigeon lost the letter because it got nervous when I put the letter on its legs. It cannot get used to being so close to a snake, but we promised each other that we would keep the peace until the whole problem with the Emperor is done.

My problem with the Emperor began one evening just before he went to sleep. He had called me because he could not find the cat. He asked me to do the cat's work, namely, make sure to catch the rats that could be in his bedroom.

The cat used to lie and wait and look into every rat hole. But I thought it was awkward because I do not see nearly as good as the cat does. So I just crawled across the floor and immediately I knew which hole I had to look into to find the rats. But now the Emperor would know how I could be so sure.

"I can sense it," I said. "It is warmer where the rats are sitting."

"What!" said the Emperor. "You cannot sense the heat on long distance. You can feel the heat. Everyone knows that!"

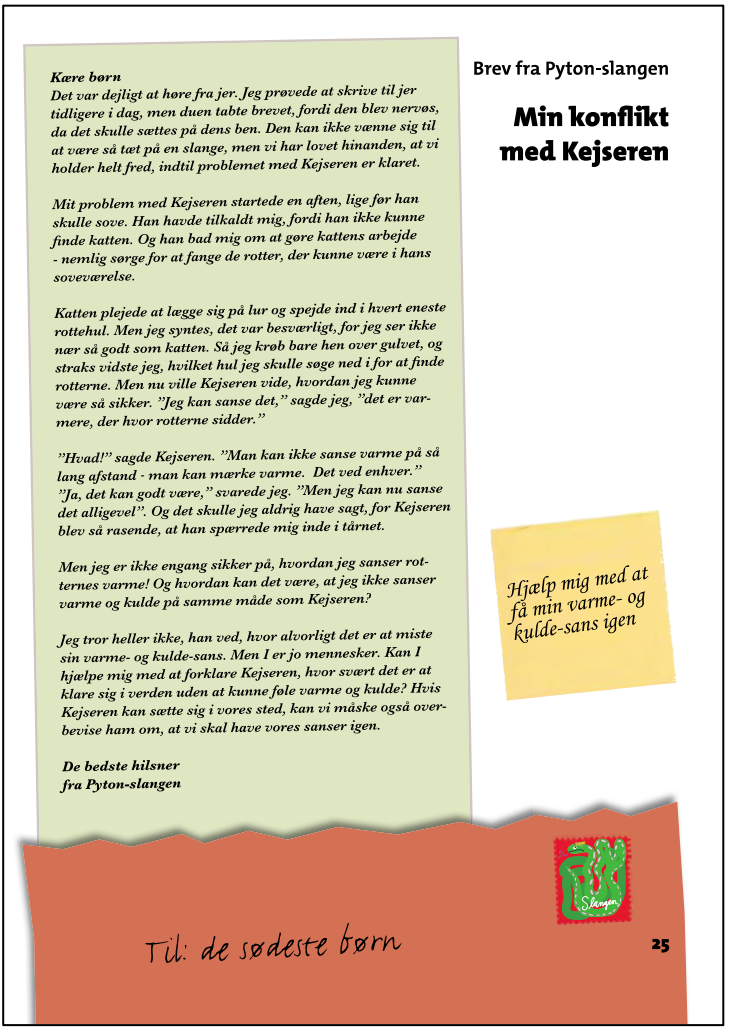
"Yes, that may be true," I replied. "But I can still perceive it anyway." I should never have said that because the Emperor got so enraged that he shut me up in the tower. But I'm not even sure how I sense rats' heat! And how can it be that I do not sense heat and cold the same way the Emperor does it?

I do not think he knows how serious it is to lose your heat and cold sense. But you are human. Can you help me by explaining the Emperor how difficult it is to succeed in the world without

being able to feel heat and cold? If the Emperor can put himself in our position, we might also convince him that we can have our senses back.

Best regards,

from the Python snake



Brev fra Pyton-slangen

Min konflikt med Kejseren

Kære børn
Det var dejligt at høre fra jer. Jeg prøvede at skrive til jer tidligere i dag, men duen tabte brevet, fordi den blev nervøs, da det skulle sættes på dens ben. Den kan ikke vænne sig til at være så tæt på en slange, men vi har lovet hinanden, at vi holder helt fred, indtil problemet med Kejseren er klaret.

Mit problem med Kejseren startede en aften, lige før han skulle sove. Han havde tilkaldt mig, fordi han ikke kunne finde katten. Og han bad mig om at gøre kattens arbejde - nemlig sørge for at fange de rotter, der kunne være i hans soveværelse.

Katten plejede at lægge sig på lur og spejde ind i hvert eneste rottehul. Men jeg syntes, det var besværligt, for jeg ser ikke nær så godt som katten. Så jeg krøb bare hen over gulvet, og straks vidste jeg, hvilket hul jeg skulle søge ned i for at finde rotterne. Men nu ville Kejseren vide, hvordan jeg kunne være så sikker. "Jeg kan sanse det," sagde jeg, "det er varmere, der hvor rotterne sidder."

"Hvad!" sagde Kejseren. "Man kan ikke sanse varme på så lang afstand - man kan mærke varme. Det ved enhver." "Ja, det kan godt være," svarede jeg. "Men jeg kan nu sanse det alligevel". Og det skulle jeg aldrig have sagt, for Kejseren blev så rasende, at han spærrede mig inde i tårnet.

Men jeg er ikke engang sikker på, hvordan jeg sanser rotternes varme! Og hvordan kan det være, at jeg ikke sanser varme og kulde på samme måde som Kejseren?

Jeg tror heller ikke, han ved, hvor alvorligt det er at miste sin varme- og kulde-sans. Men I er jo mennesker. Kan I hjælpe mig med at forklare Kejseren, hvor svært det er at klare sig i verden uden at kunne føle varme og kulde? Hvis Kejseren kan sætte sig i vores sted, kan vi måske også overbevise ham om, at vi skal have vores sanser igen.

De bedste hilsner
fra Pyton-slangen

Hjælp mig med at få min varme- og kulde-sans igen

Til: de sødeste børn

25

Strange worlds

Dear children,

Thank you so much for your letters. We have learned very much about the senses, thanks to you. The entire floor of the tower is

filled with your letters. It has been a little hard to get everyone to read them because some of us could not see it and others could not hear it, but we helped each other. And it has removed some of the sad mood in the tower.

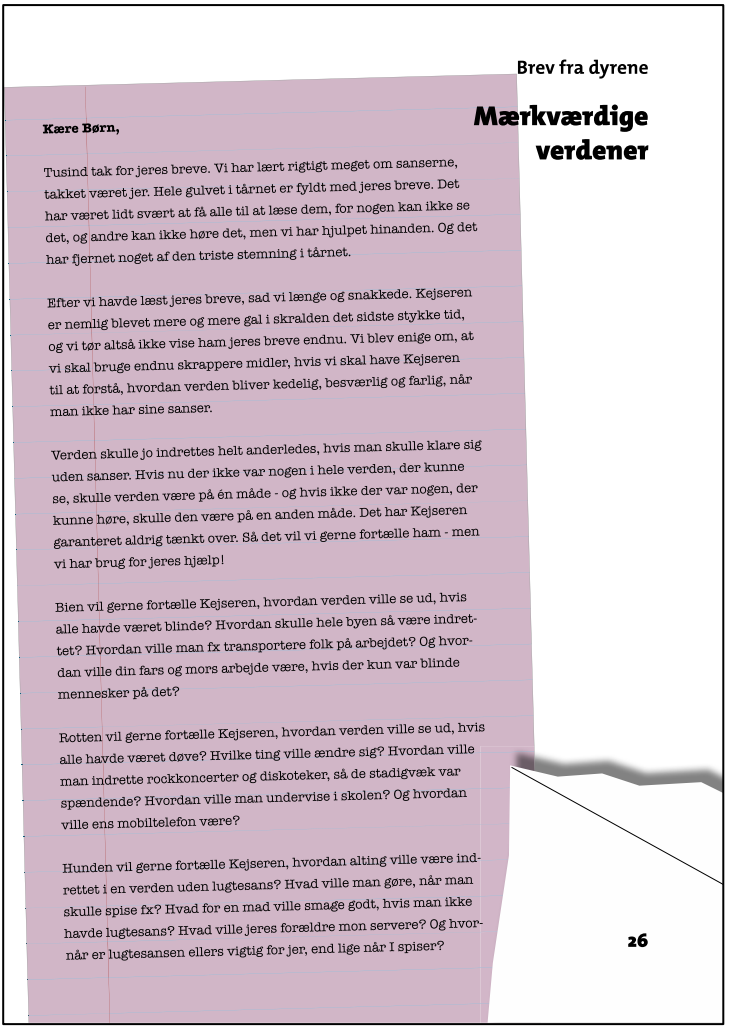
After we had read your letters we sat for a while and talked. The Emperor is in fact becoming more and more mad and we dare not show him your letters yet. We agreed that we need even tougher finds if we are to have the Emperor understand how the world is boring, difficult, and dangerous when one does not have its senses.

The world had to be completely rearranged if you had to cope without senses. If there was no one in the world who could see, the world would be one way; and if there was no one who could hear, it should be in a different way. The Emperor has never thought about this. So we would like you to tell him. We need your help.

The bee wants to tell the Emperor what the world would look like if everyone had been blind? How would the whole city then be arranged? How would, for example, people go to work? And how would your father and mother's work be if there were only blind people on it?

The rat would like to tell the Emperor what the world would look like if everyone had been deaf? What things would change? How would you organise rock concerts and discos, so they were still exciting? How would you teach in school? And how would your mobile phone be?

The dog would like to tell the Emperor what everything would be like in a world without smell? What would you do if you had to eat for example? What kind of food would taste good if you could not smell it? What would your parents serve? And when else is the sense of smell important to you, other than when you eat?



Brev fra dyrene

Mærkværdige verdener

Kære Børn,

Tusind tak for jeres breve. Vi har lært rigtigt meget om sanserne, takket været jer. Hele gulvet i tårnet er fyldt med jeres breve. Det har været lidt svært at få alle til at læse dem, for nogen kan ikke se det, og andre kan ikke høre det, men vi har hjulpet hinanden. Og det har fjernet noget af den triste stemning i tårnet.

Efter vi havde læst jeres breve, sad vi længe og snakkede. Kejseren er nemlig blevet mere og mere gal i skralden det sidste stykke tid, og vi tør altså ikke vise ham jeres breve endnu. Vi blev enige om, at vi skal bruge endnu skrappere midler, hvis vi skal have Kejseren til at forstå, hvordan verden bliver kedelig, besværlig og farlig, når man ikke har sine sanser.

Verden skulle jo indrettes helt anderledes, hvis man skulle klare sig uden sanser. Hvis nu der ikke var nogen i hele verden, der kunne se, skulle verden være på én måde - og hvis ikke der var nogen, der kunne høre, skulle den være på en anden måde. Det har Kejseren garanteret aldrig tænkt over. Så det vil vi gerne fortælle ham - men vi har brug for jeres hjælp!

Bien vil gerne fortælle Kejseren, hvordan verden ville se ud, hvis alle havde været blinde? Hvordan skulle hele byen så være indrettet? Hvordan ville man fx transportere folk på arbejdet? Og hvordan ville din fars og mors arbejde være, hvis der kun var blinde mennesker på det?

Rotten vil gerne fortælle Kejseren, hvordan verden ville se ud, hvis alle havde været døve? Hvilke ting ville ændre sig? Hvordan ville man indrette rockkoncerter og diskoteker, så de stadigvæk var spændende? Hvordan ville man undervise i skolen? Og hvordan ville ens mobiltelefon være?

Hunden vil gerne fortælle Kejseren, hvordan alting ville være indrettet i en verden uden lugtesans? Hvad ville man gøre, når man skulle spise fx? Hvad for en mad ville smage godt, hvis man ikke havde lugtesans? Hvad ville jeres forældre mon servere? Og hvornår er lugtesansen ellers vigtig for jer, end lige når I spiser?

26

The octopus would like to tell the Emperor what everything would be like with mankind in a world without taste. How on earth would you choose in a restaurant if you could not taste anything? Which dinning places would become popular and

which places would be boring? What candy would be fun to eat, and what would not matter?

The scorpion wants to tell the Emperor what everything would be like in a world, where no one had a sense of touch? And what things you would change in the world? How, for instance, would you make the hospitals efficient when no one could feel when they hurt themselves? And what would lovers do when they could not feel it when they kissed or held hands?

The Python snake wants to tell the Emperor what the human world would look like if no one could feel the heat and the cold? What things had to change? What would happen if, for instance, no one could feel the cold when they were out in a freezing weather? Or if they could not feel the heat from a fire?

Can you help us with this? We are confident that if we send BOTH your previous answers and the next here, the Emperor will understand that it is actually us animals that are right. We look forward to hearing from you. You are the nicest human kids we have ever met.

Best wishes, from the animals in the land of senses

Brev fra dyrene

Mærkværdige verdener

Blæksprutten vil fortælle Kejseren, hvordan alting ville være indrettet hos menneskene i en verden uden smagssans. Hvad for noget ville man vælge på en restaurant, hvis man ikke kunne smage noget? Hvad for nogle af de spisesteder ville blive populære, og hvad for nogen ville være kedelige? Hvad for noget slik ville være sjovt at spise - og hvad for noget ville være lige meget?

Skorpionen vil gerne fortælle Kejseren, hvordan alting ville se ud i verden, hvis ingen havde en følesans? Og hvilke ting ville man lave om i verden? Hvordan skulle man fx indrette hospitalerne, når ingen kunne mærke, når de slog sig? Og hvad skulle kærester gøre, hvis de ikke kunne mærke, når de kyssede eller holdt i hånden?

Pyton-slangen vil gerne fortælle Kejseren, hvordan menneskenes verden ville se ud, hvis ingen kunne mærke kulde og varme? Hvilke ting måtte man lave om? Hvad ville der fx ske, hvis ingen kunne mærke kulden, når de var ude i frostvejr? Eller hvis de ikke kunne mærke varmen fra et bål?

Kan I hjælpe os med det? Vi er sikre på, at hvis vi BÅDE sender jeres forrige svar OG det næste her, så vil Kejseren forstå, at det faktisk er os dyr, der har ret. Vi glæder os til at høre fra jer. I er de rareste menneskebørn, vi nogensinde har mødt.

De bedste hilsner
fra dyrene i Sanselandet

Sanselandet

27

Invitation to the Emperor's laboratory

Hello everyone,

Thank you for your good reply. We have been so pleased that you would help us. And we were sure that we had gathered enough knowledge about the senses and how bad it would be to lose them. But we think we have made a mistake because since the last letter, things have become much, much worse. The entire land of senses is actually about to fall apart because the Emperor is removing more and more senses from the animals. He has even taken the ears from a few children because they could hear better than he could. So the whole country is grieving, and the Emperor himself is impossible to talk to. Therefore, we have not dared to give him your letters yet because we are afraid that it would take even more to get him to change his mind. The Emperor will ask for evidence. Therefore, we have a new plan.

The Emperor has built a large laboratory, where he investigates the world. And he is very confident in what he discovers there. In a while, the Emperor will go travel for an entire day. We think he needs to get away from all the sad mood and from reigning in his kingdom. One of his servants are set to watch the laboratory while he is away.

What the Emperor does not know is that the waiter is on our side. The waiter said that he wants to get you into the laboratory, if you will. So you can use the Emperor's own laboratory to study how it could be that the Emperor sees the world so differently than us. When the explanations come from his own laboratory and from someone who is as smart as you, then he must surrender.

So we will simply give him all the letters and the outcome of your studies when he comes back. You only have this one chance to visit the laboratory. Therefore it is important that you plan your

study carefully. You already know a lot about the senses, and you will need all that when you do your study.

You must also plan what experiments you will use. It is a good idea to write down the experiments into a working schedule, so you can make it all before the Emperor returns again. We really hope you will do it. Pleeease help us.

Love, the animals

PS: We have hidden some small messages for you in the laboratory.

Invitation til

Kejserens laboratorium

Hej alle sammen

Tak for jeres gode svar. Vi har været så glade for, at I gad hjælpe os. Og vi var sikre på, at vi nu havde samlet tilstrækkelig viden om sanserne og hvor slemt det ville være at miste dem.

Men vi tror, vi har taget fejl, for siden det sidste brev er tingene blevet meget, meget værre. Hele Sanselandet er faktisk ved at falde fra hinanden, for Kejseren fjerner sanserne fra flere og flere dyr. Han har endda taget ørene fra et par børn, fordi de kunne høre bedre, end han kunne. Så hele landet sørger, og Kejseren selv er slet ikke til at tale med.

Derfor har vi ikke turdet givet ham jeres breve endnu, for vi frygter, at der skal ENDNU mere til, for at få ham til at skifte mening. Kejseren vil bede om at få beviser. Derfor har vi en ny plan.

Kejseren har bygget et stort laboratorium, hvor han undersøger verden. Og han har meget tillid til det, han finder frem til dér. Om noget tid tager Kejseren ud at rejse en hel dag. Vi tror han trænger til at komme væk fra hele den triste stemning, der hersker i hans rige, og en af hans tjenere er sat til at passe på laboratoriet imens.

Hvad Kejseren ikke ved er, at tjeneren holder med os. Tjeneren har sagt, at han gerne vil lukke jer ind i laboratoriet, hvis I kommer. Så kan I bruge Kejserens eget laboratorium til at undersøge, hvordan det kan være, at Kejseren opfatter verden så anderledes end os. Når forklaringerne kommer fra hans eget laboratorium, og fra nogen der er så kloge som jer, så må han give sig.

Så vi vil simpelthen give ham alle brevene og resultatet af jeres undersøgelser, når han kommer tilbage. I har kun denne ene chance for at besøge laboratoriet. Derfor er det vigtigt, at I planlægger jeres undersøgelse grundigt. I ved jo allerede en masse om sanserne, og alt det skal I bruge, når I laver jeres undersøgelse.

I skal også gøre jer klart, hvilke eksperimenter I vil bruge. Det er en god idé at skrive eksperimenterne ind i en arbejdsplan, så I når det hele, før Kejseren vender tilbage igen

.

Vi håber sådan, I vil gøre det. Pleeease hjælp os!

Kærlig hilsen dyrene

PS: Vi har gemt nogle små beskeder til jer i laboratoriet.

28

Experiments in the Emperor's laboratory

Questions:

- What do we know already that might explain why the Emperor and the animals experience the world differently?
- What do we want to find out?
- Which experiments will we do in the Emperor's laboratory?

Experiments

- Berry picker—tell the difference between good and toxic berries in the dark
- Color changes—check how colors change when you mix light
- Nectar hunter—try to gather nectar with and without bee sight
- UV patterns in nature - see UV patterns on animals and plants
- The eye gallery—see how different animals see
- The superhearer—measure how high and low notes you can hear
- DJ monkey—check how your voices sound if you change the tone
- Shoot moths—hunt moths with sounds as the bat
- The ear gallery—see how different animals hear
- Inaudible ring tones—create ring tones for your cell phone adults cannot hear
- Smell your way—check how good you are at smelling food and danger
- How little can you smell?—test how weak smells you can smell
- Name a scent—can you agree on what the fragrance will be named?
- Can you find the smells?—test to find individual odors in a mixture

- Nose gallery—see how different animals senses smell
- The five flavors—find out where on your tongue you can taste sour, sweet, salty, bitter, and umami
- Smell a taste—find out how you can taste if you cannot smell
- Find the taste buds—check your own taste buds in the magnifying glass
- Heavy gallery—see how different animals sense taste
- Supersensor—check where your hands are most sensitive
- Feel your way—test how good you are at feeling your way
- Touch and feel—check your touch
- Feeling gallery—see how different animals feel
- Snake eyes—try to find rats, using their heat
- Royal Python—meet a live royal Python
- A warm nest—test how good you are at feeling temperature regulations
- Heat/cold-gallery—see how different animal sense heat and cold

Eksperimenter i

Kejserens laboratorium

Hvad ved vi allerede, der kan forklare, hvorfor Kejseren og dyrene oplever verden forskelligt?

Hvad skal vi finde ud af?

Hvilke eksperimenter vil vi lave i Kejserens laboratorium?

Bærplukker - undersøg, hvordan det er se forskel på gode og giftige bær i mørke

Farveskifter - undersøg, hvordan farver ændrer sig, når I blander lys

Nektarjæger - prøv at samle nektar med og uden bi-syn

UV-mønstre i naturen - se UV-mønstre på dyr og planter

Øjegalleriet - se, hvordan forskellige dyr ser

Superhørere - mål, hvor høje og dybe toner I kan høre

DJ Abe - undersøg, hvordan jeres stemmer lyder, hvis I ændre tonen

Skyd Natsværmere - jag natsværmere med lyde som flagermusen

Øregalleriet - se, hvordan forskellige dyr hører

Uhørlige ringetoner - lav ringetoner til mobilen, som voksne ikke kan høre

Lugt dig frem - undersøg, hvor gode I er til at lugte mad og farer

Hvor lidt kan du lugte? - test, hvor svage lugte I kan lugte

Navngiv en duft - kan I blive enige om, hvad duften skal hedde?

Kan du finde lugtene? - test, hvor gode I er til finde enkelte lugte i en blanding

Næsegalleriet - se, hvordan forskellige dyr sanser lugte

De 5 smage - undersøg, hvor på tungen I kan smage surt, sødt, salt, bittert og umami

Lugt en smag - undersøg, hvordan I kan smage, hvis I ikke kan lugte

Find smagsløgene - undersøg jeres egne smagsløg i forstørrelsesglas

Tungegalleriet - se, hvordan forskellige dyr sanser smage

Superføler - undersøg, hvor på hænderne I er mest følsomme

Føl dig frem - test, hvor gode I er til at føle jer frem

Rør og føl - undersøg, hvilken berøring I brug lyst til

Følegalleriet - se, hvordan forskellige dyr føler

Slangeøjne - prøv at finde rotter ved hjælp af deres varme

Kongepyton - mød en levende kongepyton

En lun rede - test, hvor gode I er til at mærke jer frem til en bestem temperatur

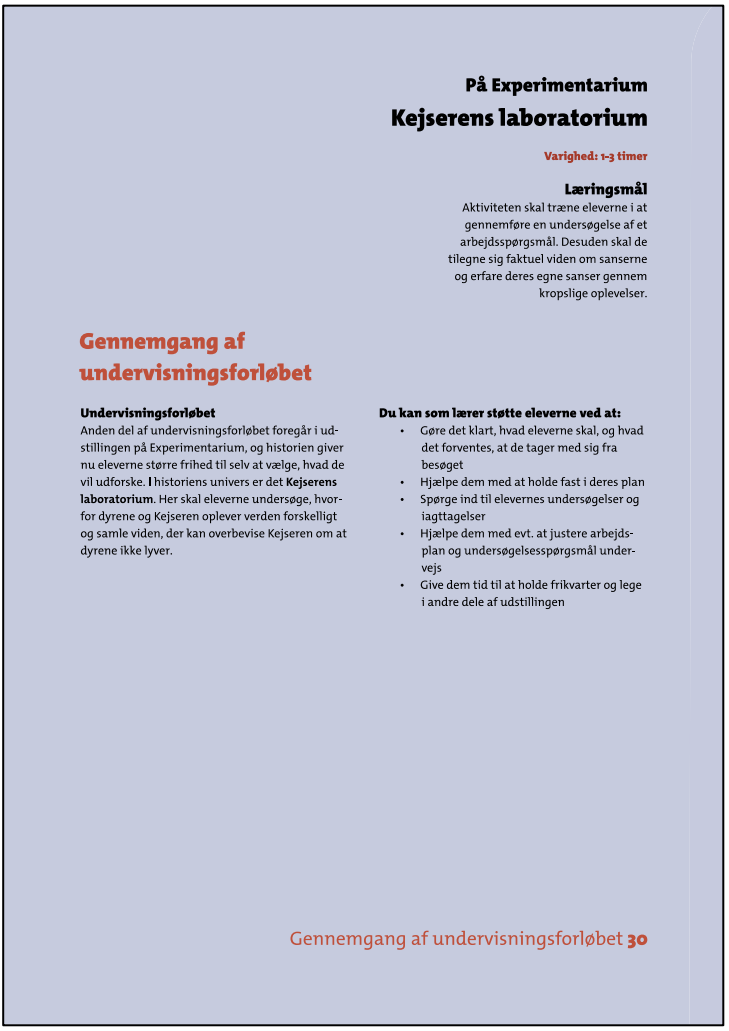
Varme/kulde-galleriet - se, hvordan forskellige dyr sanser kulde og varme

Second part—at the Experimentarium (one to three lessons)
The second part of the course takes place in the exhibition at the Experimentarium, and the story now gives the students more freedom to choose what they want to explore. In the story's universe it is the Emperor's laboratory. Here, students will examine why animals and the Emperor are seeing the world differently and gather knowledge that can convince the Emperor that the animals are not lying.

Learning objectives
The activity aims to train students to conduct a study of an assignment. They must also acquire factual knowledge about the senses and through bodily experiences learn their own sensory apparatus.

You can, as a teacher, support the students through:

- making it clear what they have to do and what is expected that they take with them from the visit
- helping them stick to their plan
- inquiring into the students' studies and observations
- helping them, if necessary, adjust the work plan, and survey questions along the way
- give them time to enjoy breaks and play with other parts of the exhibition



På Experimentarium

Kejserens laboratorium

Varighed: 1-3 timer

Læringsmål

Aktiviteten skal træne eleverne i at gennemføre en undersøgelse af et arbejdsspørgsmål. Desuden skal de tilegne sig faktuel viden om sanserne og erfare deres egne sanser gennem kropslige oplevelser.

Gennemgang af undervisningsforløbet

Undervisningsforløbet

Anden del af undervisningsforløbet foregår i udstillingen på Experimentarium, og historien giver nu eleverne større frihed til selv at vælge, hvad de vil udforske. **I** historiens univers er det **Kejserens laboratorium**. Her skal eleverne undersøge, hvorfor dyrene og Kejseren oplever verden forskelligt og samle viden, der kan overbevise Kejseren om at dyrene ikke lyver.

Du kan som lærer støtte eleverne ved at:

- Gøre det klart, hvad eleverne skal, og hvad det forventes, at de tager med sig fra besøget
- Hjælpe dem med at holde fast i deres plan
- Spørge ind til elevernes undersøgelser og iagttagelser
- Hjælpe dem med evt. at justere arbejdsplan og undersøgelsesspørgsmål undervejs
- Give dem tid til at holde frikvarter og lege i andre dele af udstillingen

Gennemgang af undervisningsforløbet **30**

Third part—the trial (approx. three lessons)

In the third and last part of the course, the groups have to convince the Emperor that the animals are not lying but merely seeing other parts of the world than the Emperor because their senses are different. Students must use all their knowledge and experiences and findings from their studies at the

Experimentarium. This part of the process is relatively open. As teacher you must, along with the story, help the students guide their work toward the goal.

Learning objectives: The goal is that students are trained to pick up, share experiences, discuss, and conclude on a study of an assignment, and they are trained to argue using professional insight. Thereby, they also become more aware of the difference between believing something and knowing something.

Activities in class after the visit
First part: Read *The Emperor's Black Pot and the Indictment*. In the story the Emperor himself decides to slaughter the animals. The animals convince him, however, that they must have a fair trial. Now it is urgent! The students must use the knowledge they have gathered to help the animals refute the accusations.

Tasks: The groups gather up on their studies and formulate arguments to convince the Emperor. They can build on the assignment questions they put before the visit and in the indictment. You can help students by giving them phrases they must complete and ask questions. Maybe you can also act as the devil's lawyer (Emperor's arguments) and challenge the students' arguments, e.g., animals experience anything other than the Emperor because . . . We know this because . . .

Why does the Emperor and the animals experience the world differently? How does your senses work? What are the differences between the Emperor and the animals' senses? You say that your animal has a different kind of eyes than the Emperor. What do you mean?

The groups then present the arguments for another group or perhaps the whole class. They provide input on how arguments can be sharpened, or what arguments work best. What convinces the other students? Why is it good arguments?

Eventually the groups' arguments are sent in a letter to the Emperor and the animals.

Second part: Read the end of the story *When the Emperor Got New Glasses, Long Ears, and a Curious Nose*. The Emperor sets the animals free and delivers noses and ears back and is thrilled that the world was actually far larger and more wonderful than he otherwise thought.

Gennemgang af undervisningsforløbet

I tredje og sidste del af forløbet skal grupperne overbevise Kejseren om, at dyrene ikke lyver, men oplever andre dele af verden end Kejseren, fordi de sanser anderledes.

Eleverne skal bruge al deres viden og erfaringer og konklusionerne af deres undersøgelser på Experimentarium. Denne del af forløbet er relativ åben. Sammen med historien skal du som lærer hjælpe eleverne med at styre arbejdet frem mod målet.

Efter besøget

Retssagen

Varighed: ca. 3 lektioner

Læringsmål

Målet er, at eleverne trænes i at samle op, dele erfaringer, diskutere og konkludere på en undersøgelse af et arbejdsspørgsmål og de trænes i at argumentere ved hjælp af faglig indsigt. Derigennem skal de også blive mere bevidste om forskellen på at tro noget og vide noget.

Aktiviteter i klassen før besøget

1. Læs - Kejserens sorte gryde og Anklageskriftet

I historien beslutter Kejseren sig for at slagte dyrene. Dyrene overbeviser ham dog om, at de skal have en fair rettergang. Nu haster det! Eleverne må bruge den viden, de har samlet for at hjælpe dyrene med at tilbagevise anklagerne.

Opgaverne:

Grupperne samler først op på deres undersøgelser og formulerer argumenter, der kan overbevise Kejseren. De kan tage udgangspunkt i de arbejdsspørgsmål, de formulerede før besøget og i anklageskriftet.

Du kan hjælpe eleverne ved at give dem sætninger, de skal færdiggøre, stille spørgsmål og udfordre elevernes argumenter. Fx:

Dyrene oplevede noget andet end Kejseren, fordi... Det ved vi, fordi ... Hvorfor oplevede Kejseren og dyrene verden forskelligt? Hvordan virker sanserne? Hvilke forskelle er der mellem Kejserens og dyrenes sanser? Du siger, at dit dyr har en anden slags øjne end Kejserens. Hvad mener du med det? Måske kan du også agere djævlens advokat.

Grupperne præsenterer dernæst argumenterne for en anden gruppe eller måske hele klassen. De giver input til, hvordan argumenter kan skærpes, eller hvilke argumenter der virker bedst. Hvad overbeviser de andre elever? Hvorfor er det gode argumenter?

Til sidst sendes gruppernes argumenter i et brev til Kejseren og dyrene.

2. Læs - Da Kejseren fik nye briller, lange ører og en mærkværdig næse

Kejseren sætter dyrene fri - leverer næser og ører tilbage og bliver begejstret over, at verden faktisk var meget større og mere vidunderlig, end han ellers troede.

Materialer til 3. del.

- **Kejserens sorte gryde s.32**
- **Anklageskriftet s. 36**
- **Da Kejseren fik nye briller, lange ører og en mærkværdig næse s. 37**

o

Story: The Emperor's Big Black Pot

The Emperor loved to sit and look out over the palace garden in the morning. He was often awake so early that he saw the sun rise. He saw how everything outside slowly changed from gray and black to all of today's colors. He listened to the birds that began to sing because he had nothing against animals as such.

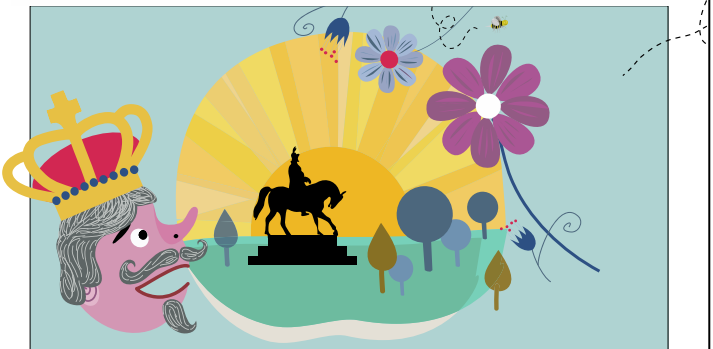
"If only they were not trying to tell me all these lies," the Emperor said. "Then we would get along fine. The birds are singing so beautifully, the bees make delicious honey, and it is nice to see the little rabbits playing on the grass in the morning." And just as he had said this a bunch of rabbits ran into the park. But they looked so strange. They had no ears.

"What on earth has happened to their ears?" the Emperor asked his servant. The servant had to explain to the Emperor that he had asked to get them cut off because the rabbits claimed they could hear better than the Emperor.

Later the dog came out in the garden—and it was completely without snout—so it did not walk around sniffing as usual. It actually looked a little sad, as if life was not quite as good as before. And the Emperor growled uncomfortably because it looked silly and behaved not like a real dog used to do. Actually, everything was just wrong. It was also the bees that flapped around without eyes, for they had said they could see more colors than the Emperor. Without eyes, they could not find the flowers anymore. They flew into each other, looking helplessly after the beehive and had not made any honey.

Late in the day when he had been thinking, he decided to see if he could solve the problems between him and the animals. He asked his servants to call all the animals to the castle, one by one.

"Start with the bee," he said. So the servant went over and locked the bee out of the tower with a message to take the bee over to the Emperor immediately. But the Emperor had to wait a long time because the bee had no eyes, and it could simply not find its way. It flapped around in the completely wrong end of the park and never found the Emperor's doorstep. Meanwhile the Emperor got impatient and thought that it had deceived him and had run away.



Kejserens sorte gryde

Kejseren nød at sidde og kigge ud over paladsets have om morgenen. Han var tit vågen så tidligt, at han så solen stå op. Han så, hvordan alting udenfor langsomt skiftede fra gråt og sort, til alle dagens farver. Og han lyttede til fuglene, der begyndte at synge, for han havde ikke noget mod dyr som sådan.

"Hvis bare ikke de prøvede at bilde mig alt muligt ind," sagde Kejseren. **"Så skulle vi nok få det godt. For fuglene synger så smukt, bierne laver velsmagende honning, og det er dejligt at se de små kaniner lege på græsset om morgenen."** Og netop som han sagde det, kom en flok kaniner ud i parken. Men de så besynderlige ud. De havde ingen ører.

"Hvad i alverden er der sket med deres ører?" spurgte Kejseren sin tjener. Og tjeneren måtte forklare Kejseren, at dem havde han selv bedt om at få hugget af, fordi kaninerne påstod, at de kunne høre bedre end Kejseren.

Senere kom Hunden ud i haven - og den var helt uden snude - så den gik ikke og snusede som sædvanligt. Den så faktisk lidt trist ud, som om livet ikke var helt så godt som før. Og Kejseren brummede utilpas, for den så fjollet ud og opførte sig slet ikke som en rigtig hund plejede at gøre. Faktisk var alting lidt forkert. Det gjaldt også bierne, der flaksede rundt uden øjne, for de havde jo sagt, at de kunne se andre farver end Kejseren. Og uden øjne kunne de ikke finde blomsterne længere. De fløj ind i hinanden, ledte hjælpeløst efter bistadet og fik ikke lavet noget honning. Sidst på dagen, da han havde gået og tænkt sig om, besluttede han sig alligevel for at se, om ikke han kunne få løst problemerne mel-

"Kejserens sorte gryde" **32**

"That mean bee," he exclaimed, "when I get my hands on it, I will pull its wings off and get my chefs to turn it in egg and bread crumbs . . . and then I will eat it like crisps!" Yes, he was really angry, one could hear. It was not nice to be the next one to come up to the Emperor.

It was the rat. It looked miserable when the servant picked it up—without his ears. It was also afraid because it could not hear anything anymore, so how on earth should it be able to answer the Emperor? "Just say, 'Yes,' or 'Yes, I will,' every time he asks for something," said the servant. "That is what we do. We say yes and smile at him! Or rather . . ." The servant did not say it. He wrote it down on a slip of paper because the rat could not hear.

"Well, at least you came instead of escaping like the bee." said the Emperor because the rat was standing before the throne.

"Yes," squeaked the rat for it remembered what the servant had said.

"You know why I cut the ears of you?" thundered the Emperor.

"Yes," the rat squeaked again and tried to smile.

"And you admit that you lied?"

"Yes," squeaked the rat, not because it could hear what the Emperor said, but just so the Emperor would not be angry.

"OK," said the Emperor with a slightly milder voice. "Now you get one last chance to make things right again. Will you ever lie to me again if you get your ears back?"

o

"Yes, I will," whined the deaf rat and smiled the best it had learned. And now the Emperor was really furious; here, the cheeky rat said that it would lie again.

At first the Emperor called on the servant, who threw the rat back in the tower. Next he called his cook because now he had to make a rat stew, he said. The rest of the animals could go the same way. He would not talk to others. Nope, he would eat the whole bunch.

lem ham og dyrene. Han bad sine tjenere om at kalde alle dyrene til slottet, én efter én.

"Start med Bien", sagde han. Så tjeneren tog over og låste Bien ud af tårnet - med besked om, at den skulle tage over til Kejseren øjeblikkeligt. Men Kejseren fik lov til at vente længe, for Bien havde ingen øjne, og nu kunne den simpelthen ikke finde vej. Den flaksede rundt i den helt forkerte ende af parken og fandt aldrig Kejserens hoveddør.

Imens blev Kejseren utålmodig og troede, at den havde snydt ham og var stukket af.

"Den tarvelige bi!" udbrød han. **"Når jeg får fat på den, hiver jeg vingerne af den og får mine kokke til at vende den i æg og rasp ... og så spiser jeg den som chips!!"** Ja, han var virkelig vred, kunne man høre. Og det var ikke rart, at være den næste der skulle komme op til Kejseren. Det blev Rotten. Den så sølle ud, da tjeneren hentede den - sådan uden sine ører. Og den var også bange, for den kunne jo ikke høre noget længere, så hvordan i alverden skulle den svare?

"Bare sig "ja" eller **"ja, det vil jeg", hver gang han spørger om noget",** sagde tjeneren. **"Det gør vi andre. Vi siger ja og smiler til ham!"** Eller rettere sagt, tjeneren sagde det ikke. Han skrev det ned på en seddel, for rotten kunne jo ikke høre.

"Nå, du kom i det mindste i stedet for at stikke af som Bien," sagde Kejseren, da Rotten stod foran tronen.

"Ja," peb Rotten, for den huskede, hvad tjeneren havde sagt.

"Du ved godt, hvorfor jeg skar ørene af dig?" tordnede Kejseren.

"Ja," peb den igen og prøvede at smile.

"Og du indrømmer at du løj?"

"Ja," peb Rotten. Ikke fordi den kunne høre, hvad Kejseren sagde, men bare for at Kejseren ikke skulle blive sur.

"OK," sagde Kejseren, med en lidt mildere stemme. **"Nu får du en sidste chance for at gøre tingene godt igen ... Vil du så nogensinde lyve for mig, hvis du får dine ører igen?"**

"Ja, det vil jeg ...," peb den døve rotte og smilede det bedste, den havde lært. Og nu blev Kejseren virkelig rasende; Her stod den frække rotte og sagde, at den ville lyve igen.

Først kaldte Kejseren på tjeneren, der smed Rotten tilbage i tårnet. Siden kaldte han på sine kokke, for nu skulle der laves rottestuvning, sagde han. Og resten af dyrene kunne gå samme vej. Han ville ikke snakke med flere. Niks, han ville æde hele bundtet.

"Kejserens sorte gryde" **33**

"At least let the dog get a chance," the servant asked because he liked the dog so much, and it had been the Emperor's best friend, so maybe it could do something. The Emperor stared tired at the waiter, but nodded anyway, so therefore the dog stood in the throne room shortly after that.

“Oh thank you for listening to us.” said the dog. “You can probably understand how difficult it is to live without your nose when you are used to walk and sniff everything. You people also use the sense of smell much.”

“Well,” muttered the Emperor, “but what has that got to do with the concoction you told me about? How you could smell the bones that were buried in the lawn?”

“But I was not lying,” said the dog. “We just do not see the world alike. We asked some quite clever kids about how it all hangs together. I have all their letters and results of testing in your laboratory—if you would just read them. They explain how you people use your senses differently than us animals.”

The Emperor then looked a little surprised at the dog, “How do you think the kids think we experience the world differently then?”

“Oooh,” said the dog bit uncertain, it was hard to explain in a few words for a dog. “Uh . . . As far as I know, a big beautiful dog snout can sense more odors than the small potato nose you people run around with,” the dog tried to speak. But before it knew it, it sat in the tower again. That kind of talk was not acceptable to the Emperor.

“Bring forward the black pot,” he shouted. “Now it must come to an end with all the cheeky animals mocking me.”

Everyone in the kingdom knew the Emperor’s black pot. It was rarely used. Actually, it was so long ago that only the oldest animals in the kingdom could remember it weakly. But now it was taken into use again. It was picked up from the black basement and dragged out in the yard. It took four elephants to drag it up the stairs and a small crane to hoist it up on top of the huge bonfire that had been piled up in the middle of the courtyard.

"Lad i det mindste Hunden få en chance," bad tjeneren, for han synes så godt om Hunden, og den havde været Kejserens bedste ven, så måske kunne den gøre noget. Kejseren så træt på tjeneren, men nikkede alligevel, så derfor stod Hunden kort efter i tronsalen.

"Åh tak for at du vil høre på os," sagde Hunden. **"Du kan nok forstå, hvor svært det er at leve uden næsen, når man er vant til at gå og snuse til alting. I mennesker bruger jo også lugtesansen meget".**

"Tja," mumlede Kejseren, **"men hvad har det at gøre med den løgnehistorie, du fortalte mig, om at du kunne lugte ben, der var begravet i græsplænen?"**

"Men jeg løj ikke!" sagde Hunden. **"Vi oplever bare ikke verden ens. Vi har spurgt nogle aldeles kloge børn om, hvordan det hele hænger sammen. Jeg har alle deres breve og resultater af undersøgelser i dit laboratorium - hvis du bare ville læse dem. De forklarer, hvordan I mennesker bruger jeres sanser anderledes end os dyr".**

Kejseren så lidt overrasket på Hunden; **"Hvordan mener børnene så, at vi oplever verden forskelligt?"**

"Jaaa," sagde Hunden lidt usikkert - det var jo svært at forklare med få ord for en hund. **"Øh ... så vidt jeg ved har en stor flot hundesnude flere lugtedimser end sådan en lille kartoffelgynter, som mennesker render rundt med,"** forsøgte hunden at sige. Men før den vidste af det, sad den i tårnet igen. Den slags snak ville Kejseren ikke finde sig i.

"Frem med den sorte gryde," råbte han. **"Nu skal det være slut med, at de flabede dyr holder mig for nar."**

Kejserens sorte gryde kendte alle i riget. Den blev sjældent brugt. Faktisk var det så længe siden sidst, at kun de ældste dyr i riget kunne mindes det svagt. Men nu blev den altså taget frem. Den blev hentet op af den sorte kælder

"Kejserens sorte gryde" **34**

In the tower the animals could see how the Emperor's 459 cooks worked down in the palace's large kitchen. The octopus sat down and cried in his bucket. The bee was saying, "Everything is going to be OK," and laughed nervously, but it had no idea about what was going to happen. Both the scorpion and the Python snake sat silent in each their corner.

“It is an impressive pot the Emperor has,” the dog said and watched the big pot with his sad brown eyes. “Yes,” said the rat and pressed down toward the ground. “I do not think he is going to settle for just carrots and vegetables.”

The cat who had come in with its soft paws without any of the animals noticing it said, “The rat is right. I have heard that the Emperor will set a fire under the pot in the afternoon and not even the little mice or the rabbits’ cute kids will be spared. Everyone who has spoken against the Emperor will go into the pot!”

Despondently they all gased down on the pot, just as the old owl landed outside the tower window. It nodded slightly to the entire assembly. That is what owls do because they are very polite animals. But it also said something that was very wise, “The Emperor will eat you because he sincerely believes that you are lying to him. He does not believe that the bee can see patterns or the rat can hear his kids when he cannot. He does not understand that we perceive things differently. Have you not given him all the evidence from the children on how everything really works?” he asked.

“We have not dared,” sobbed the octopus because its nerves were in a miserable state by now.

“What nonsense,” said the owl while it shuffled around a bit on the window sill. It had in fact been a little hard to stay awake for it was the middle of the day when every decent owl usually gets a good day’s sleep. “If you are going to be slaughtered and eaten, one should at least be allowed to have his case tried by the court. Maybe it is time that we let the children use their knowledge of the senses and gather information from the Emperor’s laboratory, so the Emperor can see that he is wrong.”

All the animals nodded and thought that the owl had said the wisest and most encouraging thing to think about they had heard that morning. therefore, they agreed to send the owl to the Emperor. And then the animals waited.

og slæbt ud på gårdspladsen. Der skulle fire elefanter til at trække den op af trapperne og en lille kran til at hejse den op på toppen af det store bål, der var blevet stablet op på midten af gårdspladsen.

I tårnet kunne dyrene se, hvordan Kejserens 459 kokke arbejdede nede i paladsets store køkken. Blæksprutten sad stille og græd i sin spand. Bien blev ved med at sige: **"Det går nok"** og le nervøst - men den havde ingen idé om, hvordan det nok skulle gå. Og både Skorpionen og Pyton-slangen sad tavse i hvert deres hjørne.

"Det er en imponerende gryde, Kejseren har," sagde Hunden og betragtede den store gryde med sine sørgmodige brune øjne.

"Ja," sagde rotten og trykkede sig ned mod jorden. **"Jeg tror ikke han nøjes med gulerødder og grøntsager."**

Katten, der var kommet ind på sine bløde poter, uden nogen af dyrene havde lagt mærke til det, sagde:

"Rotten har ret. Jeg har hørt, at Kejseren vil tænde op under gryden i eftermiddag og ikke engang spidsmusene eller kaninens søde unger vil blive sparet. Alle der har talt Kejseren imod ryger i gryden!"

Mismodigt stirrede de ned på gryden, netop da den gamle ugle landede uden for tårnvinduet. Den nikkede lidt til hele forsamlingen. Det gør ugler, for de er meget høflige dyr. Men den sagde også noget, der var meget klogt:

"Kejseren vil æde jer, fordi han oprigtigt tror, at I lyver for ham. Han tror ikke på, at Bien kan se mønstre, eller Rotten kan høre sine unger - når han ikke kan. Han forstår ikke det med, at vi sanser forskelligt. Har I ikke givet ham alle beviserne fra børnene på, hvordan det hænger sammen?" spurgte den.

"Vi har ikke turdet," hulkede Blæksprutten, for dens nerver var i en ynkelig forfatning efterhånden.

"Sikke noget pjat," sagde Uglen, mens den trippede lidt rundt i vindueskarmen. Den havde nemlig haft lidt svært ved at holde sig vågen, for det var midt om dagen, hvor enhver anstændig ugle normalt får sig en god dags søvn. **"Hvis man skal slagtes og ædes, burde man i det mindste have lov til at få sin sag prøvet ved retten. Måske er det på tide, at vi lader børnene bruge deres viden om sanserne og samle oplysningerne fra Kejserens laboratorium, så Kejseren kan indse, at han tager fejl."**

Alle dyrene nikkede og synes, at Uglen havde sagt det klogeste og mest opmuntrende de kunne komme i tanke om, de havde hørt den formiddag. Derfor blev de enige om at sende Uglen op til Kejseren.

Og så ventede dyrene. Det meste af en time ventede de - og kokkene myldrede rundt på gårdspladsen og smed

"Kejserens sorte gryde" **35**

Most of an hour they waited—and the cooks swarmed around the courtyard and threw vegetables in the pot while they glanced up to the animals in the tower. Down in the yard the pigs tried nervously to look smaller and frogs tried to hide their legs. There was honestly a really bad mood.

Finally, after an hour, the owl came back. It was breathless, as it had flown quickly, but seemed satisfied. "At first the Emperor would not listen . . . ," it said, having caught his breath a little. "He said that nobody had ever heard of a lawsuit when it came to animals being slaughtered. Firstly, there was hardly any time for that in the middle of cooking and secondly, it required that the animals had someone who could defend them in such as a lawsuit. And the Emperor did not know anybody in the whole land of senses that would be able to do so. But then, I suggested that the children from the school could make the case, and he promised me that if the dispute could be settled before dinner, he would listen to the children. Here is the indictment that explains everything that he thinks we animals have done wrong."

As soon as the cat heard it, it grabbed the indictment and jumped resolutely down the yard because even though it had been too smart to lose his eyes and become locked inside the tower, and although it had not been sad about a little mouse hunting, it seems anyway that it would be too lonely to live in this country if the Emperor had his way. So as a small lightning it ran past the black pot over the courtyard and into the bushes in the park's far end. And it ran so fast with the indictment that it lies in front of your door—just now!

The indictment: the animals are accused of lies and deception

- The bee says it can see patterns in the flowers, though the Emperor cannot
- The rat says it can hear his kids calling although the Emperor cannot

- The dog pretends to smell a bone, although the Emperor cannot
- The octopus says it can taste with its arms, although the Emperor cannot
- The scorpion claims to feel an ant walking past, although the Emperor cannot
- The Python snake claims to see heat although the Emperor cannot

It is therefore expected that the defenders explain: How animals can sense something other than the Emperor? And how the defenders can know this? Unless the defenders can prove the animals' innocence they are all condemned to be thrown into the black pot and eaten in the evening at 1800h.

grøntsager i gryden, mens de skottede op til dyrene i tårnet. Nede på gårdspladsen prøvede grisene nervøst at få skinkerne til at se mindre ud, og frøerne prøvede at gemme deres lår lidt af vejen. Der var ærlig talt en rigtig dårlig stemning.Endelig, efter en times tid, kom Uglen tilbage. Den var forpustet, for den havde fløjet hurtigt, men den virkede tilfreds.

"Først ville Kejseren ingenting høre ...," sagde den, efter at have fået vejret lidt igen. **"Han sagde, at ingen nogensinde havde hørt om en retssag, når det gjaldt dyr der skulle slagtes. For det første var der rigtig dårligt tid til den slags, sådan midt i madlavningen, og for det andet krævede det, at dyrene havde nogen, der kunne forsvare dem i sådan en retssag. Og Kejseren kendte ikke nogen i hele Sanselandet, der ville være i stand til det. Men så var det, at jeg foreslog, at børnene fra skolen kunne føre sagen, og han lovede mig, at hvis retssagen kunne afvikles inden spisetid, så ville han lytte til børnene. Her er det anklageskrift, som forklarer alt det, han mener, vi dyr har gjort forkert".**

Så snart Katten hørte det, greb den anklageskriftet og sprang beslutsomt ned på gårdspladsen. For selvom den havde været for smart til at miste sine øjne og blive låst inde i tårnet, og selvom den ikke havde været ked af lidt museragout, så synes den alligevel, at det ville blive for ensomt at bo i landet, hvis Kejseren fik sin vilje. Så som et lille lyn løb den forbi den sorte gryde, over gårdspladsen og ned i buskadset i parkens fjerneste ende ...

Og den løb så hurtigt med anklageskriftet, at det ligger foran jeres dør - netop nu!

Anklageskriftet

Dyrene anklages for løgn og bedrag

1. Bien påstår, at den kan se mønstre i blomsterne, selvom Kejseren ingen mønstre kan se.
2. Rotten påstår, at den kan høre sine unger kalde, selv når Kejseren ikke kan høre dem.
3. Hunden påstår, at der er et kødben begravet i parken, selvom Kejseren ingenting kan lugte.
4. Blæksprutten påstår, at den kan smage med armene, selvom Kejseren ingenting kan smage med sine arme.
5. Skorpionen påstår, at den kan mærke en myre gå forbi, selvom Kejseren intet kunne mærke.
6. Pyton-slangen påstår, at den kan se varmen fra rotter, selvom Kejseren ikke kan se varme.

Det forventes derfor, at forsvarerne på et retsmøde kan argumentere for:

- Hvordan dyrene kan sanse noget andet end Kejseren?
- Og hvordan forsvarerne kan vide det?

Medmindre forsvarerne kan bevise dyrenes uskyld, idømmes dyrene til at blive smidt i den sorte gryde og spist i aften kl. 18.

"Kejserens sorte gryde" **36**

Story: When the Emperor Got New Glasses, Long Ears, and a Peculiar Nose

It was a fantastic day. The whole kingdom was gathered around the Emperor's palace, where the trial was held. The hall was crammed to bursting point and in the courtyard people stood like herrings in a barrel. Defense speeches and argument had arrived from the school, where the smartest kids went. Yes, many sides had tried to convince the Emperor that there were many ways of perceiving the world, depending on how your senses work.

Someone had spoken of the snakes' ability to sense heat from other animals while others had talked about the bees' ability to see ultraviolet light. Descriptions of the dogs' noses and the bats' ears had filled the table in front of the Emperor and everyone who was lucky enough to have been seated in the palace got to see how his face changed its expression through the day.

Da Kejseren fik nye briller, lange ører og en mærkværdig næse

Det blev en fantastisk dag. Hele riget var samlet omkring Kejserens palads, hvor retssagen blev holdt. Selve salen var proppet til bristepunktet, og på gårdspladsen stod folk som sild i en tønde. Fra de skoler, hvor de klogeste børn gik, var der kommet forsvarstaler og argumenter strømmende. Ja, fra mange sider havde man forsøgt at overbevise Kejseren om, at der var mange måder at opfatte verden på, alt efter hvordan ens sanser virkede.

Nogen havde talt om slangernes evne til at sanse varmen fra andre dyr, andre havde talt om biernes evne til at se ultraviolet lys. Beskrivelser af hundenæser og flagermuseører havde fyldt bordet foran Kejseren, og alle, der var så heldige at have fået plads i salen, kunne se, hvordan hans ansigt skiftede udtryk gennem dagen.

”Da Kejseren fik nye briller ...” **37**

In the morning he entered the hall with an irritated expression. Just before lunch, he had been angry about the animals’ stubbornness; but early afternoon, when he had read the children’s arguments out loud, he became more quiet and thoughtful. It was right around teatime that the big change came. The Emperor had

just heard about the bat's ears because the waiters said that the court would take a break, so the Emperor could have his tea.

"No, no, no . . . ," said the Emperor irritated, "we cannot take a break now. I have to know how it could be that the bats can navigate in complete darkness without flying into everything."

And the waiters stepped away while the animals tried to explain it to the Emperor. And now the Emperor completely forgot his tea. Instead he ordered the servants to retrieve a pair of bat ears he could borrow and he ordered the courtroom darkened, so he could find out if it was true that the bats could use their voice and ears to move around in the dark without any problem. The servants came running with bat ears from the basement, and when the Emperor had tried them on, the servants also had to run down and retrieve a set of rabbit ears. And so went the afternoon with the Emperor trying on fly eyes, snake-heat sensors, dog noses, and pig snouts.

Om morgenen var han kommet ind i salen med en irriteret mine. Lige før frokost var han blevet hidsig over dyrenes stædighed, men først på eftermiddagen, da han fik læst børnenes argumenter op, blev han mere stille og tænksom. Det var lige omkring tetid, at den store ændring kom. Kejseren sad netop og hørte om flagermusens ører, da tjenerne sagde, at retten ville holde pause, så Kejseren kunne få sin te.

"Nej, nej, nej ...," sagde Kejseren irriteret, "vi kan ikke holde pause nu. Jeg må lige have at vide, hvordan det kan være, at Flagermusen kan finde vej i buldermørke, uden at baldre ind i alt muligt."

Og tjenerne trak sig baglæns ud, mens dyrene prøvede at forklare det for Kejseren. Og nu glemte Kejseren helt sin te. Han beordrede i stedet for tjenerne ned for at hente et par flagermuseører han kunne låne, og han beordrede retssalen mørklagt, så han kunne finde ud af, om det var sandt, at flagermusen kunne bruge stemme og ører til at færdes i mørket uden problemer. Og tjenerne kom løbende med flagermuseørerne fra kælderen - og da Kejseren først havde prøvet dem, måtte de også løbe ned og hente et sæt hareører. Og sådan fortsatte eftermiddagen med, at Kejseren prøvede flueøjne, slange-varme-sensorer, hundenæser og grisetryner.

Først da det var ved at blive mørkt, rømmede et par af kokkene sig nede fra nogle af stolerækkerne. De havde egentligt forberedt sig på, at der skulle slagtes en masse dyr efter retssagen

"Da Kejseren fik nye briller..." **38**

Not before it was getting dark, a couple of the cooks coughed down from some of the rows of chairs in the back. They had really prepared themselves to slaughter a lot of animals after the trial and had prepared a large quantity of soup, steak, and pies with venison. But now they pulled it all out. The Emperor looked at

them through a pair of fly eyes he had borrowed and was suddenly aware that everyone was waiting for his conviction of the case.

"Known for the right," he said. "I have listened to the children's defense of the country's animals. And according to the decree in abeyance's circular elements I have decided to . . ." One truly only speaks as such when it has to do with important laws. "According to all that . . . ," he continued. "I have decided that no animals are to be slaughtered, but instead have their noses, ears, and eyes given back—if only they would loan them out to me sometimes. The cooks have to make vegetarian soup tonight."

"What?" asked the cooks. "Now we have prepared snout soup, stuffed pickled ears and eyes . . ." But it did not help anything. There was not anyone to be slaughtered that night.

The animals sent out a thank-you speech for the children who had saved their lives and senses but had also made the Emperor wiser and happier altogether. And if I had to describe how wonderful the birds sang that night and how wonderful everything smelled, I would never be able to finish.

But here sat the Emperor then with a pair of glasses that seemed like a deer's eyes, a pair of big rabbit ears, and a strange snout, which were impossible to recognise, as the sun went down. Everyone heard him say the famous words that you could also read in the newspaper the next day. They sounded like this:

"The world can be perceived very differently through our senses. So sometimes it can be very healthy to see the world through the eyes of others than your own . . ."

And the animals, well, they pretty much lived happy ever after.

og skulle tilberedes en større mængde suppe, steg og tærter med dyrekød. Men nu trak det hele ud. Kejseren betragtede dem gennem et par flueøjne, han havde lånt og blev pludselig klar over, at alle ventede på hans dom i sagen.

"Thi kendes for ret ...," sagde han. **"Jeg har lyttet til børnenes forsvar af rigets dyr - og i henhold til bekendtgørelses-paragraffernes cirkulære-bestemmelser har jeg bestemt mig til ..."** Ja, sådan taler man virkelig, når det har med vigtige love at gøre ...

"I henhold til alt det ...," fortsatte han. **"Har jeg bestemt mig til, at ingen dyr skal slagtes, men i stedet have deres næser, ører og øjne tilbage - hvis bare de vil låne dem ud til mig en gang imellem. Og kokkene bliver nødt til at lave vegetarmad i aften."**

"Hvad for noget?" sagde kokkene, **"nu har vi forberedt snudesuppe, farserede ører og syltede øjne ..."** Men det hjalp ikke noget. Der blev ikke slagtet nogen den aften.

Og dyrene sendte en takketale til børnene, som havde reddet deres liv og sanser - men som også havde gjort Kejseren klogere og gladere samtidig. Og skulle jeg beskrive, hvor dejligt fuglene sang den aften, og hvor skønt alting duftede - ja, så blev jeg aldrig færdig.

Men her sad Kejseren altså med et par briller, der virkede som hjorteøjne, et par store kaninører og en besynderlig snude, som ikke var til at genkende uden videre, mens solen gik ned. Alle hørte ham sige de berømte ord, som man også kunne læse i avisen næste dag. De lød sådan her:

Og dyrene - ja, de levede egentligt temmelig lykkeligt, til deres dages ende.

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