Museum of Science®

The Science Behind PIXAR

Teachers' Guide for senior pupils

Exhibition Overview

The Science Behind PIXAR

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INTRODUCTION

This guide to *The Science Behind Pixar* exhibition is aimed at senior pupils (7th – 10th grade).

The guide provides an overview of The Science Behind Pixar exhibition and suggests topics that can be discussed in class, including related learning targets.

The Science Behind Pixar is a unique look into production at Pixar – the groundbreaking animation studio behind world-famous animated movies such as *Toy Story, Monsters Inc.* and *Inside Out*.

The Science Behind Pixar was produced by the Museum of Science in Boston in close consultation with Pixar. Its visit to Experimentarium will be the first time this popular traveling exhibition can be seen in Europe.

The Science Behind Pixar explains the skills of the STEM subjects in a creative interplay with art.
The objective of the exhibition is to inspire children and adolescents to choose an education within natural science, technical and art subjects, and to show them that such subjects are not necessarily opposites, but that they can combine to generate considerable creativity.

MORE ABOUT THE EXHIBITION

Animated movies were born in a creative interplay between art, natural science and technology. When pupils work with *The Science Behind Pixar* and its themes, they will gain a unique insight into applied natural science, and experience a creative, playful approach to the STEM subjects. The Science Behind Pixar also represents a lot of learning potential within a number of subjects, making it ideal for inter-subject visits.

A visit to *The Science Behind Pixar* starts with a short introduction film providing a general description of the process used by Pixar to take an idea all the way to a finished movie. It also sets the stage for a more detailed experience of the exhibition. Pupils can then set off to explore the eight areas of the exhibition, which take a close look at the eight phases of the production of a new animated movie.

As always at Experimentarium, they will learn through using their senses and body. The 54 interactive activities of the exhibition allow pupils to experiment with the tools of the trade used by movie makers, such as animation technologies, lighting and camera angles, and they will be given a detailed look into the whole process from initial idea to finished animated movie.

The interactive activities of the exhibition were inspired by Pixar's popular animated movies such as *Toy Story, Monsters Inc., Inside Out* and many others. Pupils can try their hand at modeling, animating and breathing life into some of Pixar's most popular film series and characters. Each activity is based on one of Pixar's films, awakening delight at seeing old favorites and an understanding of how films and their stars were made.

The exhibition features experienced film makers from Pixar talking about their roles in the production of Pixar's animated movies and giving pupils an insight into the various skills brought together to create that spark of film magic.

Pupils will be given a thorough insight into how animated movies are made, with knowledge and know-how interwoven into the exhibition's interactive activities. Learning is achieved by exploring and experimenting as they pass through the exhibition, the eight areas of which are ideal for group working.

OVERVIEW OF CONTENT AND THE EXHIBITION

The diagram below shows the eight phases an animated movie has to go through from idea to completion. The same eight phases are reflected in the eight exhibition areas in *The Science Behind Pixar*:

START

Modeling
Digital modelers create virtual 3D models of the characters based on the art designs.

Rigging
Riggers create the virtual joints and muscles for the models so the they can move.

Surfaces
Surfacing artists construct each aspect of an object's appearance with computer programs called shaders.

Sets & Cameras
Set designers are architects, building the virtual environment. Camera artists are the cinematographers of the virtual world.

Animation
Animators bring the story to life, posing characters to act out each scene.

Simulation
Simulation technical designers write computer programs to make hair, clothing, and other effects.

Lighting
Lighting designers light each scene to highlight the story and enhance the emotional impact.

Rendering
Renderers turn all the data and programming into the final 2D images.

EXHIBITION THEMES

The consistent themes of the exhibition are:

- Art, technology, natural science, mathematics, computer science and digital technologies are used creatively and together to produce an animated movie.
- The film makers at Pixar use computers and other devices to create animated movies.
- Mathematics and natural science are creative tools deployed in the making of animated movies.
- Making animated movies requires teamwork, bringing together artistic, natural science and technological skills.

Themes cover the following general objectives:

- Pupils will gain a better understanding of how important the STEM subjects are to computer animation.
- They will become more aware of how important creative interplay between art and the STEM subjects is for Pixar and the animation industry in general.
- They will learn to tackle complex problems and challenges systematically, by breaking them down into manageable parts.
- They will enjoy a positive perception of the natural science and technologies used in animated movies.
- They will discover the various tasks and skills used in the production of Pixar's animated movies.

LEARNING OBJECTIVES AND SKILLS AREAS

7th - 10th grades

MATHEMATICS

Skills area

- Mathematical skills (*Modeling, Representation and symbolism & Communication*)
- Numbers and algebra (*Equations, Formulas and algebraic expressions & Functions*)
- Geometry and measurement (*Geometric drawing, placing and movements*)

Make good use of the examples of science knowledge and skills objectives below.

Examples of learning objectives for pupils	
Knowledge objectives	*Skills objectives*
Pupils will gain knowledge of mathematical problems from the world at large	They will be able to use digital models
They will gain knowledge of variables and how they change into animation	They will be able to use and evaluate variables in a digital tool
They will gain knowledge of spatial figures and their use in animation	They will learn industry jargon to describe the various elements in animation
They will understand the relationship between mathematics and animation	They can study linear and non-linear equations in certain contexts

PHYSICS/CHEMISTRY

Skills area

- Investigation (*Production and technology*)
- Modeling (*Production and technology*)
- Perspectives (*Production and technology*)
- Communication (*Production and technology*)

Make good use of the examples of science knowledge and skills objectives below.

Examples of learning objectives for pupils	
Knowledge objectives	*Skills objectives*
The pupils will gain an understanding of the uses of programming within animation	They can explore and try out different types of programming

GRAPHIC ART (OPTION)

Skills area

- Producing images (*Forms of expresssion, Sketches & Experimentation*)
- Graphic communication (*Visual communication*)

Make good use of the examples of science knowledge and skills objectives below.

Examples of learning objectives for pupils	
Knowledge objectives	*Skills objectives*
Students will be aware of the choices they have to make to create the expressions of a figure	They can use digital tools to create an animated figure
They will understand the different layers and phases involved in animation	They can differentiate between the different layers in animation from sketch to final product

CINEMATOGRAPHY (OPTION)

Skills areas

- Film production (*The means and methods, Production process & Operating equipment*)
- Film analysis (*Aesthetics & Culture*)

Make good use of the examples of scientific and skills objectives below.

Examples of learning objectives for pupils	
Knowledge objectives	*Skills objectives*
Pupils will gain an understanding of camera angles and the use of lighting in animation	They can determine the importance of choices during the production process for the final look
They will gain an understanding of the production processes in an animated movie	They can describe and argue for the production processes

MEDIA (OPTION)

Skills areas

- Media production (*Production process, Communication & Operating equipment*)
- Media analysis (*Aesthetics & Design*)

Make good use of the examples of scientific and skills objectives below.

Examples of learning objectives for pupils	
Knowledge objectives	*Skills objectives*
Pupils will gain an understanding of the design process in an animated movie	They can describe the use of digital tools for animation production
They will gain an understanding of the making of aesthetic choices to create a better end result	They can evaluate aesthetic expressions from the choices made
They will gain an understanding of the many elements, phases and work functions used	They can place those work functions in various phases and put the phases into sequence

Exhibition Map

The Science Behind PIXAR

BEFORE A VISIT

Before you visit The Science Behind Pixar, it will be an advantage if your pupils gain a general awareness of animation and animated movies. We suggest taking an initial class debate, in which they can brainstorm the subject and focus of the exhibition. You could start with these questions:

- What is Pixar?
- Which animated movies from Pixar can you think of? Which is your favorite animated movie – and why?
- Put into words what you perceive is special about Pixar's animated movies.
- What skills are needed when working with animated movies?
- What are the differences and similarities between different types of film (animated movie, cartoons, live action, documentary etc.)?
- Which animated movies have you seen? What do they have in common?
- Examine the movies in relation to the narrative model. Are there stories that are particularly suited to being told as animated movies or as live action with actual actors? Which strengths or weaknesses do the two types of film have in comparison to each other? Are there any genres the two types are best suited to, and why?
- How do you think the STEM subjects and art interact when creating an animated movie?

You can find more information on *The Science Behind Pixar at Experimentarium's* website: www.experimentarium.dk/pixar.

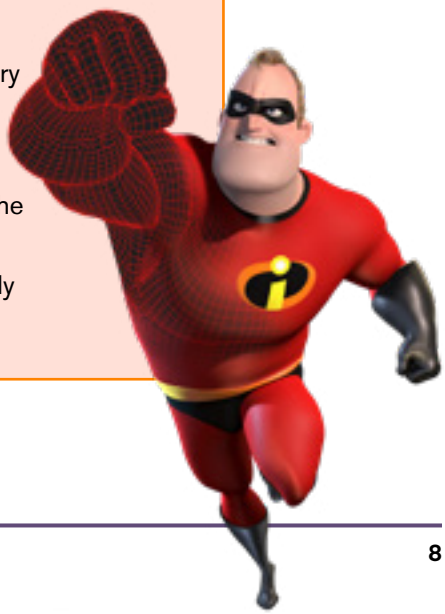
DURING A VISIT

The Science Behind Pixar exhibition is on Experimentarium's 2nd floor. It has fixed start and end points.

Start by visiting the exhibition cinema, where the pupils can start their journey by watching a short introduction film that tells a general story of Pixar's route from idea to movie. It also sets the stage for the more detailed expe-

The eight exhibition areas consist of:

- Interactive activities, screen-based and physical, which give the pupils chance to try their hand with the tools and models used by movie makers, animate and breathe life into some of Pixar's most popular movie series and characters.
- Video stories in the form of short films, in which Pixar's own personnel talk about the jobs they do in the production of Pixar's animated movies. Some of the films focus on the career options that exist in the animation industry and how to work creatively within the STEM subjects.



SUBJECT FOCUS

The various subjects can be explored in *The Science Behind Pixar*. Here are a few examples:

Mathematical focus

Animation is built up using mathematics. You can study spatial figures, variables and 3D coordinate systems in animation. The pupils can find the points in the animation process where mathematics are used. They can enhance their understanding and train their verbal explanation of mathematics in use, which can also be presented back in school.

Focus on the characters

The personalities of the Pixar characters shine through in their appearance and body language. You can focus on this by looking at modeling and how programming their surfaces such as skin, clothing and metal affects their appearance. Discuss the characters – who's the bad guy and who's the hero? Why do you think they look and behave as they do?

Cineamtic focus

Even though everything in animated movies is made on computers, film companies use the same means and methods they do in a live action film with actors. Settings, i.e. scenography and props, camera position and movements are all important to how the storyline of the movie is told – while lighting highlights the most important aspects of a scene and creates atmosphere. Pupils can study the various means and methods that carry the storyline, and discuss their importance.

Focus on understanding the technology

The pupils can study which technologies are used in the production of Pixar's animated movies. How are scenes programmed? What do "simulation" and "rendering" mean for example? Pupils could be given the task in advance of finding the right technological term in the exhibition, followed by trying to understand and describe it. They can also put into perspective the other contexts where the same or similar technologies are used.

Carrer focus

Pupils can focus on the people working in the animated movie industry. For example, they could discuss which jobs have to be combined to produce a finished animated movie. They could be "given" a job for example, which they have to find in the exhibition and examine in detail: where does that job feature in the process, and what tasks does it fulfill? Can they recognize subjects they have in school being used (e.g. mathematics, graphic art, physics, cinematography/media?).

AFTER A VISIT

After their visit, pupils can continue to work at school with their newly-acquired knowledge. For example, they can brainstorm the same questions given before their visit. Have their answers changed?

They can also look at certain technical terms and themes from the exhibition, seek to obtain a deeper understanding of the mathematic used in an animated movie. They can choose a given scene from one of Pixar's animated movies to examine in depth and analyze given the knowledge they've gained from the exhibition.

If the school has the right computers and software, they can work with their own production of an animated movie.

INTER-SUBJECT FOCUS

A visit to *The Science Behind Pixar* is an excellent opportunity for an inter-subject lesson, ideally as a supplement to a course on animation or digital technologies.

The exhibition touches on the skills and expertise of several natural science subjects. Mathematics in use, visual methods, technical options and media perspectives can be involved. Humanities subjects such as Danish, English and social studies can also be involved. Storytelling techniques can be used in Danish, along with storyboards, narratives and story constructions. Linguistic understanding can be worked with in English. In social studies, cultural impact or political attitudes expressed in the movies could be examined. (See also under Learning objectives and Skills areas).

Links to relevant English teaching materials:

https://www.khanacademy.org/computing/pixar

Pixar in a Box is a behind-the-scenes look at how Pixar artists do their jobs. You will be able to animate bouncing balls, build a swarm of robots, and make virtual fireworks explode. The subjects you learn in school — math, science, computer science, and humanities — are used every day to create amazing movies at Pixar. This collaboration between Pixar Animation Studios and Khan Academy is sponsored by Disney.

http://sciencebehindpixar.org/educators

The Science Behind Pixar exhibition has been designed to let visitors experience the art, science, computer science, and math that Pixar uses to create their groundbreaking films. The resources on this website can help you make the most of a visit to the exhibition, or to find ways to incorporate the science behind Pixar into your classroom directly.