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Enterprising Science and Technology at Primary School

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Abstract

This paper focuses on adventurous possibilities of introducing science and technology to the primary school classroom. Young learners are usually highly motivated for conducting experiments and often ask unexpected questions. Pupils are naturally creative and inquisitive, which makes them perfect scientists. There is never a lack of questions and ideas coming from their eager minds. It is our responsibility as teachers to facilitate creative thinking and encourage children's natural scientific curiosity.

Abenteuer Naturwissenschaften und Technik in der Volksschule

Zusammenfassung

Dieser Artikel beschäftigt sich mit erlebnisreichen Möglichkeiten, Naturwissenschaften und Technik in der Volksschule einzuführen. Lernende dieses Alters sind üblicherweise hochmotiviert, Experimente durchzuführen und stellen oft unerwartete Fragen. Kinder sind von Haus aus erfinderisch und neugierig, was sie zu idealen Wissenschaftlern macht. Ihre wissbegierigen Köpfe sind stets voller Fragen und Ideen. Es liegt in unserer Verantwortung als Lehrpersonen, kreatives Denken zu fördern und die natürliche Neugierde für Naturwissenschaften und Technik anzuregen.

Keywords:	*Schlüsselwörter:*
Science and technology	Naturwissenschaften und Technik
Primary school	Volksschule
Experiments	Experimente

1 Introduction

Introducing young learners to science and technology provides many advantages and numerous possibilities of facilitating the development of thinking skills. According to the Austrian national curriculum for primary schools (*Lehrplan der Volksschule,* 2012), pupils have to acquire a basic knowledge of physics, chemistry, biology, history, geography as well as intercultural awareness and personal skills within a subject called „Sachunterricht" that comprises all the mentioned aspects. (*Lehrplan der Volksschule,* 2012, p. 84) Preparing and conducting scientific experiments, explaining phenomena and reflecting experiences does not only convey matter of fact knowledge in science and technology but also promotes competences that are needed for communication about and understanding of subject matter in a motivating and fun manner. Moreover, it generally facilitates the development of cognitive skills and, therefore, supports the learning effect in other subjects as well.

The following chapters give an overview of introducing science and technology to the primary school classroom and offer examples of how to provide fun and motivating learning sequences in this context.

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2 Science and technology at primary school

Experiments facilitate the application of subject-specific methods such as observing, classifying and documenting, and foster activity oriented, exploratory learning. Conducting experiments usually requires team-work or group-work. Consequently, pupils have to develop a sense of responsibility as well as the willingness to learn and cooperate. Another goal is the development of environmentally responsible behaviour. Children are encouraged to use resources responsibly, save water and energy and learn to contribute to environmental protection.

2.1 Educational tasks and learning outcomes – the requirements of the curriculum

With regard to science and technology, which are embedded in the subject of „Sachunterricht", the Austrian curriculum for primary schools stipulates learner-oriented teaching in an expert and matter-of-fact manner that is appropriate for children. Pupils are supposed to consider their living environment critically and should adopt a conscious, self-reliant, responsible attitude. Learning processes and experiences have to be organised in a way that fosters the development of basic knowledge, competences and insights. In this connection, the preparation, conduction and reflection of experiments seems convenient. Experiments request the application of subject-specific methods and facilitate activity oriented, exploratory learning. They support the development of responsibility in students as well as the willingness to learn and cooperate. Furthermore, conducting experiments offers a chance for practising and reflecting environmentally responsible behaviour. Pupils incrementally learn to gather information, interpret and analyse material and to adopt a critical attitude towards provided data. By preparing for assignments and solving problems, they acquire the ability to work independently and goal-oriented and practice reflecting their work. (*Lehrplan der Volksschule,* 2012, p. 84)

2.2 Science and technology in connection with "craft, design and technology"

In studying science and technology at primary school, a child's field of experience, i.e. its immediate environment, is always the starting point for further investigations. The aim is to provide a deeper understanding for humans' position and role in nature and their dependency on nature and its fundamental laws. Children are supposed to take responsibility for interventions and changes in the environment and learn about possible implications of their actions. Teaching science and technology in connection with a subject called „Werken", which may be equivalent to "craft, design and technology" aims to convey information on technical conditions in children's surroundings, equip learners with an insight into forces and their effects as well as on substances and their transformation. Science-experiments at primary school target on practising appropriate, responsible and thrifty handling of substances and gadgets. (*Lehrplan der Volksschule,* 2012, p. 86)

2.3 Educational principles for teaching science and technology

Children usually have a natural curiosity for science and technology. Personal, real-world experiences provide activity-oriented and discovery-based learning. The acquisition of information in an exploratory and experimental way in connection with cross-disciplinary learning plays a central role in this approach. It aims to teach profound, matter-of-fact knowledge primarily through observations, investigations and reflexions in the context of scientific and technological experiments. Conducting these experiments involves the practice of subject-specific methods and promotes pupils' willingness to learn, to assume responsibility and to work cooperatively. (*Lehrplan der Volksschule,* 2012, p. 104)

3 Learning objectives

The learning objectives of teaching science and technology may be categorised into four main groups, which are technical conditions and realities within a child's immediate surrounding, various forces and their effects, substances and their transformation, and specific working techniques.

3.1 Technical conditions and realities

The first aspect within the category of technical conditions and realities focuses on the acquisition of skills and knowledge on technical factors. Children are supposed to talk about the use of tools and should get familiar with their correct application. The second item comprises the dealings with objects and investigations on them. Learners should become acquainted with specific ways of working such as observing, measuring and conducting experiments using basic tools and gadgets. In this context, pupils are supposed to experience the importance of responsible and careful handling of technical devices. They have to be aware of possible dangers in order to avoid accidents. In connection with the school subject "craft, design and technology", students should study and try out simple machines. (*Lehrplan der Volksschule,* 2012, pp. 90, 99f)

One simple, practical example for dealing with objects and conducting investigations is the "object hunt". Pupils are required to choose a different object for each challenge and find something made from plastic, something made from more than one material, something that would survive fire, etc. There are endless possibilities and one can chose different tasks for different age groups and with reference to the aim of the specific lesson. This experiment as well as the following one may be found among other inspiring ones on the website of the science museum in London at http://www.sciencemuseum.org.uk/educators/classroom-resources.

Building structures using spaghettis and marshmallows is an uncomplicated and fun example for acquiring knowledge on technical factors. It also requires practical testing, problem-solving and teamwork to help build a tall, strong tower.

3.2 Force and effect

Within the category of forces and their effects, learners are supposed to gain insight into possible impacts of elemental forces such as magnetism, wind energy and hydropower. With the aid of appropriate teaching material, students are expected to observe the operating principles of these forces and conduct basic experiments. Pupils have to study the effects of heat, the physical expansion of substances and should be familiar with various weather conditions and their possible threats. The operating principles of various forces have to be observed, measured, compared and documented. Furthermore, experiments on buoyancy, floating and sinking as well as on grip and slip should be conducted. (*Lehrplan der Volksschule,* 2012, pp. 91, 100)

One example for an experiment with forces and their effects is creating a "pinball power machine". It can easily be constructed by pupils using a shallow box, wooden sticks from ice lollies, a marble, scissors and sticky tape. Again, this experiment may be found at http://www.sciencemuseum.org.uk/educators/classroom-resources.

3.3 Substances and transformation

Children are supposed to name objects that are present in their environment and talk about them. They determine certain objects' characteristics such as fluid, rough, firm, etc. and consider the suitability of their utilisation. States of matter (solid, liquid, gaseous) have to be named and learners should be familiar with the conditions for changing the physical state of substance (e.g. temperature). Pupils distinguish soluble and insoluble substances and recognise air as significant for biological processes such as respiration, incineration and combustion. Pollutive substances, for example exhaust fumes, synthetics and detergents, are known as well as their proper disposal and possibilities for recycling. (*Lehrplan der Volksschule,* 2012, pp. 91, 101f)

A safe and fun example for an experiment with a water-insoluble substance are "fireworks in a glass": A few drops of oil are mixed with food colouring and are poured into a glass of warm water. As the food colouring is water based, it will sink to the bottom leaving traces of colour that look like fireworks while the oil will float on top of the water. This and other examples for experiments may be found at http://www.twinkl.co.uk.

3.4 Specific working techniques

Regarding the preparation, conduction and reflection of experiments, attention is devoted to specific working techniques and methods that have to be applied. The first and most basic proficiency of importance is observation. Pupils are supposed to study the functioning of magnets, pay attention to the weather and examine the various states of water depending on the particular temperature. With respect to the second technique,

classification, learners are supposed to categorise objects and substances according to similarity or difference in certain characteristics such as magnetic and non-magnetic, float and sink, or according to specific changes such as growing bigger, lighter or harder that occur under particular circumstances. Common experiments include filtering, mixing and separating of substances, as well as evaporating, freezing and melting of liquids. Quantification of figures and measurements involves the detection of length, mass, temperature and time. Finally, observations and experiments need to be documented. Procedures may be described and charted, results can be logged and figures may be recorded in tables. In connection with "craft, design and technology", pupils are supposed to acquire basic skills in using tools properly and responsibly. (*Lehrplan der Volksschule,* 2012, pp. 91, 100)

Last but not least, pupils are supposed to draw conclusions of their observations and findings. They are expected to deduce guiding principles for economic and responsible handling of resources and study, communicate, and practice safe ways of using technical devices. (Umgeher, 2004, pp. 337f)

A great possibility to train specific working techniques is introducing "talking points" cards that can be designed according to the specific topic or interest that is supposed to be covered. They can be made up of pictures and questions to stimulate thinking and discussing. Once more, this example may be found at http://www.sciencemuseum.org.uk/educators/classroom-resources.

4 Conclusion

In order to foster the development of higher-order thinking skills, educators have to make sure to give pupils the opportunity to be curious, discuss, ask questions and explore their questions. Teachers have to find ways of eliciting pupils existing ideas, use them as starting points for science activities and allow them their own ways of working.

In closing, it might be well to remember that strengthening the competences in the field of science and technology may also enhance the learning effect in other fields. By going through activities such as observing, conducting experiments, doing research and documentations of processes, having conversations, asking questions, giving explanations and drawing conclusions, pupils practice all kinds of skills that are necessary for all sorts of domains. This way, enterprising science and technology really prepares learners for life.

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