

Playing with science in the kindergarten

C. P. Barbosa, M. C. Martins Gonçalves¹, A. A. Almeida², J. B. Oliveira³, J. Miranda⁴, J. Soares⁴, P. Martins⁴, D. R. Fernandes, R. Fontes⁵, M. A. Sá³, A. Guerra, A. T. Esteves, R. Almeida⁵, C. Leite⁶, and M. J. Martins^{*5}

¹"Laboratório Nobre", Faculty of Medicine, University of Porto, 4200-319 Porto, Portugal;

²REQUIMTE, Chemistry and Physics Department, Faculty of Pharmacy, University of Porto, 4050-047 Porto, Portugal;

³Faculty of Sciences and IFIMUP-IN, University of Porto, 4169-007 Porto, Portugal;

⁴UPmedia, University of Porto, 4050-453 Porto, Portugal;

⁵Biochemistry Department (U38-FCT), Faculty of Medicine, University of Porto, 4200-319 Porto, Portugal;

⁶Educational Sciences Department, Faculty of Psychology and Educational Sciences, University of Porto, 4200-392 Porto, Portugal.

A DVD was created for kindergarten educators, describing a set of activities/experiments based on basic principles and techniques of Chemistry and Physics and organized in 7 main chapters: 1. Colour, translucency, opacity and transparency; 2. Gravity, weight, mass, volume, density, area, space and shape of bodies; 3. Solubility, miscibility, density and buoyancy; 4. Magnets and magnetism; 5. Static electricity; 6. Air, atmospheric pressure, gas and sound; 7. Solid state, liquid state and gaseous state, hot and cold, to heat and to cool.

Keywords simple science experiments; DVD; kindergarten

1. Introduction

In recent years, following the desire to make positive changes in the training of children and young people, the politics of education in Portugal have stated the importance of the input in Science and experimental method. Science could and should be used in kindergarten, but in a simple and pleasant way, to expand the knowledge and understanding that children have of the biological and physical world, and to help them develop more effective and systematic means of discovery. Early contact with Science has been emphasized by the fact that it helps to develop intellectual, social and moral children.

A DVD was created for kindergarten educators (as a "*Science in the kindergarten*" workshop support tool) describing activities/experiments based on basic principles and techniques of Chemistry and Physics. The DVD is organized in 7 main chapters, and experiments can be carried out almost entirely with "*equipments/materials and reagents*" easily found either in kindergarten or at home. Two minor chapters were also included in the DVD providing all the educational and scientific aims as well as bibliographic references.

2. Educational and scientific features of the project

The environment and daily leisure time in kindergarten provide powerful and distinct opportunities to explore, taking advantage of the children's interest in the world around them. So, the combination of science and fun was organized into sets of simple activities/experiments designed to promote an active and meaningful construction of knowledge, where the steps of the scientific process/method can and should be applied in their resolution.

Activities/experiments will promote verbalisation of ideas/hypothesis/problems/doubts, encourage partnerships and working together for their accomplishment, facilitating children decentralization, acceptance and/or discussion of others' opinions as well as the sharing of "*equipments/materials and reagents*".

2.1 Orientations for (aims of, guidance for) kindergarten educators when performing the activities/experiments

Lead the child to ask questions, raise problems, formulate hypothesis and look for the solutions (the basis of scientific method development). Awaken the child's awareness for daily circumstances, for which she does not have answers/explanations in order to direct the search for explanations and to the formulation of hypothesis. Help the child verifying (new/recently formulated) hypothesis, resorting to observation and to experimentation. Compare the child's perspectives with the vision given by the educator. Increase the child's knowledge by performing new investigations. Help the child to build more rigorous concepts based on the initial knowledge.

* Corresponding author: e-mail: mmartins@med.up.pt, Phone: +351 225513624

2.2 Simple and direct consequences for children when carrying out the activities/experiments

Development of visual-motor coordination. Improvement of the ability to perform activities. Improvement of manual skills and fine motricity. Development of physical knowledge about material objects (to know how to nominate and adequately use tools and equipments of different kinds, exploring different possibilities as an introduction to Science). Development of the cause-effect connection/notion. Perception of constancy and preservation of objects' properties and connections/relationships. Initiation to the concept of size and measurement activities. Achievement of the observation of the experiment, experimental practice and register of occurrences [using tables and other supports (labels, free drawings and wording of texts) as a form of registration/recording]. Contribution to the organization and systematisation of recently acquired knowledge.

3. DVD main structure and organization: description and justification

The DVD is organized in 7 main chapters: 1. Colour, translucency, opacity and transparency; 2. Gravity, weight, mass, volume, density, area, space and shape of bodies; 3. Solubility, miscibility, density and buoyancy; 4. Magnets and magnetism; 5. Static electricity; 6. Air, atmospheric pressure, gas and sound; 7. Solid state, liquid state and gaseous state, hot and cold, to heat and to cool. Where appropriate, relationships/links among the subjects/activities/experiments of each chapter were pointed out.

The activities/experiments (originals or collected from the literature) proposed in each chapter of the DVD can be carried out almost entirely with "*equipments/materials and reagents*" easily found either in kindergarten or at home. Therefore, children can, easily, become teachers of their close family regarding what they have done/learnt in the kindergarten. This "*reproduction*" made by children, at home, will strengthen the recent acquired knowledge and exercise or identify doubts about what they have done in the kindergarten.

Each chapter of the DVD presents, at the beginning, the appropriate scientific "*words/names/vocabulary*" that educators should introduce into their language when performing the activities/experiments with children, which will substantially increase children's vocabulary, at the most appropriate age. Very early in their development children will start using vocabulary that is familiar in higher levels of education, at which time they will pay more attention since they already heard and were introduced to.

Most of the scientific experiments presented, in each chapter of the DVD, were based on simple every day situation. Children will be introduced to scientific process, to Science, through the urge to obtain answers, to solve/interpret a daily problem/situation. Hopefully, the joy of discovery will motivate children to be interested in Science. Fun manual work and "*magical experiments*" were also included, sequentially, in each chapter. Children's motivation to participate and communicate is increased when something exciting happens.

Photographs and short videos (all originals) of some of the experiments were included in each chapter of the DVD (with a random distribution among each of the three activity levels of each chapter). Also children's free drawings of some of the activities/experiments were included in some of the chapters. Videos were filmed both in "*laboratorial*" and "*kindergarten*" environments. However those recorded with children were not included in the DVD, for children's safety and anonymity, but just shown in the workshop for kindergarten educators.

Each chapter of the DVD presents, at the end, a list of both educational and scientific specific aims, according to the chapter physical and/or chemical subject, followed by examples (in the form of questions) of every day situation that introduce some of the experiments and concepts.

Simple explanations of the chemical and physical concepts of the experiments were provided in each chapter, so that educators can fully understand the experiments and, at the same time, acquire the necessary scientific background to modify/adapt/change them in the future. Additionally, educators will learn the correct scientific "*words/names/vocabulary*" to each step of the activities/experiments described and extrapolate to new every day situation to which they could come across.

4. Two examples

4.1. Regarding colour

Some of the questions suggested to start activities/experiments of chapter 1 (Colour, translucency, opacity and transparency) are: "What around us does posses colour?" and "How can we create colours?".

Food and animals (for example drinks and birds, respectively) can be very colourful. Consumption of soft drinks (Figure 1), in a glass, during a sunny afternoon (Figure 2), while constructing birds made of paper (Figure 3) can be associated with colour activities/experiments.



Fig. 1 Emergence of a green colour by mixing a yellow soft drink with a blue one.

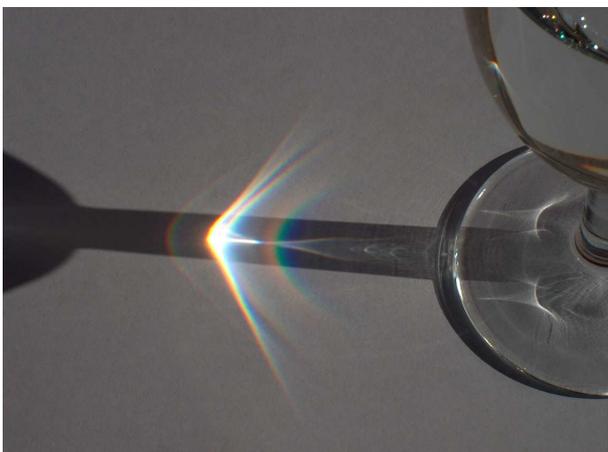


Fig. 2 Sun light decomposition, using a glass filled with water. The rainbow is obtained by sun light refraction and dispersion, by propagation through glass and water.



Fig. 3 Composition or decomposition of colours using a bird made of paper, constructed according to an origami scheme (A), by adding small drops of a liquid (water in this case; but ethanol or vinegar could be used) into the drawings in the bird wings (B and C). Decomposition/separation of colours is achieved by performing paper chromatography.

4.2. Regarding magnetism

One of the questions suggested to start activities/experiments of chapter 4 (Magnets and magnetism) is: “How do small travel souvenirs hold to the refrigerator door?”.

Objects that stick to the refrigerator door can be used (or laboratorial magnets instead) in the classroom to identify some materials that are attracted by magnets (Figure 4). Magnets can also be used to create colours (Figure 5).

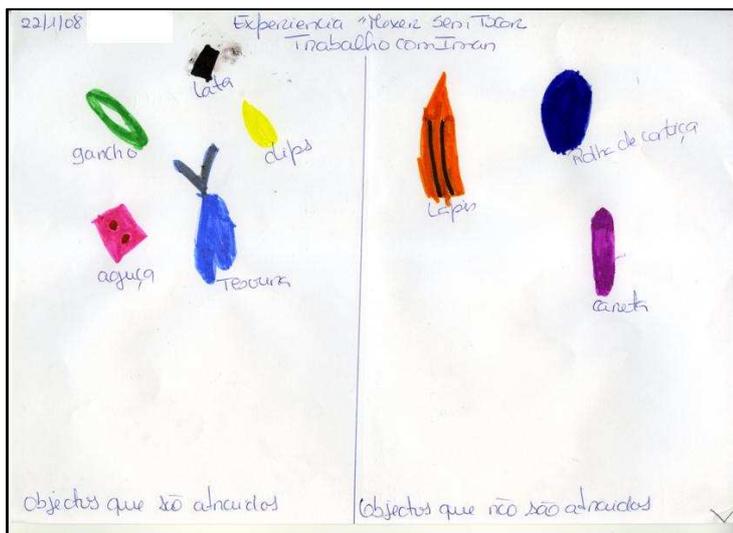


Fig. 4 Free drawing, made by a child (5 years old), identifying what is (on the left) and what is not (on the right) attracted by a laboratorial magnet (hair-pin, tin, clip, pencil-sharpener and scissor on the left; pencil, cork and pen on the right).



Fig. 5 Two laboratorial magnets are used to mixture food colourings: the movement of a magnet over a sheet of white paper (directed by the movement of a second magnet under the metal tray) composed colours by mixing some drops (over the paper) of yellow, red and blue food colourings.

5. Conclusions

In short, the proposed activities/experiments will enable the development and stimulation of: a) scientific curiosity, b) scientific and experimental attitudes, c) organizational skills, d) decentralization and sharing, e) attention, concentration and memory, f) vocabulary, g) logical thinking [as a consequence of generation of cognitive conflict (search for answers)], h) sensing and perception as well as encourage the creation of artistic productions.

Educators are provided with the necessary scientific background to rigorously introduce basic chemical and physical concepts and vocabulary to children in the kindergarten, as simple and funny activities/experiments.

Acknowledgements The support by João Manuel Borregana Lopes dos Santos, President of Physics Department, Faculty of Sciences, University of Porto, Portugal (allowing the use of Sala Eureka) is gratefully acknowledged. The financial support by Ciência Viva (project number 2006 – 258), POCI and FEDER is also gratefully acknowledged.



References

- C. Leite and M.L. Rodrigues. Jogos e contos numa educação para a cidadania. (IIE, Lisboa, 2001).
- C. Kamii and R. Devries. A teoria de Piaget e a educação pré-escolar. (Socicultur, Lisboa, 1978).
- D. Chauvel and V. Michel. A par e passo ... Brincar com as ciências no jardim-de-infância. Como explicar fenómenos complexos de forma simples. (Porto Editora, Porto, 2006).
- I. Siraj-Blatchford. Manual de desenvolvimento curricular para a educação de infância. (Texto Editores, Lisboa, 2004).
- Portuguese legislation: Lei nº 46/86 (Lei de Bases do Sistema Educativo Português) e a sua reformulação pela Lei nº 49/2005.

The full list of references is provided in the DVD. Here the authors provide only the pedagogic ones.