Web-based materials for Parents

Dear parents,

The materials provided here aim to inform you about the project Ark of Inquiry: Inquiry Activities for Youth over Europe. This project aims to give you the opportunity to follow your child on the exciting journey of exploring scientific questions, draw evidence-based conclusions and to get an insight on real scientific challenges. In the platform of Ark of Inquiry you can find stimulating ideas and supporting materials that will help you in fostering your child's scientific way of thinking.

In the context of Ark of Inquiry project, your role is considered essential in facilitating your child's engagement in inquiry activities. To enhance your role and contribution towards this direction, we developed several web-based materials that will help you familiarize yourself with

- background information about the outline of the Ark of Inquiry project,
- what is scientific inquiry through an example of an inquiry activity,
- how to support your children at home.

Ark of Inquiry

Background information about the outline of the Ark of Inquiry project

The Ark of Inquiry project aims to raise youth's awareness, by bringing together different aspects of the relationship between sciences and innovations, such as ethics, gender equality, or science education. Young European citizens between the age of 7 and 18 will be provided with a variety of engaging inquiry activities to improve their inquiry skills. The project enables students to keep track of their inquiry skills development and to improve them independently from teachers and parents. This is achieved by providing appealing inquiry activities via the Ark of Inquiry web-based platform for pupils to work on, and for parents to find help for supporting their children at home. You simply need to register with the platform to gain access to the materials provided.

Once this is done, students will be able to conduct inquiry activities at their leisure. In doing so, first their current inquiry skills will be assessed automatically and recorded. Based on this, working on further activities will increase their inquiry skills while their progress will be recorded as well.

In the course of the project, the students with the highest achievements will be rewarded with Inquiry Awards. The relative scale is similar to international Olympiads where there is a fixed ratio of gold, silver and bronze medals. So there is another motivation for the students to develop inquiry skills.

Explaining what is scientific inquiry through an example of an inquiry activity

The experience from domestic activities can foster the development of better understanding of chemistry, biology, physics, math and other important subjects we aim to promote at school.

So how you can help your child to approach, for example, the baking of a cake from the perspective of inquiry?

STEP 1 - Forming scientific questions and hypotheses

Firstly, you can work together with your child to respond to the following question: "What kind of cake would you like to bake?"

If you already identified the type of the cake you would like to bake, you can proceed in responding to the next question: "What kind of ingredients will you need?" Make a list of needed ingredients together with your child. Next, it is time to form a **scientific question**. For example: "What is the importance of every single ingredient that is used for baking the cake? Will there be any difference if I left behind the addition of a specific ingredient?"

You also can discuss and write down your possible scenarios to the paper, to compare the results later.

What is the difference between posing a question or telling how to do?

Most parents feel the need to answer their children's questions as precisely as they can, as naturally they have the urge to help and support their children and make life easier for them. However, this might lead the children to depend on their parents for help and to provide them with easy ready-made answers whenever they encounter a problem. Moreover, it will prevent the children from developing their own problem-solving skills, as it will lead to an accumulation of factual knowledge that might be meaningless for the children. It is important to raise students' interest in answering their own questions. The best questions are those that relate to children's interests that they themselves would like to extend their learning on a specific subject. Also, a "good" question is considered the one that can be answered through research in natural sciences.

STEP 2 – Planning and realization of an investigation

Now it is time to think about, how it is possible to find out, and what is the impact of of the different ingredients that are used for baking the cake. Give your child the opportunity to propose the steps that should be followed for answering the research question, and help him/her understand what should be varied and what should be constant while baking several cakes to compare the impact of a specific ingredient to the baking of the cake. For instance, if you want to test whether the *baking powder* affects the baking of a cake, then it is important to help your child understand that for answering this question you need to bake two cakes that will differ only in the addition of the baking powder (e.g., one should contain baking powder and one without baking powder), while all the rest of ingredients and external variables (e.g. heating temperature, size and type of the baking pan, time of baking, etc) should remain the same for both cakes. At the end of the experiment, it is important to help your child decide if the addition of the baking powder influenced the baking of the cake and provide evidence to support his/her conclusion.

Why it is important to search the evidence?

Encourage your children to reason with evidence that derives from the experiment being performed rather than posing mere guesses and unsupported assumptions. The concept of evidence has a central role in scientific research. Basically, if there is no evidence for something, it does not exist or is not true, respectively. But what is scientific evidence? Evidence helps to reinforce your question, or more scientifically, your hypothesis. With enough evidence the answer you are formulating becomes trustworthy and robust. It is also important to collect evidence from a variety of sources. In our example it is not enough to bake one cake. If we need to know what is the role of baking powder, we should bake also the cake without baking powder.

STEP 3 - Analysis and reflection of the data

Now the cakes are ready and we can see the results. What we can tell about the cakes? What we could test?

a) *How does it look like?*
b) *How does it taste?*
c) *Something else….*

What kind of conclusions can we make? What is the actual role of the baking powder?

How can you do this with your child? It is a very crucial aspect of scientific thinking. You have to start with the initial question and see, if your data can be used in answering your questions or not. Maybe you have to change form of representing the data, from a table to a graph for example, to make the "outcome" more visible for your child. When thinking of the experiment, the following questions will help you to structure this step. For the planning and executing try to find answers to the following questions:

- …concerning the correct strategies of experimentation
- …concerning strategies of variable control
- …concerning strategies of data analysis

The next sub-step is to think about the complete process, and to the examine elements that are transferable to other situations. It is a difficult step, and a lot of pupils, and of course most of the children, stop thinking about the problem once they solved it. They become not explicitly aware about the mechanism and the meaning of problem solving process. What were the factors that lead to success? Why did I fail? As a result, they have to start from the beginning when they try to solve a similar problem in a context, only a little bit different from the first one. But you can help your child to get one step further! Try to discuss with him/her for example the following aspects explicitly …

- …about application or transfer of the tasks
- …about possible sources of experimental errors
- …about enhancement of experimental setting

How to support your children at home?

The Ark of Inquiry project focuses on engaging the students in inquiry activities during designed instruction by their teacher. The teacher will get a special training for this instruction. Once they have developed their inquiry competence the students will be able to work independently with the activities that will be provided through the platform. You, as parents have the important role of guiding and motivating your children in conducting their inquiry activities.

Most parents feel the need to answer their children's questions as precisely as they can, as naturally they have the urge to help and support their children and make life easier for them. However, this might lead the children to depend on their parents for help and to provide them with easily accessible answers whenever they encounter a problem. Moreover, it will prevent the children from developing their own problem-solving skills and lead to an accumulation of factual knowledge at best.

Raising students' science awareness is the aim of this project. You as parents can help and guide your children in conducting their inquiry activities so that your children can improve their science awareness. A situation in which inquiry learning can be realised is characterized by five essential features (NRC 2000, p. 24):

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
3. Learners formulate explanations from evidence to address scientifically oriented questions.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations.

A variety of pedagogical frameworks are used to "transfer" these features into teaching strategies for science classrooms, and a lot of research is carried out to evaluate the effectiveness of different instructional models. Most approaches have in common, that learning by inquiry is a cycle. Once the student has found an answer, a new question arose upon the result. The easiest way for you to support your child at home is to take the following three steps into account. They summarise the key features and make inquiry learning easy to adapt at home.

Posing questions

Posing questions is an important starting point in the inquiry cycle. This is a worthy and crucial activity for students to engage with. What are the characteristics of the questions that we would like to answer in the context of inquiry?

The first important characteristic of a question is the topic of the question. It is important that students are genuinely interested in answering questions. If they do not care about the questions they will not be interested in doing the work to answer them. The best questions are about things children actually want and need to know about. For example:

- What are bubbles in mineral water make of?
- What factors influencing the growth of a plant?
- Why does lemon juice prevent the brown coloring of fresh peeled apples?

Another important element that makes a question worth of dealing with is whether the question can be answered through research and not by merely guessing its response. It is important to keep in mind that some questions are unanswerable; for instance, the question about the number of sand grains in the world is not a question that neither can be answered or merits of research interest. The format and nature of the questions should enable your children to follow a feasible path for answering them.

The third point that you have to consider is the clarity of the formulated question. Not only for you but also for your children. If it is confusing, check whether your question refers to more than just one theme (e.g., the question “Does soil, sun, and water affect plant growth?” entails three variables that cannot be tested at the same time). If a question entails two themes at the same time, break it into two questions that each can be tested individually.

Consider the following as an example of a good formulated question: *What is the effect of the amount of baking powder on a cake?* As parents you often bake cakes, quite often children participate during this task. So it can be an interesting question for you, too. The question can be answered through research, because you have everything for conducting a research in your own house and with different amounts of baking powder you can answer this question. Also the question is clear and includes only one variable, i.e., the amount of baking poweder.

After posing a question in a more every day style, try to develop this question into a scientific one. Identify the dependent and independent variables, and make a prediction of the effect. Which factor is influencing the result? A statement like this is called *hypothesis*. For the above example, with the effect of baking powder the hypothesis could be: The baking powder makes the cake to “rise”. This hypothesis be tested following the scientific method. You can plan an experiment that entails baking two cakes that differ only in the

addition of baking powder (e.g., only one of the cakes contains baking powder), while the rest of the ingredients must be the same, and of course the baking conditions (temperature, time, …) must be for both cakes exactly the same.

Searching for evidence

The concept of evidence is considered as one of the central aspects of scientific inquiry. Basically, if there is no evidence for something, it does not exist or it is not true, respectively. But what is scientific evidence? All types of observations and measurements that can be collected from a phenomenon under study are considered as evidence. Evidence helps to reinforce your hypothesis. With enough evidence you can answer your question. So it is important to collect evidence from a variety of sources. In our example, it is not enough to bake one cake with a certain amount of baking powder. Only after using different amounts of baking powder in several cakes you can collect enough evidence to prove your hypothesis and answer your question.

Encourage your children to reason with evidence that can be proven rather than accepting guesses and assumptions. If your arguments are falsified, think about your hypothesis and look for evidences that will help in confirming or rejecting your hypothesis.

Finding relevant equipment for experimentation

Another type of support for your children is to create a *scientific environment* at home. It is possible to explore some of the principles of science in your kitchen. In the Ark of Inquiry project a platform is developed which offers carefully selected inquiry activities easily be done at home with everyday materials. Also there are a lot of sites in the Internet with experiments you can do with your children at home, e.g.:

- http://tinkering.exploratorium.edu/projects
- http://www.science-sparks.com/2013/04/27/kitchen-science-round-up/
- http://foodscience.psu.edu/youth/youth
- http://www.sciencekids.co.nz

If you are interested in learning a little bit more about the competencies of scientific thinking at different age stages of your child, please visit the following link: http://www.kidspot.com.au/schoolzone/Science-experiments-Science-experiments-for-kids+4372+314+article.htm