

Background information

Title: All together! The world of ants at Città della Scienza Museum

Brief Description: The activity is meant for primary and middle school pupils visiting the exhibition about ants as social insects with their teachers. The experience is divided into two stages: the first involves a training meeting for teachers so that they are better informed of the experience that their pupils are going to carry out; the second is the actual activity that involves the pupils. For 75-90 minutes, pupils listen to the guide, observe and sometimes even touch the insects, observe models and watch videos. They also need to answer the questions and complete tasks in a special notebook. At the end of the activity, they talk about their experience with insects and what they have learned. Learning about the behaviour of social insects, pupils get introduced to topics from biology, zoology, ethology and ecology. Tasks and questions in the notebook are specially designed for the age range of the participants with some reference to the curriculum in natural science in school. This way the activity connects learning in formal and informal settings.

This activity mainly contributes to sparkle students' interest to science and developing their understanding of social animals, with a bit less contribution to developing scientific reasoning and reflection. This fits IDIS profile as a science museum with their priorities in terms of contribution to science proficiency being developing interest to science, engaging in scientific reasoning and understanding scientific content.

This is the true activity where the pupils will carry out a guided exploration in an exhibition showing real anthills of different species of ants.

This activity consists of spur students towards an interdisciplinary scientific vision inserting also social aspects of an organised community, capable of dealing with the complexity of the natural world, explaining how science can be connected to a model of daily lives. This activity can be insert also into activities model of Open schooling approach foresees an active meeting between students and explainers in the field of natural science and in an informal location off the school.

Based on the need to make young people, particularly girls aware on what science and technology professions are, activity was aimed at: connecting the schools with the world of the research and of the science centres; for building a direct contact between experts and students; give new opportunities for students to understand scientific data processing and analyzation in the research world.

The key element of the activity is the contact between the young people and the world of research that changes the idea on how to work in the scientific field.

Perception of science at school is very different from the one of in the “real world”. It is well known that whereas science at school is seen as boring and “far away”, other science communication forms can be more stimulants and appealing.

In the “outer world” outer of the schoolwork in science sector, however, still is a quite unknown and usually regarded unattainable, far removed from reality, difficult and, still today, considered not suitable for women.

Therefore, for students to overcome these stereotypes, it is necessary to integrate more and more extracurricular activities in scientific contexts, where there are more women than men, preferably young female researchers.

Keywords: Biology, museum, guide tour, biology, science life, communication science

Target audience: Primary and secondary school pupils, teachers, parents, public.

Age range: 6-13

Context(s): science centre/museum

Time required: 2 hours for visit the exhibition on the museum and 1 hour for answer to the questions and discuss together with teachers.

Technological tools required: No items needed

Author(s)'s background: responsible of exhibition area of the museum, naturalist expert on ants and expert in educational activities.

Connection with the curriculum: Life sciences (biology, zoology, ethology, ecology, evolution)

Learning objectives: subjects of natural sciences, botany, biology and sociology will be studied. For the art we will work on the structures present in nature that animals build for their survival. Pupils will carry out a guided exploration in a garden to find real anthills to observe. After this they will organize their knowledge answering some questions.

Guidance for preparation: to prepare the students involved in the study topics of the activity both through online research and in school textbooks related to some of the topics described below.

Social organization

Ants live in groups that can be made up of a few tens or millions of specimens. Inside the anthill, each ant has its own task and role.

- The queen lays the eggs: her job is to give life to other ants and she is also able to decide the sex of the unborn, usually female workers but, once a year, she brings new young winged queens into the world and winged males, ensuring the continuity of the species.
- The backbone of the company is made up of workers who take care of the eggs and raise the larvae, look for and store the food, build the anthill and keep it clean and tidy.
- The soldiers, always female ants, are in charge of defending the nest.
- The task of the males is to become adults in order to take flight, participating in the nuptial flight swarm, and then die after mating with the queen.

Ecological role

Ants play a vital ecological role. They are the most important soil mixing agent: they bring nutrients to the surface, useful for other living organisms, thus keeping the soil fertile. They are also the main predators of other insects and spiders, especially those harmful to plants.

A training aimed to let the teachers would be aware about the proposal their pupils will attend. During and immediately after the visit the pupils will answer the questions. To make this task more enjoyable for them, the questions should be proposed in the most playful way possible, for example, a specially written booklet, printed or in digital format on tables provided to pupils by the organizers. The pre-test would be submitted to the pupils by their teachers some time before the visit to the exhibition, as well as the post test would be proposed to them sometime later once they return to school. This is to avoid overloading the children with too many tests in a short time since they will already have to answer the questionnaire during the visit to the exhibition.

TEMPLATE : Create an artwork inspired by a scientific idea, phenomenon or process

1. Setting the scene

Screenplay (this visit includes a section inside the exhibition of Insects and another part in the garden. If for the latter the weather conditions do not allow it – or if the period in which it takes place does not allow the observation of ants in nature, it is replaced with a short laboratory activity at the end of the cards.)

The activity consists of 3 moments:

- 1) Previous knowledge about ants
- 2) Observation and discussion in front of the showcases
- 3) Field observation and/or laboratory activity

Previous knowledge about ants

The visit begins with a short chat with students about their knowledge of ants. The guide will write down or keep in mind the most interesting things (true or false) heard by the students' voice. He will ask if they have seen documentaries about ants on TV and what they remember about those documentaries. Sometimes ants are also topic of the news. The guide will take notes of those news that will then allow him to build (or destroy) on those statements his own speech at the appropriate time. For example, if the children say:

Student affirmation	→	Topic to be explored
Ants are annoying	→	Argentine ants, polygynous colonies, man-made problems
Ants can lift objects 100 times their weight	→	Anatomical structure of the ant, special examples
Ants have a hierarchical structure	→	Structure of the ant colony and their respective roles
Ants sting	→	Evolution of ants from wasps
I really like ants	→	The inclusion of all elements of the colony and the distribution of tasks

It is important that we can capture those beliefs and / or information, true or false that allow us to deepen the themes of the evolution of ant societies, the differences

with other insects, the communication between the individuals of a colony and the advantages of group work. If these questions are not asked by the children, it will be up to the guide to introduce them starting from simple questions. I find it very useful to compare human societies with those of ants because even with the obvious differences due to our reasoning, the evolution of societies has many similarities, to which we will return later.

2 Look around

Turning an anthill into a work of art. The anonymous US artist, after having melted the metal, pours it into the anthills which he uses as a mould. Once the aluminium solidifies, the works take shape.

Anthill Art, the pseudonym of an American artist who creates very special aluminium sculptures, is causing a lot of talk. He creates works using an original but much-discussed technique: as the video shows, the artist first melts the metal and then pours it directly into the anthills he uses as a mould. After pouring the red-hot liquid, the sculptor waits for it to solidify and then extrapolates the entire clod of earth (cleaning it first with a jet of water).

However, the artist has ensured that the molten aluminium was only poured into the burrows of the red ants, which are harmful to the environment. Their nests are exterminated by the millions in the United States using poisons, gasoline and fire, boiling water, and very rarely molten aluminium.



3 Investigation – Part 1

Observation and discussion in front of the showcases

In this section we want to address the issue of communication and collective behaviour, especially in those categories of insects defined as social. It will be shown how the development of sociability has allowed to greatly increase the potential of ants, wasps, bees.

Ants represent a group of insects that appeared for a long time on Earth's history, about 90 or 100 million years ago, but the peculiar characteristic of this group, eusociality, is much more recent, it is thought to be about 20 million years ago. Eusociality has allowed ants to dominate the world of terrestrial invertebrates, so much so that both in numerical size and biomass, ants surpass any other group of invertebrates. Even the biomass of ants is higher than that obtained by weighing all humans.

What is eusociality? It is the highest level of social organization that is realized by some animal species, and that meets the following conditions: cooperative care of the offspring, overlapping of adult generations and division of labour between the fertile queen and sterile workers (known as workers) This type of intraspecific interaction

can give rise to real "cities" of insects, all linked by a family bond, with a remarkably complex social structure and an extraordinary diversification and specialization of tasks.

Such a complex social structure is regulated and kept under control by the queen thanks to pheromones, which also have the function of inducing sterility in the workers (in Hymenoptera all sterile individuals are females). The other great achievement of ants is their self-organization: in an anthill there is no ant that commands, but the actions that the colony performs are the result of the interactions of many individual behaviours that are regulated by positive feedback mechanisms; that is the ants recruit their mates whenever there is a task to be carried out (search for food, construction and maintenance of nest, defence of the colony) .

The first stop of the visit is at the anthill of *Formica rufa*. The thing to point out immediately to the students is the architecture of the acervo. Given that the ants made it and that our colony is about 4 years old, the next questions for the students will be: "how was it built, in your opinion? What materials and instructions are needed to make such a structure?"

The second stop is the *Camponotus fulvopilosus* anthill of South Africa. The fake skull and the desert rose in the arenaci help to predict the type of environment in which they live. Once we have established that they are desert ants, we make students think about the adaptations of ants to life in torrid environments. The morphology and behaviour of these ants are direct derivation of the environment in which they live. We note that like most ants, we are faced with hunter-gatherer societies. In this location it is also possible to illustrate (and observe live) the life cycle of ants.

The next installation is that of harvester ants, *Messor capitatus*. Contrary to the previous, the *Messor* collect seeds of cereals and other plants, and once collected they bring them to the nest, where they will be opened, crushed, and reduced to flour, The flour then mixed with water, allows the ants to knead the so-called "ant bread", food for the larvae, which can also be observed in the lower part of the nest. We are faced with a kind of ant with a more complex organization as they transform a natural element to obtain another with different characteristics. Even here you can show the similarity with the first human societies when the hunting and harvesting of fruits were flanked by the cultivation and processing of cereals.

The other two anthills, that of *Camponotus vagus* and that of *Liometopum microcephalum* allow us to talk about communication between ants. In fact, both species mark with pheromones the path for food so as to leave an olfactory trace that subsequent ants can follow. The first ones have a long acrylic tube that they can travel,

the latter, smaller, make up beautiful black lines from the nest to the food, which intensify with the passage of time.

4 Investigation – Part 2

Field observation and/or laboratory activity

Weather permitting, the guide accompanies the students to the garden where in two specific locations it is possible to observe two wild colonies, the Messor minor and the Tapinoma magnum. These ants are excellent species to study because they have high numbers and very different behaviours. The Messor have a very orderly course, collect seeds and have a marked intra-colony dimorphism. While Tapinoma are fond of sugars, they move chaotically and are very fast.

The students, divided into small groups of 4 will first observe their behaviour in the absence of external stimuli, then give different foods (seeds, cooked chicken, dead insects and water with sugar) and observe the different reactions to the respective foods given.

They will then individually fill in a field form as per the attached model.

If the weather conditions or the season do not allow to observe the colonies in nature, we end the path with the compilation of a small notebook in the laboratory space, which serves to fix the ideas on what has been observed and discussed.

Possible Questions

The ants I observed are called TAPINOMA / MESSOR

Their colour is:...

They move in a manner...

Workers are of different sizes (Yes/No)

As food they accepted:

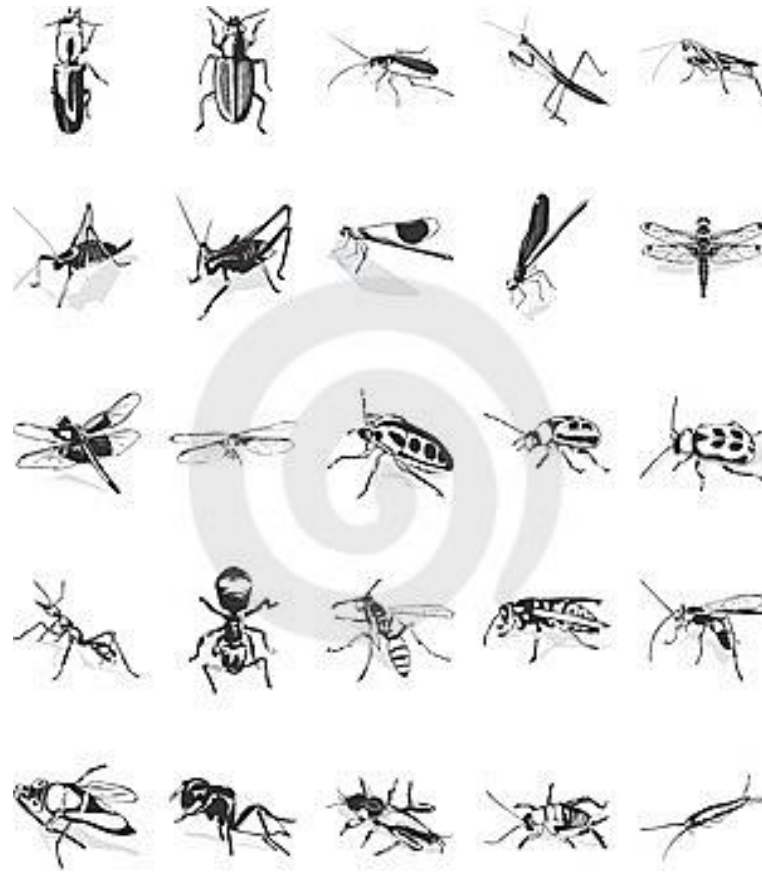
Sugar (Yes/No)

Seeds (Yes/No)

Chicken (Yes/No)

What else have you noticed about these ants?

In our visit today we saw how ants are made. What are ants in the image below? Try to remember them by drawing a circle around the insects seen



Now try to answer these short questions:

- | | | | |
|--|--------------------------|--------------------------|--------------------------|
| | 3 | 4 | 5 |
| 1) What are the parts that make up the body of an ant? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2) What does it mean when we say that an ant does metamorphosis? | | | |
| <input type="checkbox"/> That the ant divides into two halves | | | |
| <input type="checkbox"/> That the ant dies | | | |
| <input type="checkbox"/> That the ant changes shape and way of life | | | |
| 3) What are social insects? | | | |
| <input type="checkbox"/> They are very nice insects | | | |
| <input type="checkbox"/> They are insects that live in organized societies | | | |

They are parasitic insects

4) Chi "commands" in an anthill?

The Queen

Males

The workers

5) What do Messor ants eat?

The leaves

Seeds

Bread

6) What are "castes"?

The different types of ants

The nests of ants

Waste left by ants

7) How many different types of ants have you seen in the anthill of Città della Scienza?

2

5

10

5 Creation

We build connections between schools and science museums by integrating informal and digital educational experiences into science teaching and learning.

Scope

The positive impact and contribution of informal learning settings to formal education are well documented in educational research and practice. Student visits to science museums have long been part of the educational curriculum of all schools across Europe.

How can school communities access the services and educational resources provided by science museums? Are there effective methods and technological tools that can facilitate profitable interactions between visitors and exhibitions?

Vision

The course provides a model of interaction between schools and informal scientific learning contexts by incorporating digital technologies into daily school activities.

The pathway provides opportunities for schools and museums to work together through small-scale experimental projects that apply agile and user-friendly digital technologies to a selected area of activity, exploring the social communities of ants.

In doing so, the track will demonstrate the development of solutions that enhance the digital presence of science museums in student learning through field visits and AR applications.

Approach

The approach is based on the Open Schooling concept which promotes the collaboration of schools with non-formal and informal education providers and civil society to ensure relevant and meaningful engagement of all society actors with science and increase learning of scientific studies and promote the choice of science-based careers.

The Ant Path approach, methodology and AI tools were tested and evaluated by 50 teachers of schools of all types and levels, including schools in rural and remote areas. Combining the skills of innovative interventions in schools and informal science learning settings, the proposed pathway will support 21st century skills development by engaging students in activities that simulate real science work by building on the strengths of both formal and informal science pedagogy.

Student learning objectives

The activity is meant for primary and middle school pupils visiting the exhibition about ants as social insects with their teachers. The experience is divided into two stages: the first involves a training meeting for teachers so that they are better informed of the experience that their pupils are going to carry out; the second is the actual activity that involves the pupils. During 75-90 minutes, pupils listen to the guide, observe and sometimes even touch the insects, observe models and watch videos. They also need to answer the questions and complete tasks in a special notebook. At the end of the activity, they talk about their experience with insects and what they have learned. Learning about the behaviour of social insects, pupils get introduced to topics from biology, zoology, ethology and ecology. Tasks and questions in the notebook are specially designed for the age range of the participants with some reference to the curriculum in natural science in school. This way the activity connects learning in formal and informal settings.

6 Communication and discussion

The choice of this activity of natural sciences, biology and sociology on ants and their articulated social organization as an example in nature of interdependence between living beings (anthills), was suggested by the fact that in the Science Center of Città della Scienza there is an exhibition dedicated to insects from all over the world and in particular there is an exhibit (the anthill) which develops slowly with the activity of the ants that they build. An exhibit with which a large number of visitors interact, especially groups of students from schools of all levels. Ants are particularly representative of that heterogeneous group defined as "social insects" and are characterized by the peculiarity of articulated individual behaviors such as to allow their own colony to achieve extremely sophisticated "social" objectives. Through this experience, it was therefore intended to convey to the students the importance of interdependence as a fundamental social value also in human communities.

With this intervention, the intention was to propose to the classes involved a topic that touched across various curricular disciplines, in particular the natural sciences and history, but which was characterized by clear references to ethical, social and, more generally, cultural issues. In particular, the interventions related the ethology of slave ants to the history of slavery in human societies, and that of raiding ants to the barbarian invasions, respectively.

This model of activity can be applied to different topics of other scientific disciplines.