

La main à la pâte*: a French endeavour to renovate science education in primary schools

E. Di Folco¹ and P. Léna²

¹Observatoire de Paris, France

²Académie des Sciences, France

Abstract:

Since almost 10 years, the French operation *La main à la pâte* has developed a broad network of teachers, trainers and scientists not only in France but through world-wide collaborations to reconcile children and teachers with science. Inquiry-based science teaching has proven to be highly efficient in revitalizing science education in primary schools. Focussing on interdisciplinary activities -including physics and astronomy, several exciting projects have been developed, which involve hundreds of schools at international scale and propose simple scientific activities for young pupils. Two ongoing projects, *Europe of discoveries* and *In the footsteps of Eratosthenes* will be presented as well as the renewed teaching method based on the process of investigation and the fundamental questioning attitude.

1 Introduction

Launched in 1996, the French *La main à la pâte* operation has undertaken to renovate and revitalize the teaching of science in primary schools. Supported by the Académie des sciences, and in close collaboration with the Ministry of Education, it has developed a new approach of science education, that has been recently integrated in national French curricula. In 2004, it was shown that more than 35 % of children really practice science in their classroom, whereas there were only 3 % when the operation was started, thus demonstrating the efficiency of the effort undertaken.

2 Inquiry-based science teaching

The program is based on 10 principles, which focus on developing the questioning attitude of children when they face a concrete experiment. The proposed activities, based on experimentation and observation of facts, encourage teachers to accompany the pupils in building their own knowledge. The minimum time to be dedicated represents about 2h/week during more than 6 months. A progressive and interdisciplinary approach of science is favored in a

*<http://www.lamap.fr> (French site) ; <http://www.mapmonde.org> (international site)

close collaboration between pupils and teachers. Instead of accumulating large amounts of knowledge, teachers are encouraged to make the children appropriate the scientific concepts and experimental techniques through their own process of investigation.

Learning by doing is the leitmotiv of the pedagogical approach, based on the personal investigation, that helps pupils develop cognitive processes as well as the sense of curiosity and creativity. In front of new and unexpected concrete situations, they are invited to reason, argue and question the nature itself, thus building up a new relationship to the sensitive world and to the "truth". Inquiry-based activities allow them to acquire new communication skills, through open debates in the classrooms, and with the teacher. Instead of the classical schemes of memorization and concentration of scientific concepts or formulas, the proposed methodology insists on the appropriation of knowledge through the individual investigation and questioning attitude, leading the children to learn by experimenting in partnership with the teacher.

3 A world-wide initiative

Initially tested in 3,000 classrooms in France, the program has been extended to more than 10,000 classrooms, linked to 14 local pilot centers that mutualize resources, coordinate the activities and eventually propose to support the teachers in their school. In parallel to this national enlargement, there has been a constant and progressive extension of the interest for the renovation of science education world-wide. Similar national initiatives have been developed in China, Columbia or Chile, inspired by the well experienced operations *Hands on physics* in the United States and *La main à la pâte* in France.

Besides, a tens of countries can be considered as direct collaborators of *La main à la pâte*, implying regular exchanges of material and know-how (bilateral translations of locally developed activities, short-time training of teachers or exchange of pedagogical material). Such partnerships are very active in Afghanistan, Argentina, Brazil, Cambodia, Chile, China, Columbia, Egypt, Malaysia, Morocco, Mexico, Senegal, Slovaquia and Romand Switzerland, often initiated through the support of national academies. Mirror websites have also been created in Chinese, Arabic, Spanish and Portuguese. In addition, there are more than 20 partner countries directly involved in built-in activities available through the web site (in various languages) and who participate to international projects led by the French team.

4 Interdisciplinary projects

We will present two of these international scientific projects, that aim at encouraging collaborations between classrooms beyond the national frontiers, taking advantage of their geographical or cultural differences. Astronomy can play a major role in such projects because it is a fascinating field where physics, mathematics, technology, computer science, chemistry and even biology meet together. It offers a unique opportunity to propose interdisciplinary activities in an integrated teaching, that allows pupils to reinforce their knowledge in various fields and practice exciting science at the same time.

The first initiative, called *Europe of discoveries*, aims at introducing scientific discoveries to European pupils, that can lead to developments and experimentations in the classrooms. Volta's battery or Galilee's telescope are excellent examples of possible technological developments inscribed in a well-known national historical context. The project usually starts from an historical observation or question raised by the famous scientist, which led to a major discovery and has to be reproduced, step by step, by the pupils with basic and affordable material.



Figure 1: Summer solstice measurement of the circumference of the Earth by Egyptian pupils in front of the new Great Library of Alexandria.



Figure 2: Intensive debate after experimentations: the questioning attitude as a key-point of the La Main à la pâte approach.

In the case of Galilee's telescope, the starting point can be his observations of mountains on the moon or of sunspots through his instrument. During the activities, the children do not only learn the scientist's discovery or play with lenses and telescopes: they face unexpected situations and problems for which they have to find a solution through experimentations and debates in a team-working spirit. How to align the lenses and maintain them in a tube ? How to stabilize the instrument to allow continuous observations ? Why do the images of the moon or stars move behind the ocular ? Do the sunspots really belong to the sun or are they dirty spots on the lens ? They build hypotheses, that they have to test through new experiments (which are defined with help of their teacher) and thus explore their own path before converging toward a solution. Every step of the reasoning and experimentation is written on the notebook to register the progressive approach of each group and improve the mastering of written and oral language. Once completed, the project is summarized and presented to other classrooms to allow children to appropriate the new scientific concepts, acquire communication skills and share experiences.

The second initiative, started in 2000, is well designed for international collaborations since it aims at sizing the Earth thanks to the very simple and well-known method discovered 22 centuries ago by the ancient Greek Eratosthenes. Since the beginning, the project has gathered hundreds of schools world-wide, which have followed month after month the evolution of the shadow of a stick, planted vertically in the ground. The pupils discovered that, by comparing their measurement of the shadow at solar noon with that of a partner located at a different latitude, it is possible to measure the size of our planet with a remarkable precision without moving away from their school ! The interdisciplinary activities are very appreciated by children who can practice technology, mathematics and physics together with history and geography. They discover and experiment the relationship between shadows and light, observe the daily path of the sun in the sky and the associated evolution of shadows, learn the solar noon, experiment that the Earth is really round. They build their own instrument (a vertical stick) and learn how to install and tune it, they measure angles and compute circumferences. The project can also provide a good opportunity to learn about old civilizations, historical and geographical notions (like the latitude and longitude). Finally, the use of new technologies (to report their measurements) is highly motivating and very helpful for exchanges and comparisons with other partners from other countries, through a dedicated website, that mutualize all the measurements of the year. The website, developed by the La main à la pâte team, provides all the pedagogical material to

help teachers setting up the activities in their school. This includes: a multilingual description of activities guidelines, scientific documentation for teachers, dedicated web tools, e-postcards facilities to contact other partners from other countries, follow-up of the classrooms involved in the project. On the summer solstice, when the historical measurement was performed, an international event is organized, consisting of synchronous measurements at solar noon from various schools including egyptian classrooms from Alexandria and Aswan, near the historical site of Syena. The project, although quite long and strongly constrained by meteorological conditions, has proven to be a motivating adventure, where even pupils experiencing difficulties at school can find a role in a team, express their own point of view and finally change their relationship to the teaching.

5 A partnership with the teachers

In order to assist teachers in setting up the experimental activities, a partnership is proposed in various ways. Two broad networks of pedagogical trainers and engineers and scientists has been created, who can be contacted via the main website. Teachers can ask questions related to scientific concepts, technological problems or teaching methods and share with other partners their own experience and difficulties or pedagogical advices. They are also invited to report their activities and propose locally developed projects. Workshops and short time training are organized, where teachers are placed in the same pedagogical situation as children. Without any scientific background, they have to face new situations, build experiments, argue, make hypotheses, draw conclusions and finally learn the scientific investigation process .

Teachers can find large amounts of resources on the main website (<http://www.lamap.fr>), that offers not only an extensive description of experimental activities but also scientific documentation written by specialists and the complete set of exchanges with scientists and trainers. An international website (<http://www.mapmonde.org>) has been recently developed, that proposes comparable resources in various languages and links towards international projects. Five major projects will be organized in 2005-2006 : Marco Polo on the road of knowledge, Living with the Sun and Hygiene and beauty in the roman world (in addition to the already mentioned In the footsteps of Eratosthenes and Europe of discoveries), that have been based on an interdisciplinary and fully integrated approach. The new methodology, which is encouraged by the La main à la pâte program does not only help to make science more attractive, it has also deeply changed the relationship between teachers and pupils and has successfully renovated the manner of teaching science in thousands of primary schools.

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